

International Conference of Agriculture and Agricultural Technology

Proceedings of the 2nd Annual Conference

**Theme:**

**Climate-Smart Agriculture in the Post Covid Era: A Gateway to Food Society in Africa**

Edited by:

**Prof. Alabi, O.J., Dr. (Mrs) Akande, K.E., Dr. Otu, B.O., Dr. (Mrs) Adeniran, O.A., Dr. Rajan Sharma, Dr. Muhammad, H.U., Mr. Ibrahim A. and Mr Adesina, O.A.**

11th – 13th December, 2022

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**SCHOOL OF AGRICULTURE AND AGRICULTURE TECHNOLOGY**

The School of Agriculture and Agriculture Technology was established in January 1986 with two Departments (Animal Production and Crop Production) and four pioneer academic staff (Dr. Z. Stecki, Dr. S. Plonka, Mr. E. K. Tsado and Mr S. L. Lamai). With subsequent development, four more departments (Soil Science and Land Management, Water Resources, Aquaculture and Fisheries Technology and Agricultural Economics and Farm Management and Agricultural Extension and Rural Development) were created. The Department of Soil Science started as a Unit under the Department of Crop Production in1987 and attained full status as a department in 1988 and name was changed to Department of Soil Science and Land Management. The Department of Fisheries Technology, now known as Department of Water Resources, Aquaculture and Fisheries Technology started in 1987 as a Unit in the department of Animal Production which transformed to the Department of Animal Production and Fisheries Technology in 1989 and was split into department of Animal Production and Department of Fisheries Technology in 1991. The Department was repackaged and renamed Department of Water Resources, Aquaculture and Fisheries Technology in 2006. A new Unit, Agricultural Economics and Extension Technology was created during the 1997/1998 section under the Department of Crop Production. The Unit was separated from the mother Department and upgraded to a full-fledge Department in 2002. Approval has also been given for creation of Department of Agricultural Extension and Rural Development while the mother Department will henceforth bear Department of Agricultural Economics and Farm Management. Proceedings of Food Security in Africa in 1997, the proposed Department of Food Science and Nutrition took off as a Unit in the Department of Animal Production and became a full-fledged Department of Food Science and Technology. Similarly, the Horticulture unit has emerged in the Department of Crop Production, and it now stands as a separate Department of Horticulture. The student intake into the school at inception in 1986 stood at two (one student each for Department of Animal Production and Department of Crop Production), and these graduated in 1989. Since then, the school has witness tremendous progress in terms of staff recruitment and development, infrastructural development and student enrolment. Today, the staff and student population stand at 107 and 1,444 respectively. Dr. Z. Stecki was the first Coordinator for the school (1986 September 1988). Dr. E.A. Salako took over as School Coordinator from October 1988 to 1990 and served later as Acting Dean until he became the only Professor in the School when he was made the Dean. After his tenure, the school reverted to the position of Acting Deanship since no Professor was on ground then. These were Dr. J.A. Oladiran (1995-1998) and Dr. S.L. Lamai (1998-2001). By September 2001, with more Professors on ground portraying the extent of development, the Board of School of Agriculture and Agricultural Technology, in accordance with the University regulations, elected Prof. O.O.A. Fasanya as the Dean of the School for a two-year term. Since then, the Deanship position in the school has been filled by election. Prof. E.A. Salako took over from Prof O.O. A. Fasanya in 2003 and Prof. S.L. Lamai took over from Prof. E.A. Salako in 2005. In January 2008, following the appointment of Prof. S.L. Lami as the dean of postgraduate school, Prof. K.M. Baba assumed Deanship of the School. In February 2012, Prof. M.G.M. Kolo succeeded Prof. K.M. Baba who had completed his second two-year term. Professor Kolo was re-elected another term of two years from February, 2014. While servicing the second term, he was appointed Dean of Postgraduate School which necessitated another election leading to the emergence of Prof. R.J. Kolo the new Dean in March 2015. Following the completion of the second term of Prof. Kolo, elections were conducted and Prof. A. J. Odofin emerged as the Dean as from 9th of April, 2019. Presently, the Dean of the School is Prof. J.N. Nmadu, he is a Professor of Econometric.

**INTERNATIONAL CONFERENCE OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY**

The Committee of the 2nd International Conference of Agriculture and Agricultural Technology (ICAAT 2022) is pleased to announce the conference. This conference is an avenue to disseminate innovative research results and latest development in technologies related to agriculture which are aimed at improving food security and reduce risks faced by farmers due to climate change. The conference will bring together leading researchers and scientists in agriculture and allied fields, and even commoners in the domain of interest from around Africa and the world. This international conference brings together experts, intelligentsia and potential researchers from various fields of agriculture to cross fertilize ideas and ponder on the recent innovations and techniques aimed at focusing on climate change, tradeoffs that exist between productivity, adaptation and mitigation in Africa. Therefore, during the three-day conference, all participants will have plenty of opportunities for exchanging ideas, findings and the latest research results.

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# AGRICULTURAL ECONOMIC, EXTENSION AND RURAL SOCIOLOGY

## ADOPTION INDEX OF MAIZE PRODUCTION TECHNOLOGIES AND CORRELATION MATRIX IN SMALLHOLDER SYSTEMS

\*Onuwa, G.C1., Chizea, C.I2., Onemayin, J.J2., Abalaka, E.A2., Idris, S.R2 and Ebong, A.C2.

1Department of Agricultural Extension and Management, Federal College of Forestry, Jos, Nigeria.

2Research Unit, Northern Guinea Savannah Research Station, Nasarawa

\*Corresponding author:onuwag@gmail.com; (08035606473)

ABSTRACT

*Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demand. This could be attributed to low productivity from maize farms due to non-adoption of improved technologies by farmers. This study analyzed the index of adoption of maize production technologies and the correlations of adoption cost, index and output of smallholder farming systems in Toro, Bauchi State, Nigeria. Multistage sampling technique was adopted in selecting 101 respondents for this study. Primary data collected were analyzed using Adoption index and Multivariate Correlation Techniques. Findings from the study revealed that most (61.4%) of the farmers have low adoption index of ≤ 0.39. In addition, the results revealed that there was a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index). The estimated correlation coefficients for rxz, ryz and rxy were -0.65, 0.52 and 0.58 respectively. Subsidizing cost of production technologies, improving access to agricultural technology, credit, extension contact, labour supply and tenure policy modifications are strongly recommended to ameliorate adoption constraints*.

**Key words:** Adoption, correlation, maize farmers, production technology, yield

INTRODUCTION

Maize (*Zea mays*) is a cereal produced across the world. Maize is one of the most important cereal crop cultivated in the rainforest and derived savannah zones of Nigeria. Maize has now risen to a commercial crop on which many agro-based industries depend on as a source of raw material (Iken and Amusa, 2004). It is a high yielding crop, easy to process digested with cost advantage when compared to other cereals (IITA, 2001). It plays an important role both in terms of food security and nutritional intake accounting for about 43% of calorie intake with a daily consumption quantity of 53.20g per capita (Komolafe *et al*., 2010). It is also used extensively as the main source of calories in animal feed formulation (Idrisa *et al*., 2012). Maize is used as a staple human food, feed for livestock, raw material in agro-industries and industrial products; it is also useful in preparation of medicines (Saka and Lawal, 2009; Ouma *et al*., 2002). It constitutes a staple food in many regions of the world particularly in developing countries (Abebaw and Abelay, 2001). Maize is a staple food of great economic importance in the sub-Saharan Africa of which Nigeria is inclusive. In Nigeria, it is the third most important cereal crop after sorghum and millet; globally it is one of the three most important cereals after wheat and rice, with the widest distribution of any cereal (Matata *et al*., 2010; Bonabana-Wabbi*,* 2002). In some countries, maize is the most important foodstuff and in particular provides the daily bread for indigenous population of rural communities. According to them, the crop is primarily grown for its grain which is consumed as human foods. In some developed countries, maize is also grown for animal feed and as a base for industrial products such as oil, syrup and starch. Maize is the second most important cereal crop in the world in terms of acreage and production. Global production of Maize was about 1040 million MT in the year 2016–2017, wherein USA and China contributed about 38 and 23%, respectively. Maize can be cultivated successfully in loamy sand to heavy clay, well aerated, neutral pH soils. Furthermore, extended low temperature of less than 5°C severely affects the crop; hence, temperature of ranging between 25°C-35°C is ideal for optimum growth and yield. Maize crop can be cultivated throughout the year with high yield levels. The average yield of maize in Nigeria is about 2500–3500 kg/ha of threshed grain using recommended fertilizers, varieties, seed-dressing, and improved cultural practices (Ali-Olubandwa *et al*. 2010). The total land area planted to maize in Nigeria is above 2.5 million hectares with an estimated yield of about 1.4 metric tons per hectare, though, maize production is still very low especially if considered in relation to the growing food demand of the country (Idrisa *et al*., 2012). About 20% is processed for secondary uses (Iken and Amusa, 2004).

Growth in maize utilization has been driven by the rapidly increasing demand for maize as livestock feed, food and industrial non-food products. The population of Nigeria is expected to grow at a rate of more than 3% per year, while food production is likely to grow at a rate of 2% or less a year. Closing this gap and increasing food production will require intensive agriculturally based use of modern technologies such as the use of improved seed varieties, agrochemicals, management practices, etc. Higher solar radiation received in the northern part of the country relative to the southern part, increases the potential of maize production in the northern zone (NAERLS & FDAE, 2014). Improved agricultural practices are farming practices that have been researched on, tried and found to bring about increased crop yield (Ali-Olubandwa *et al*. 2010). The practices include use of certified seeds, agronomic practices, fertilizer and agrochemical application among others. Ouma *et al*. (2002), defined adoption as a decision to make full use of an innovation or new technology as the best opportunity available to the farmers. In view of the uncertainty about the outcome or otherwise profitability of such innovation, a greater effort is required of the farmers so as to decide whether to use the innovation or not. Agricultural productivity in the developing countries like Nigeria continues to be low and it is generally believed that non-adoption of research results by majority of farmers is the main reason for this situation (Idrisa *et al*., 2012). Bawa and Ani (2014), found a positive and significant association between ages, farming experience, training received, socio-economic status, cropping intensity, economic motivation, innovativeness, information sources, utilization, adoption, etc. However, there has been a fluctuating trend in maize production over the last decade which threatens household food security. Maize has yielded compelling success stories with the adoption of new technologies that has increased small holder maize production. The diffusion of new technologies in Africa has been more widespread for maize than for other food crops (Iken and Amusa, 2004). This implies that technologies adoption can provide a basis for further increase in maize production. Farmers' efficiency in maize production resulting from technological innovations also has some food security implications. Food crises is more serious in sub-Saharan Africa where the attainment of food security is intrinsically linked with poor agricultural techniques which results in decrease in agricultural growth rate (Matata *et al*., 2010). Despite the economic importance of maize in Nigeria, it has not been produced to meet food and industrial demand. This could be attributed to low productivity from maize farms attributable to non-adoption of improved technologies by farmers. Therefore the study intends to evaluate the index of adoption of maize production technologies and the correlation with adoption cost and farm output. To this effect, the following research questions would be asked;

1. What is the adoption index of maize production technologies among the respondents?
2. What is the correlation between adoption cost, adoption index and farm output?

METHODOLOGY

Study Area

Toro Local Government Area (LGA) covers a total land area of 6932km2 and a total population of 350,000 people, projected at 3% growth rate per annum to be 499,586 in 2018 (NBS, 2012). Toro local government is topographically hilly with altitude of 100m above sea level. It is located on longitude 9°N and 12°E and latitude 8°N and 11°E. It is in the Sudan Savannah zone of Nigeria with an average rainfall ranging between 830mm to 1,100mm annually starting from April to October, with average temperatures of 35°C for lowland and 31°C for highland areas respectively (NBS, 2012).

Sampling Techniques

A multistage sampling technique was employed to select maize farmers in the study area. At first stage, Toro Local Government Area was selected; due to the prevalence of smallholder maize farmers in the area. The next stage involves a purposive selection of the three district of the Local Government. The three districts selected were Toro, Lame and Jama'a. The third stage involves a simple random sampling of two villages from each district. In the last stage, from compiled lists of maize farmers, by the local enumerators and extension agents; 10% respondents from each village was selected which gave an overall sample size of 101 respondents.

Method of Data Collection

The data collected for this study was obtained from primary sources. The data for this research was collected through the use of well-structured questionnaires.

Analytical Techniques

Data for the study were analyzed using adoption index and multivariate correlation techniques.

Model Specification

Adoption index

The index of adoption of maize production technologies was measured using the adoption index. Adoption index was computed for individual farmer following Saka and Lawal (2009) whereby adoption index (Bi) is given by:

Bi = ∑ (Ri/RT) ……………….. (1)

Where:

Bi = the adoption index of maize production technologies by ith farmer.

Ri = number maize production technologies adopted by ith farmer; and

RT = Total number of maize production technologies available to the ith farmer.

i = (1………….n)

For this study, adoption index of ≤0.39 indicates low adoption index, while index of ≥0.4 indicates high adoption index.

Some of the recommended maize production technologies available in the study area include: Adjustment in planting date; Planting method and seed varieties; Plant spacing and seed rate; Weed management; Harvesting technology; Fertilizer application and management; Pest management; Postharvest Processing techniques; Storage methods; Water management; and Disease control.

Multivariate Correlation Analysis

The correlation analysis was used to analyze the multivariate relationship between adoption cost (x), adoption index (y) and farm output (z), where multiple correlation coefficients (R, r) are defined in equation (1), following Gujarat (2004):

Rz, xy = √r2xz+ r2yz– 2rxz .ryz .rxy/ 1-r2xy…….. (1)

Rz, xy= multiple correlation coefficient between dependent and independent factors; z= dependent variable z; x= independent variable x; y= independent variable y; r2= coefficient of determination; r2xz = coefficient of determination between x and z; r2yz = coefficient of determination between y and z; r2xy = coefficient of determination between x and y; rxz= correlation coefficient between x and z; ryz= correlation coefficient between y and z; and rxy= correlation coefficient between x and y.

**Decision Rule:** The strength of relationships based on the correlation coefficient (r) is expressed as follows:

≥ +/-0.7 (strong linear relationship); +/- 0.4 - 0.69 (moderate linear relationship); and ≥ +/-0.39 (weak linear relationship).

RESULTS AND DISCUSSION

Index of Adoption of Production Technology

Table 1: Distribution based on the Index of adoption of Production Technology

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Adoption index |  | Frequency |  |  | Percentage (%) |  |
| Low adoption index  High adoption index |  | 62  39 |  |  | 61.4  38.6 |  |

**Source: Field survey, 2020**.

The result in Table 1 reveals that most (61.4%) of the farmers have low adoption index of ≤0.39; while, 38.6% have high adoption index of ≥0.4. The respondents indicated that several technologies for improved maize production were available in the area. However, the index of adoption of these technologies is very low and not satisfactory. This trend is responsible for the existing low farm productivity for this crop in the area as observed in previous studies (Maiangwa, 2008). It is well known that in sub-Saharan Africa low agricultural productivity by small scale farmers have been attributed to poor adoption of improved agricultural technologies. Therefore, identification of factors hindering adoption/uptake of improved agricultural technologies becomes very critical in the area (Bonabana- Wabbi, 2002).

Correlation of Multivariate Factors (Output, Adoption Cost and Adoption index)

Table 2: Correlation Coefficient Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| Factors | Farm Output (z) | Adoption cost (x) | Adoption index (y) |
| Farm Output (z) | 1.00 |  |  |
| Adoption Cost (x) | -0.65\* | 1.00 |  |
| Adoption index (y) | 0.52\* | -0.58\* | 1.00 |

**Source: Field Survey, 2020; \*Correlation coefficient (r) is significant at 5% level (2-tailed**).

Table 2 revealed that the result of the correlation analysis was significant at 5% level of probability. This suggests that a significant correlation between multivariate factors exists. The estimated correlation coefficient between x and z (rxz) was -0.65; which suggests a moderate and inverse linear relationship between the factors. This implies that as adoption cost increases technology adoption decreases and consequently overall farm output declines. The estimated correlation coefficient between y and z (ryz) was 0.52 which suggests a moderate linear relationship between the factors. This implies that as the adoption index increases the level of farm productivity tend to also increase. The estimated correlation coefficient between x and y (rxy) was -0.58, which suggests a moderate and inverse linear relationship between the factors. This implies that as adoption cost increases the index of adoption of maize production technologies among the farmer’s declines. The implication of these findings is that adoption of production technologies tends to increase the level of farm productivity in the study area and hence improve agricultural sustainability. Furthermore, the cost of production practices determines farm level adoption. Thus, this result corroborates with the findings of Yasin (2003) who also evaluated the relationship among similar multivariate factors.

CONCLUSION AND RECOMMENDATIONS

This study analyzed the adoption index of maize production technologies and the correlation with adoption cost and farm output in smallholder farming systems in Toro, Bauchi State, Nigeria. The findings revealed that there were several maize production technologies available in the study area; however adoption of these technologies was relatively low. Furthermore, a significant linear relationship between the multivariate factors (farm output, adoption cost and adoption index) exists; thus, positive correlates facilitate agricultural sustainability. Based on the findings of this study, the following recommendations are made: Formulation and implementation of policies that will subsidize the cost of maize production technologies; improve farmer’s access to production technologies and improve farmers' access to agricultural credit will enable them adopt more options of production technologies. Further, improving extension activities by establishing agro service centers in the area will also facilitate technology transfer.

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RURAL WOMEN AND AGRO – PROCESSING: A CASE STUDY OF RURAL WOMEN PARTICIPATION IN GROUNDNUT PROCESSING IN KATSINA STATE

Yusuf, A. and Isa, A. O.

Department of Agricultural Education, Federal College of Education, Katsina

Correspondence email: [abubakar.yusuf5@gmail.com](mailto:abubakar.yusuf5@gmail.com), Phone: 07032136669

ABSTRACT

*The study was conducted in three agricultural zones (Ajiwa, Dutsin-ma and Funtua) of Katsina State and focused on the participation of women in groundnut processing. A multistage sampling technique was adopted to collect data from two hundred and ninety-seven (297) women involved in agro-processing activities. Descriptive statistics and analysis of variance were used for data analysis. Findings of the study revealed that majority of agricultural processing activities in the area were carried out by women and children with 55.56 % of the women involved been educated the mean age of women groundnut processors in the area is 37 years with a mean household size of 7 members. The study shows that women accounts for 85.86% of groundnut processors with a mean value of 28.73 engaged in the business. It further revealed that 68.01% of women groundnut processors in the area were married with a mean value of 22.44. Years of experience in groundnut processing among the participating women varies but the mean years of experience of women groundnut processors in the area is 6 years. The results from the analysis of variance conducted show that P > 0.05 which indicate that age and educational level influence women participation in groundnut processing business. The F - ratio for both age and education level are very high (FC> FT) at 5% level of significance indicating a relation with participation of women in groundnut processing venture. Based on findings of the study, it is recommended that simple and affordable groundnut processing technology should be made available by relevant agricultural mechanization agencies to women in the rural areas for increased productivity and higher income.*

**Keywords:** Agro-processing, groundnut, participation, processing, women,

INTRODUCTION

Agro – processing can be traced back to pre – historic period when the early man learns how to dry under the natural sun the fruits and flesh as food materials. It is an important component of agribusiness development where agricultural products pass through some degree of transformation after harvesting to final use. Agro–processing is a set of techno economic activities carried out on an agricultural product to make it more useful as food, feed, fiber, fuel or industrial raw materials (Tamil Nadu, (2015). Aboki (2015) defined processing “as any activity that maintained or raise the quality or alters the physical and/or chemical characteristics of a product or material”. It is generally a value addition that is being carried out in order to produce a new product in a more acceptable form of improved quality and increased shelf life. Adesope, *et al*., (2010) pointed out that agro–processing is carried out to reduce spoilage, waste and other losses in quality and quantity of agricultural products between the time of harvesting and time of marketing to consumption.

Food processing is an ancient activity that begins with home cooking to industrial processing with increased emphasis on safety and nutritional quality of processed products. The important characteristics defining food quality such as appearance, texture, taste and nutritional content are significantly affected by processing method and techniques used. Food processing is therefore, becoming increasingly challenging and diverse to provide food materials with certain characteristics to meet consumer’s requirements for acceptability and usage (Adesope *et al.,* 2010). The major agricultural products from crops that are processed into food materials and consumed in the rural communities in Nigeria include cowpea, groundnut, soybean, cassava, maize and wheat while agricultural products from animals include milk, fish, egg and flesh. Food processing can be simple and easy or complicated and the factors that affect the processing operation include the following:

1. The agricultural products to be processed.
2. Technology employed for the processing.
3. The level of processing (output) required.
4. Skill of the processor.

Groundnut production is dominated by men especially in the northern part of Nigeria while more than 75% of groundnut is undertaken by women and children (Muhammad – Lawal, Animashun and Towujo, 2012). According to Food and Agricultural Organization (FAO) (2011), groundnut processing activities in the rural areas are at small scale level requiring low initial capital outlay, hence can be undertaken by women. Groundnut processing venture by the rural women plays significant roles toward development of rural economy as pointed out by Aliyu (2015). These include improve local income of the rural women, increased rural women empowerment, provide supplement in the family diet, provide high quality livestock feed and improve financial status.

Women in the rural areas are the major small-scale processors of groundnut in Katsina State to provide local informal economic contribution to household welfare. They have a very high regard for groundnut processing business because of its contribution towards the development of the rural economy. However, according to Adesope *et al.* (2010), there are none or limited knowledge on the contributions of rural women towards proliferation of rural – based agro- processing industry. It is therefore of paramount importance to understand the level of participation of the rural women in groundnut processing.

Objectives of the Research

The specific objectives of the research are to:

1. examine the socio-economic characteristics of rural women groundnut processors;
2. determine the level of participation of rural women in groundnut processing business and
3. determine if any relationship existed among the age, educational level and women participation in groundnut processing enterprise.

Research Hypothesis

1. There is no significant relationship between age of women and their participation in groundnut processing business.
2. There is no significant relationship between educational level of women and their participation in groundnut processing business.

MATERIALS AND METHODS

Description of Katsina State

Katsina State is located on coordinates 12.15o N, 7.30o E in Northern Nigeria (MOI, 2020). It occupies a total land area of 24,192 square kilometers predominantly inhabited by Hausa and Fulani with a population of 7,831,300 (NPC, 2016). Katsina State boarders Kaduna State to the south, Jigawa and Kano States to the east, Zamfara State to the west and the Niger republic to the north. The State has an average annual rainfall ranging between 550 mm to 600 mm. High temperature of 32oC – 33oC is experienced from the month of March to April and low temperatures of 19oC – 22oC from December to February (Nigerian Meteorological Agency NIMET, 2018). According to International Fund for Agricultural Development (IFAD) (2010), the major agricultural crops produced include millet, sorghum, groundnut, maize, cotton and cowpeas. In the year 2019, a total land area of 105,000 hectares was devoted to groundnut production in Katsina State with a production of more than 56,000 metric tons (Tsedeke, 2020).

Sampling Procedure and Sample Size

A multistage sampling technique was employed in the research. In the first stage, three agricultural zones (Zone I - Ajiwa, Zone II - Dutsin-ma and Zone III - Funtua) of the State were chosen. In the second stage, two Local Government Areas (LGAs) from each zone were purposively selected based on the predominance of women groundnut processors, giving a total of six LGAs for the study. The selected LGAs are Katsina and Mani from Zone I, Bakori and Danja from Zone II, Dutsin-ma and Kankia from Zone III. In the last stage, random sampling technique was adopted to select two villages from each of the LGAs. The villages selected are Shinkafi and Dandagoro from Katsina LGA, Muduru and Tsagem from Mani LGA, Guga and Tsiga from Bakori LGA, Tandama and Dabai from Danja LGA, Karofi and Kuki from Dutsin-ma LGA, Kafinsoli and Rimaye from Kankia LGA. Random selection was also used select twenty-five women groundnut processors from all the villages to have a sample size of 300 rural women groundnut processors.

Data Collection Methods

A structured questionnaire was used to collect information on the socio-economic characteristics of the respondents, type of agro-processing under taken and years of experience in groundnut processing business.

Analytical Tool

Data were subjected to descriptive statistical analysis (percentages, frequency and mean). Inferential statistical analysis was also conducted. The relationship between age, educational level and women participation in groundnut processing were tested using analysis of variance at 5% level of significance.

RESULTS AND DISCUSSION

Distribution of socio-economic characteristics of women participating in groundnut processing from the three agricultural zones of Katsina State is presented in Table1. The results in Table 1 show that majority of women involved in groundnut processing business were within the age of 36 years to 45 years (78.45%), they were married 68.01% with household size of between 6 members to 10 members (35.69%). This result is in accordance with the report of Mohammed and Olaleye (2015) which reveals that 48% of women groundnut processors had a household size of 1 to 10 members. It implies that more youth women participate in groundnut processing business than elderly women. This may be due to the hard work involved in groundnut processing activities.

The result clearly indicates that women were involved in agricultural processing activities with more women participating in groundnut processing (85.86%). This is in line with report of Maigida (2012) which states that women groundnut processors contributed significantly in agricultural processing activities. From the result, the women groundnut processors had either in formal or formal education. It reveals that only women with in formal education (44.44%), primary (39.73%) and post primary (15.83%) education level participate more in groundnut processing venture. This result supported the report of Adesope *et al.* (2010) that revealed women of higher education were less involved in agro-processing than women with lower level of education.

**Table 1: Socio-economic characteristics of women groundnut processors in the study area**

|  |  |  |  |
| --- | --- | --- | --- |
| Socio economic  Characteristics | Frequency | Percentage  (%) | Mean  ( x̄ ) |
| Marital status  Single  Married  Divorced  Age  15 – 25 yrs   1. – 35 yrs   36 – 45 yrs  Above 45yrs  House hold size  2 – 5 members  6 – 10 members  Above 10 members  Educational level  Non formal education  Primary education  Post primary education  Tertiary education  Type of agro – processing  Grain threshing/ milling  Groundnut processing  Garri processing  Other agro-processing  Years of experience processing  2 – 5 yrs  6 – 10 yrs  Above 10 yrs | *71*  *202*  *24*  *16*  *33*  *233*  *15*  *99*  *106*  *92*  *132*  *118*  *47*  *-*  *31*  *255*  *-*  *11*  *152*  *128*  *17* | 23.91  68.01  8.08  5.39  11.11  78.45  5.05  33.33  35.69  30.98  44.44  39.73  15.83  10.44  85.86  -  3.7  51.18  43.10  5.72 | 7.89  22.44  2.67  37  7  14.67  13.11  5.22  3.44  28.33  -  1.22  6 |

The relationship between age, education level and participation of women in groundnut processing in the three agricultural zones of Katsina state is presented in Table 2.

**Table 2: Analysis on age, education level and women participation in groundnut processing**

|  |  |
| --- | --- |
| Parameters | Variables  Age Education level |
| Sample size N  F ratio (5%)  Coefficient of variation R2 | 297 297  151.97\* 77.98\*   * 1. 0.56 |

Source: ANOVA \*Significant at 5% level

Result from the analysis of variance on Table 2 show that age and educational level of the women groundnut processors influence their participation in groundnut processing business. From result of the study in Table 2, P > 0.05, the F - ratio for both age and education level are very high (FC> FT) at 5% level of significance indicating a relation with participation of women in groundnut processing venture.

CONCLUSION

Agro-processing has become an important agribusiness among rural women with a very high regard to groundnut processing business. The rural women engaged in different agro-processing venture in order to support their families. The study reveals that youth among women participate more in groundnut processing than the elderly women due to the hard work involved in groundnut processing activities. It also shows that women with informal and lower level of education dominate groundnut processing business in the area while women of higher level of education do not participate in groundnut processing or any other agro-processing activities. The study indicates a significant relationship between age, education level of the rural women and their participation in groundnut processing venture.

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## PROFITABILITY OF DRIP IRRIGATED MAIZE PRODUCTION FOR IMPROVED FOOD SECURITY IN MAIDUGURI SEMI-ARID REGION OF BORNO STATE, NIGERIA

Ali Umar Bashir1 and Goni, Muhammed2.

1 Department of Agricultural and Environmental Resources Engineering University of Maiduguri

2National Agricultural Extension Research and Liaison Services Ahmadu Bello University Zaria,

Email: [alfakiumarbashir@gmail.com](mailto:alfakiumarbashir@gmail.com).

ABSTRACT

*In the arid and semi-arid areas of Nigeria, water is the major constraint in crop production. Farmers in the region use furrow irrigation method and fixed irrigation interval schedule for maize production. The irrigation method and schedule used by the farmers has become unsustainable due to low yield, low water use efficiency, low quality of maize kernels and low net farm income. Thus, there is a growing gap between the demand for maize and its production to meet the food requirement for the growing population in the region. And one of the existing Climate Smart Agriculture (CSA) Practices in recent times is ‘Water smart’ which included drip irrigation. The aim of this study was to determine profitability of irrigated maize production in semi-arid environment of Nigeria. Two field experiments were conducted in the 2014 and 2015 seasons at the Teaching and Research Farm of Ramat Polytechnic Maiduguri, Borno State which is in the semi-arid region of Northern Nigeria. The experimental design was a randomized complete block design with irrigation scheduling methods at three levels namely fixed irrigation interval, scheduling using tensiometer at trigger level of 30 centibar and pan evaporation method. The profitability analysis result revealed that, the combination of drip irrigation and tensiometer schedule at trigger level of 30 centibar* *had a net farm income and benefit cost ratio of $695.2 and 3.20, respectively. It is recommended that farmers in the semi-arid region of Nigeria should use gravity drip irrigation system with irrigation interval of 4 days for the replenishment of soil moisture to the desired level for optimum maize production to meet the increasing demand for food for the growing population based on its proven performance and economic viability as shown in this study.*

**Keywords***:* Drip, Irrigation, Profitability, Semi-Arid

INTRODUCTION

Irrigation agriculture is crucial to the economy, it is too important to be marginalized as it is vital for world food security (Ayinde, 2016). This is particularly so due to water scarcity because of the impact of climate change and the increasing global demand for water from many sectors including agriculture, especially in semi-arid regions where irrigation is the only alternative for crop production to meet the demand for food for the rapidly growing population (Bashir, 2018). Irrigation has made higher and more reliable yield possible as crops can be planted more than once in a year within the topics, apart from bigger and reliable yield as against yearly cultivation, which is often at the mercy of seasonal rainfall (Worlf, 1995). It has also been seen that drip irrigation systems have increased farmers’ resilience to climate-induced water scarcity (FAO, 2021). One of the existing Climate Smart Agriculture (CSA) Practices is ‘Water smart.’ This is inclusive of Rainwater harvesting, drip irrigation, less water requiring crops, re-use of wastewater shifting of crops, use of flood and drought resistant varieties, mulching etc. (Sharma, 2016). Globally one type of technology that may contribute to the improvement of water supply management and the associated food crisis is drip irrigation (Bukar et al., 2019)

Agricultural production and activities have a problem when either too much or too little water is available in the root zone. A shortage of water can be compensated by irrigation. Surface irrigation is related to a potentially heterogeneous water supply to crops and water losses in terms of water run-off, deep percolation, evaporation, and wind-drift. In contrast, drip irrigation systems can significantly reduce water losses because only the immediate root zone of each plant is wetted. In Bulgaria, Koumanov *et al.* (2006) showed that on raspberry plantations water savings between 4 and 17 per cent may be obtained through this method without significant reductions in yield. While flood irrigation was suitable in many places in Asia during the 20th century, but water availability and cost factors could make small-scale, low-cost, drip irrigation suitable for places in Africa in the 21st (Chigerwe, Manjengwa, et al., 2004).

In the arid and semi-arid areas of Nigeria, water is the major constraint in crop production. Rainfall is extremely irregular, to the extent that the amount and distribution in space and time had not been ideal to optimally support crop production (Dibal *et al*., 2006).

Farmers in the region use furrow irrigation method and fixed irrigation interval (7 days) schedule for maize production. The irrigation method and schedule used by the farmers has become unsustainable due to low yield, low water use efficiency, low quality of maize kernels and low net farm income (Bashir, 2018). Thus, there is a growing gap between the demand for maize and its production to meet the food requirement for the growing population in the region. The aim of this study was to determine profitability of drip irrigation method for maize production for semi-arid environment of Nigeria.

Maize accounts for about 43% of calorie intake in Nigeria (Alabi and Esobhawan, 2006). Apart from being a food crop, maize has equally become a commercial crop on which many industries depend on for raw materials (Abd El-Waheed and Ali, 2012). Maize contributes to about 80% of poultry feeds and this has significant effect on the protein intake in Nigeria (IITA, 2008). Therefore, maize can be considered very vital to the economic growth of the nation through its contribution to food security and poverty alleviation.

Addressing the challenges of poverty and food insecurity calls for boosting agricultural production in Nigeria (Xie *et al*., 2017). Irrigation that had the highest contribution to increasing the global food production is the only alternative solution to this problem (Adeniji, 2002). Currently, crop production in Nigeria is rain fed; the irrigated agriculture accounts for only 1% of cultivated area in the country (FAO AQUASTAT, 2017). This rain fed agriculture makes crop production in Nigeria vulnerable to climatic variability, both intra-annually and inter-annually.

Irrigation has also greatly helped in stabilizing food production and prices over the years (Rosegrant *et al.,* 2002). Today irrigated agriculture continues to make civilization less dependent on the vagaries of climate for food and fiber requirement to sustain life.

The general objective of this study is to examine the economics of irrigated maize production in Maiduguri, Borno State, Nigeria.

Specific objectives are to:

* 1. determine the costs associated with maize production using drip irrigation method under different irrigation schedules
  2. determine the profitability of maize production using drip irrigation method under different irrigation schedules

MATERIALS AND METHODS

Study Area

Field experiments were conducted at the Teaching and Research Farm of Ramat Polytechnic Maiduguri, Borno State which is situated at latitudes 11° 46'18"N to 11° 53' 21"N and longitudes 13° 03' 23"E to 13° 14' 19"E in the semi-arid region of Northern Nigeria as shown in Figure 1. Maiduguri lies within the Lake Chad Basin formation and is about 355m above sea level. The climate of area is semi-arid or tropical grasslands vegetation which is known for its dryness. The area has a long dry season of 6 to 7 months spanning from November to Mach and a short-wet season that last for about four months (July to October). The area has high temperatures which ranges from 20-43ºC with an average annual precipitation of about 640mm. The hottest months are usually April and May, while the cold and the dry periods of harmattan are from November to January.



**Figure 1: Map of the study area**

Drip Irrigation System layout

The system of irrigation used is gravity drip irrigation system. The system consists of a reservoir, mainline, laterals and drippers which were all made from plastic materials. Each treatment had three (3) laterals which were laid on ridges at a spacing of 0.75m. The internal diameters of the mainline and laterals were 19.1mm and 12.7mm, respectively. The drippers were spaced 0.5m along the laterals as shown in Figures 2. The spacing of 0.75m and 0.5m were chosen based on the recommended spacing for growing maize.

Experimental Design and Treatment

The experimental design was a randomized complete block design with irrigation scheduling methods at three levels namely fixed irrigation interval, scheduling using tensiometer at trigger level of 30 centibar and pan evaporation method.

Irrigation Schedule

The exact amount of water required by the maize crop was applied using different irrigation intervals based on the use of tensiometer, pan evaporation and fixed irrigation interval. Irrigation was conducted in the plots monitored by the tensiometer whenever the trigger level of 30cb is reached. The choice of 30cb as the trigger level was based on the research findings of Rhodes and Stanley (1973) and Rivera-Hemendez *et al.* (2010) where both reported optimum yield and water use efficiency of maize at 30cb.

The evaporation pan used was the standard class A evaporation pan made from galvanized iron and is 120.5cm in diameter and 25 cm deep filled with water to a depth of 20cm. The crops were irrigated based on the ratio of irrigation amount (IW) to cumulative pan evaporation (CPE) that is IW/CPE ratio. Daily records of pan evaporation data were taken from the class A evaporation pan located in the research farm and irrigation was conducted at 1.0 IW/CPE ratio for optimum yield. The choice of the ratio of IW/CPE of 1 for scheduling maize in this work was based on the findings of earlier research which shows higher yield and water use efficiency values when irrigation was scheduled at the ratio of IW/CPE equals to 1 (Simsek *et al*., 2013).

A fixed irrigation interval of 7 days was used for irrigating the maize crop under all the different irrigation systems based on the traditional irrigation cycle used by the farmers

Determining the Performance of the Farm Enterprises

The net farm income was calculated using equation 1 used by Haruna *et.al*. (2010)

NFI=TR-TC.................................................................................................................... 1

Where:

NFI = net farm income from production per hectare.

TR = total revenue/returns from production per hectare.

TC = total costs of production per hectare.

Benefit cost ratio (BCR)

The benefit cost ratio (BCR) which is the ratio of the present value of benefit and the present value of cost was determined using equation 2:

BCR=Benefit/Cost........................................................................................................... 2

These were performed by showing all costs incurred and the total revenue obtained from the production based on the drip irrigation and schedules used in the study. All costs were classified as either fixed or variable cost. Costs that were incurred due to land hiring, land preparation, seed, fertilizer, water used, fuel, rented pump, rented water reservoir, water application, planting, fertilizer application, weeding, harvesting, and threshing were classified as a variable cost. While costs incurred from the drip irrigation components were classified as a fixed cost. The variable cost and fixed cost were summed up to arrive at the total production cost for the research. The total revenue was obtained by quantifying the yield in monetary terms. The two costs-production cost and selling price (total revenue) were compared to evaluate the economic viability of different irrigation methods and techniques for maize production. The net farm income, benefit cost ratio and were determined using the procedures outlined by Rao (1994), Brennan (2008) and Srivastava (2012) as shown in equations 1 and 2, respectively.

Costs of Production

Costs of production are classified into fixed costs and variable costs. To facilitative the calculation of net farm income and benefit cost ratio which were used to determine the profitability and economic viability.

The different cost items were identified, quantified and the amount involved in their use in the maize production were summed up and subtracted from the total returns. The following are the different costs in the maize cultivation.

Land Hiring, Land Preparation, Seed Cost, Cost of Fertilizer, Cost of Fuel, rented pump, Water used Cost, Rented Water Reservoir Cost, and Labour Cost

RESULTS AND DISCUSSION

Economic analysis of maize production under drip irrigation methods and schedules

The process of choosing the most economically viable combination of schedule is one of the most important considerations in the development of irrigated agriculture especially in arid and semi-arid areas.

The results of the total cost involved under drip irrigation methods and schedules are presented in Table 1. The result shows that the total cost of production varied from 296.45 to 316.04

The fixed costs accounted for 19.07 to 20.33% of the total cost of production. The variable costs per hectare and schedules were 236.18 to 255.77 $/ha.

The variable costs were higher in pan and tensiometer irrigation techniques with shorter irrigation interval (4days) which resulted in higher cost of fuel and water application compared to the fixed irrigation interval of 7 days. The total variable cost contributed 79.67% to 80.91% to the total cost. Fertilizer and water application costs accounted for 40.3 to 61.00% of the total variable cost.

Table 1: Total cost involved under drip irrigation methods and schedules

|  |  |  |  |
| --- | --- | --- | --- |
| Variable inputs cost (VC) | Fixed | Tensiometer | IW/CPE |
| Land hiring | 10.71(4.53) | 10.71(4.19) | 10.71(4.19) |
| Land preparation | 17.86(7.56) | 17.86(6.98) | 17.86(6.98) |
| Seed | 4.76(2.02) | 4.76(1.86) | 4.76(1.86) |
| Fertilizer | 144.05(60.1) | 144.05(56.3) | 144.05(56.3) |
| Water used | 3.75(1.59) | 6.67(2.61) | 6.67(2.61) |
| Rented water reservoir | 11.9 | 11.9 | 11.9 |
| Water application | 21.43(9.07) | 38.1(14.90) | 38.1(14.90) |
| Fertilizer application | 8.93(3.78) | 8.93(3.49) | 8.93(3.49) |
| Weeding | 4.46(1.89) | 4.46(1.90) | 4.46(1.74) |
| Harvesting | 4.76(2.02) | 4.76(1.86) | 4.76(1.86) |
| Threshing | 3.57(1.51) | 3.57(1.40) | 3.57(1.40) |
| Sub Total | 236.18 | 255.77 | 255.77 |
| Drip components | 60.27 | 60.27 | 60.27 |
| Sub Total | 60.27 | 60.27 | 60.27 |
| Total Cost | 296.45 | 316.04 | 316.04 |

Source: Field experimental data 2014/2015

Land hiring, preparation, seeds, water used, weeding, harvesting, and threshing contributed 5 to 7.56%, 3 to 4.53%, 1.33 to 2.02%, 1.54 to 3.40%, 1.25 to 1.90%, 1.33 to 2.02% and 1 to 1.51% of the total variable cost, respectively. Fuel and rented pump accounted for 4.13 to 21.33% and 2.05 to 6.67% of the total variable cost, respectively. A substantial proportion of the total variable cost was spent on fertilizer and water application. The total revenue ranged from 468.3 to 1011.2 as shown in Table 2.

The total revenue amounted to $1011.2 as shown in Table 1. This could be due to the higher drip water application efficiency of 80% which resulted in improved yield production. The tensiometer at trigger level of 30 centibar and the ratio of irrigation amount to cumulative pan evaporation techniques also gave higher total revenue when compared with the fixed irrigation interval (7 days).

Table 2: Net farm income for maize production

|  |  |  |  |
| --- | --- | --- | --- |
|  | Fixed | Tensiometer | IW/CPE |
| Yield (kg) | 2431.3 | 5056.0 | 5049.3 |
| Unit price/100kg | 20 | 20 | 20 |
| Total revenue | 468.3 | 1011.2 | 1009.8 |
| Total Cost | 296.45 | 316.04 | 316.04 |
| Net farm income | 171.8 | 695.2 | 693.8 |
| Benefit cost ratio | 1.64 | 3.2 | 3.1 |

The result further revealed a net farm income and benefit cost ratio of $695.2 and 3.2 The result of this study is similar to the findings of Bostch *et al*. (1992), Hengler (1997), O’Brein *et al*. (1998) and Namara *et al*. (2007).

CONCLUSION

Based on the research conducted to determine the proper irrigation method and schedule for maize production in the semi-arid environment of Nigeria, the following conclusions can be drawn:

1. The combination of drip irrigation with tensiometer schedule was found to be the most profitable irrigation method and schedule for maize production with higher net farm income of $695.2 and benefit cost ratio of 3.2 compared to the net farm incomes of $693.8 and benefit cost ratios of 3.1 obtained using drip and pan evaporation schedule and $171.8 and 1.64 from the drip and fixed irrigation interval schedule.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. The use of gravity drip irrigation system with tensiometer that resulted in irrigation interval of 4 days is recommended for farmers in this region for the replenishment of soil moisture to the desired level for optimum maize production to meet the increasing demand for food for the growing population based on its proven performance and economic viability as shown in this study.
2. Government should assist farmers to acquire drip irrigation kids to intensify its usage for optimum maize production in the region.

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## PROFITABILITY ANALYSIS OF POULTRY EGG PRODUCTION IN IBADAN METROPOLIS, OYO STATE, NIGERIA

Okeab\* F, O., Idowuac O.P.A., Akugbeb R.O. and Adegbiteab D.A.

aAgricultural Media Resources and Extension Centre, Federal University of Agriculture, Abeokuta, Nigeria.

bDepartment of Agricultural Economics and Farm Management, Federal University of Agriculture, Abeokuta, Nigeria.

cDepartment of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria.

\*Corresponding Author’s E-mail: folasadeolukemioke@gmail.com

Phone number: 07030625030

ABSTRACT

*This study was executed to estimate the profitability of poultry egg production in Ibadan, Oyo State, Nigeria. A structured questionnaire was used to collect primary data from a cross-section survey of 120 poultry farmers gathered using a two-stage sampling technique. The data obtained was analyzed using descriptive statistics and cost and returns analysis. Results revealed that the majority (75%) were male, with an average age of 41 years. Many (64.2%) of the poultry farmers had secondary education and 25.8% had farming experience of 1-4 years. Majority (88.3%) were members of cooperative society and 87.5% operated battery cage system of poultry management. The cost and returns result showed that poultry egg production is a profitable venture in the study area given that ₦1,449,494.72 was incurred as cost per annum on egg production with ₦3,272,747.33 as revenue and a net income of ₦1,823,252.61. Furthermore, an average poultry egg farmer realized 2,504.34 crates of egg per annum and this was sold at the rate of ₦1,050 per crate. The profitability ratio further showed that for every ₦1 invested in poultry egg production, the poultry farmer earns ₦0.26 as profit. Based on the findings of this research, it is recommended that policies that will assist the poultry egg farmers to attain a drastic reduction in the cost of poultry feed possibly through subsidies should be formulated by the government. In addition, use of local materials in feed formulation that will eventually increase profit level should be encouraged.*

**Keywords:** Cost and returns, Egg, Poultry, Production, Profitability ratios

INTRODUCTION

Agriculture is a prominent non-oil sector in Nigeria that contributes remarkably to the country's economic growth. In real terms, this industry produced approximately 26.2 percent of the entire Gross Domestic Product (GDP) in 2018. The livestock business is one of the agriculture's subsectors, that employs about 25 million Nigerians directly or indirectly and primarily in the poultry industry (National Bureau of Statistics, NBS, 2018). Livestock contributed between 6% and 8% of the nation’s GDP (Africa Sustainable Livestock, ASL, 2018). According to Okunmadewa (1999), livestock are tools that can improve the socioeconomic conditions of rural populace, particularly in developing countries. They can be raised on a small, medium, or big level. Nigerian livestock includes poultry (chickens), cattle, pigs, sheep, and goats. According to Federal Ministry of Agriculture and Rural Development (FMARD, 2017) report, the annual output of livestock produced in Nigeria was 18.4 million cattle, 43.4 million sheep, 76 million goats, 7.5 million pigs, 180 million poultry birds and 1.4 million equids (horses, donkeys and so on). According to Central Bank of Nigeria (CBN, 2019) report, the output realized from the poultry population was 650,000 metric tonnes (MT) of eggs and 300,000MT of meat as against the demand for eggs and meat which are about 790,000MT and 1,500,000MT respectively, thus creating a huge demand gap which are often met through smuggling from Benin Republic. There are numerous lucrative prospects in the poultry industry in Nigeria, although chickens are more commonly raised than other poultry birds. For example, broiler is reared for meat production and layers for egg production either under free range, semi-intensive and intensive system of management. Poultry offers a wide range of economic opportunities, including egg and meat production, hatcheries and input suppliers which generates additional revenue for the household. Despite the obstacles, the production of poultry products in Nigeria has increased throughout the years, but the proportion of increases still falls short of demand as it only caters for the 30% of the chicken eggs and meat needs of Nigerians as per capita egg consumption is 60 eggs per annum compared to advanced countries where per capita egg consumption is 250 eggs per annum (Babban Gona, 2021). According to Alabi and Isah (2002), the main reasons for the low poultry output in Nigeria compared to what is obtainable in other African countries are inadequate capital, diseases and parasite infection, enormous feed costs and the use of poor breed of birds. The high costs of maize and soybeans have put most poultry producers out of business (Sahel, 2015). The exorbitant cost of foreign sourced feed has caused the majority of farmers to improvise and reformulate poultry feeds with sub-standard materials such as peanut cake, cotton seed and palm kernel meal and thus exacerbating the input dilemma (World Poultry, 2013). The high cost of inputs is a big problem in the poultry industry because feed purchases consume as much as 70% of the cost of production, leading to a significant reduction in the number of commercial poultry farmers, particularly small-scale ones who are unable to bear the high-cost of egg production (Adebiyi, 2000; Ashagidigbi *et al.,* 2011) and subsequent reduction in the farmer’s profit level (Hamzat *et al.,* 2020). The exorbitant input cost would undoubtedly have an impact on the income level of poultry egg producers. The Nigerian government has implemented a number of programmes aimed at addressing the issue of high input costs in the poultry industry both in the past and in the present. Some of these include the Micro-Credit Scheme for Livestock Production and the Community-Based Agricultural and Rural Development Project (African Development Fund, ADF, 2003). However, some of these programmes appears to be no longer functional possibly due to lack of funding and proper monitoring that would ensure continuity. The current study aims to evaluate the profitability of poultry egg production in Ibadan metropolis, Oyo state. The study specifically calculated the costs and returns involved in poultry egg farming.

METHODOLOGY

The research was conducted in Ibadan metropolis, Oyo State Nigeria, which comprises of 11 Local Government Areas (LGAs). It lies between longitude 3°55′0″E and latitude 7°23′47″N and has an estimated population of 6,000,000 in 2021. Ibadan has a tropical wet and dry climate, with a long-wet season and relatively consistent temperatures (between 24oC and 25oC) all year. Because of the favourable weather, poultry farming is popular among the farmers in the study area. A well-structured questionnaire was used to elicit relevant information that supported the study objectives from the respondents. A two-stage sampling procedure was employed in selecting the respondents. The first stage involved the purposive selection of two (Lagelu and Oluyole) out of the 11 LGAs in the metropolis due to intensive poultry egg farming in the area. The Poultry Association of Nigeria, Oyo state chapter (PANOY) provided a register of all poultry egg farmers in the selected LGAs. The second stage involved a proportionate sampling to size of 120 poultry egg farmers from the list obtained from PANOY as the number of registered poultry farmers from the two local government were not the same. 50 farmers were interviewed in Lagelu while 75 farmers were interviewed in Oluyole. Data collected were analyzed using descriptive statistics (frequency counts, percentages and mean) and cost and return analysis.

Estimation of Net Income

To determine the profit to be realized by the poultry egg producers in the study area, the profitability of egg production was evaluated using the net income estimation approach. Costs incurred and returns from egg farming were estimated, including the cost of all inputs used (fixed and variable), the quantity of output (eggs) produced in crates and the price per crate. This can be specified as shown in equations 1-4.

NIi = TRi − TCi (1)

TRi = Pi ∗ Qi (2)

TCi = TFCi + TVCi (3)

Therefore, NIi = Pi ∗ Qi − (TFCi + TVCi) (4)

Where:

NIi = Net income realized from the sale of egg (₦);

TRi = Total revenue realized from the sale of eggs (₦);

TVCi = Total variable cost expended on production of eggs (₦);

Qi = Total quantity of eggs produced by the farmer (crates);

Pi = Current price per unit of output (₦/crate);

TFCi = Total fixed cost expended by the farmer (₦)

Profitability ratios like Net Income (NI), Returns on Investment (ROI) and Net Profit Ratio (NPR) were calculated from the cost and returns analysis.

Following Olaoye et al., (2016), poultry egg farming is profitable if

RESULTS AND DISCUSSION

Socioeconomic characteristics of poultry egg farmers

The socioeconomic characteristics of the poultry egg farmers sampled in the study area are presented in Table 1. Majority (75%) of the poultry egg farmers are male while very few (25%) are female. An average poultry egg farmer in study area was 41 years old with a cumulative majority (80%) below 50 years of age. This implies that the farmers were still economically active and productive, thus will be able to withstand the arduous tasks involved in poultry egg production. This result is similar to the earlier findings of Adedeji *et al.,* (2017) and Johnson *et al.,* (2020) who reported an average age of 41 years for poultry egg farmers in Oyo State, Nigeria. Majority (77.5%) of the poultry farmers are married while a few (17.5%) are single. In terms of educational qualification, very few (2.5%) had only primary education, 33.3% had secondary education while more than half (64.2%) attained tertiary education level. This high literacy rate among the farmers could bring about more informed decision and possibly increase output level as reported by Adenuga *et al.,* (2013). About one-quarter (25.8%) of the poultry farmers had between 1-4 years of experience while an average poultry egg farmer in the study area had 12 years of experience. This suggests that there are relatively few new entrants in the business, but the long years of experience could improve profit level possibly due to perfection that sets in following repetition of production activities over time as documented by Adeyonu *et al.,* (2016); Oyinbo *et al.,* (2016) and Oke *et al.,* (2022). Many (59.2%) of the respondents had 5-8 persons in their households while the mean household size was 5 persons while majority (88.3%) of the poultry farmers are members of the cooperative society. In addition, (87.5%) of the poultry farms operate battery cage system of management while just (12.5%) operate a deep litter system.

Table 1: Socioeconomic Characteristics of Poultry Egg Farmers in the Study Area

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Frequency** | **Percentage** | **Mean** |
| **Sex** |  |  |  |
| Male | 90 | 75.0 |  |
| Female | 30 | 25.0 |  |
| **Age (years)** |  |  |  |
| ≤30 | 23 | 19.2 |  |
| 31-40 | 40 | 33.3 |  |
| 41-50 | 33 | 27.5 |  |
| 51-60 | 18 | 15.0 |  |
| 61 and above | 6 | 5.0 | 41.2 |
| **Marital status** |  |  |  |
| Single | 21 | 17.5 |  |
| Married | 93 | 77.5 |  |
| Widow | 3 | 2.5 |  |
| Separated | 3 | 2.5 |  |
| **Educational qualification** |  |  |  |
| Primary | 3 | 2.5 |  |
| Secondary | 40 | 33.3 |  |
| Tertiary | 77 | 64.2 |  |
| **Household size (number)** |  |  |  |
| 1-4 | 47 | 39.2 |  |
| 5-8 | 71 | 59.2 |  |
| 9 and above | 2 | 1.6 | 5 |
| **Experience (years)** |  |  |  |
| 1-4 | 31 | 25.8 |  |
| 5-10 | 36 | 30.0 |  |
| 11-15 | 16 | 13.3 |  |
| 16-20 | 18 | 15.0 |  |
| 20 and above | 19 | 15.8 | 11.6 |
| **Membership of cooperative society** |  |  |  |
| Yes | 106 | 88.3 |  |
| No | 14 | 11.7 |  |
| **Poultry management system** |  |  |  |
| Battery cage system | 105 | 87.5 |  |
| Deep litter system | 15 | 12.5 |  |

Source: Field Survey, 2021

Cost and Returns Analysis in Poultry Egg Production

Analysis of the profitability in poultry egg production was examined using the net income estimation approach. The cost and returns to poultry egg enterprise in the study area is presented in Table 2. The depreciated cost of fixed items (TFC) incurred was ₦121,841.30 and this represented 8.4% of the total cost (TC). The mean value of the total variable cost (TVC) was ₦1,327,653.42 per annum and this value constituted about 92.0% of the total cost (TC). Break down analysis of the total variable cost (TVC) incurred in the course of production revealed that labour cost, cost of laying birds, medications and feeds accounted for 97.9% of the total cost incurred in egg production. The table further showed that the four substantial inputs in the production of poultry eggs are feeds, laying birds, labour and medications. These significant inputs took nearly all (97.9%) of the total cost involved in egg production. It was also noticed that about 60.3% of the total cost involved was expended on feeding the birds, thus making it the most expensive variable cost item in egg production. This result is also similar to earlier documentation on the subject. For instance, recent studies in Nigeria including those of Adedeji *et al.,* (2017); Johnson *et al.,* (2020) showed that cost of feeding poultry birds accounted for the largest share of the total cost of production.

The result also showed that all other variable cost items including transportation, electricity, fuel, maintenance and repairs, water and wood shavings represented 2.1% of the total cost. In terms of revenue, an average poultry egg farmer realized 2,504.34 crates of egg per annum and this was sold at the rate of ₦1,050 per crate. The mean value realized from the sales of eggs and spent layer was ₦3,272,747.33 although egg sales represented 80.3% of the total revenue while revenue from spent poultry birds accounted for about 19.7% of the total revenue. The implication of this findings is that egg is a significant revenue source in poultry egg production. The profitability result showed that poultry egg production was a profitable venture in the study area, given a net income of ₦1,823,252.61. The profitability ratios computed in this study revealed that the returns on investment (ROI) was 1.26 which implied that for every ₦1 invested in poultry egg production, a profit worth of ₦0.26 will be realized by the farmer. In the same vein, a net profit ratio value of 0.55 generated implied that ₦0.55 will be realized as gain on every ₦1 expended on poultry egg production. The profitability ratios reported in this study are relatively higher than the Bank of Agriculture (BOA) and Bank of Industry (BOI) lending interest rate of 10%. The result further supports the findings of Afolami *et al.,* (2013) that egg production is a profitable enterprise.

Source: Computed from Field Survey, 2021

CONCLUSION

The study concluded poultry egg production is a profitable venture in the study area given the net income and the profitability ratio which are both positive and greater than zero respectively. However, efforts and policies that will assist the poultry egg farmers in achieving a drastic reduction in the cost of poultry feed possibly through subsidies and also the need to encourage the use of local materials in feed formulation that will eventually increase profit level is recommended.

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## ADOPTION OF MODERN BEEKEEPING TECHOLOGIES IN SELECTED LOCAL GOVERNMENT AREAS OF BENUE STATE, NIGERIA

B. Abdullahi\*, O. J. Ajayi, M. Ibrahim and M. Yakubu

Department of Agricultural Extension and Rural Development, Federal University of Technology, Minna, Nigeria

\*Corresponding author E-mail and Phone number: [Abdullahibashiru70@gmail.com](mailto:Abdullahibashiru70@gmail.com) +2348136506362

ABSTRACT

*This study was carried out to examine adoption of improved beekeeping technologies in selected Local Government Areas of Benue State. Three-stage sampling procedure was used to select 212 beekeepers; primary data were elicited from the respondents with the aid of a semi-structured questionnaire complemented with an interview schedule. Data were analyzed using descriptive statistics and survival Model analysis model. The findings indicated that bee suit, baiting and Kenya top bars have the highest adoption rate with beekeepers making these decisions within the first three years of their beekeeping practices. Also, water provision, hives inspection, swarm and queen catcher had moderate adoption rate. In addition, honey is the most utilized bee product; wax was occasionally utilized while propolis, bee venom, bee pollen and royal jelly were never utilized in the study area. Youth restiveness stemming from higher rate of unemployment has wreaked havoc on the study area; therefore, the study recommended that policymakers and other relevant stakeholders should promote beekeeping among youth as their level of participation is low in the study area.*

**Key words:** Propolis, Adoption, Wax, Baiting, and Bee suit

INTRODUCTION

Agriculture is the mainstay of the Nigerian economy with regards to employment and is linked with other sectors of the economy. It contributed 23.78% to the Gross Domestic Product (GDP) in the second quarter of 2021 (Nigeria Bureau of Statistic (NBS), 2021). It is one of the most important index for measuring and comparing the economic progress of a nation. Approximately about 70% of Nigeria’s active population engaged in agricultural production at a subsistence level, (Eboh, 2008). Despite the large involvement of Nigerians in agriculture, Nigerian agriculture was unable to produce enough food to meet the needs of its burgeoning population, which is expected to grow at a 2.54% annual rate (NBS, 2021). To reduce poverty and enhance livelihood in rural areas, it is essential to focus on high potential areas of agricultural sector that could be more productive as well as diversifying the source of income. Beekeeping is one of the agricultural sub-sectors where such potential exists. Beekeeping in Nigeria is a seasonal activity that predominantly remains rudimentary and unexploited, but has the potential of increasing Nigeria export base (Ajao and Oladimeji, 2013). Honey and other bee by-products offer great potential for income generation, poverty alleviation and sustainable use of forest resources. Apart from honey and other by-products such as bee wax, propolis, bee venom, bee pollen and royal jelly which are highly priced globally most especially in non-producer countries, it was suggested that 35 - 73 percent of the world's cultivated crops are been pollinated by different breeds of bees indicating that most of the plant species rely on bee insects for pollination (Harshwardhan *et al.*, 2012). When compared with other agricultural sectors such as arable and cash crops, poultry, fisheries and livestock rearing, beekeeping is a comparatively low investment venture that can be undertaken by most people (men, youth, disabled, women and the elderly).

Previous studies (Bunde and Kibet 2013; Adgaba *et al.,* 2014; Gebiso, 2015; Asmiro *et al,* 2017; Jebesa, 2017) on beekeeping adoption have focused on the level of adoption and the categories of adopters. The adoption of a survival model for this study will help to clarify the time variation in the adoption of various bee technologies. Furthermore, past study has primarily focused on the economic and nutritional benefits of bee products (wax, propolis, bee venom, bee pollen, and royal jelly), with little documented evidence of beekeepers' utilization of these products. The identified gaps in the literatures necessitate the conduct of this research. Therefore, the study seeks to assess adoption of modern beekeeping technologies among rural households in selected LGAs Benue State, Nigeria and specifically; the study aimed to: describe the socio-economic characteristics of bee farmers; determine the rate of adoption of modern beekeeping technology in the study area and assess the rate of utilization of bee products in the study areas.

METHODOLOGY

The study was carried out in Benue State. The state is one of the six states constituting the North Central region of Nigeria with its headquarters in Makurdi. Benue State is located between Latitude 6030'N and 8010'N and Longitude 6033'E and 100E. The State covers a total land area of 33,955 square km. The human population of the State is 3,950,249 people as at 2006 Census (National Population Commission (NPC), 2006). With the state population growth rate of 3.04%, the projected population of the state is 6,474,050 people in 2020.

Three-stage sampling techniques was employed to select 212 bee farmers in the study areas derived using the Taro Yammane model as used by Sunday *et al.* (2015). Primary data were elicited from the respondents with the aid of semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive and survival analysis

RESULTS AND DISCUSSION

Socio-economic characteristics of beekeepers

The results in Table 1 depict that the majority (76.0%) of the beekeepers were between the age of 41–60 years, with a mean age of 50 years. This means that in the study areas, beekeeping was dominated by men who were at the margin of their active and productive age. This implies a low level of youth interest in beekeeping, which could lead to a decrease in the rate of adoption of improved beekeeping technologies. About (79.2%) had post secondary education, 19.3% had secondary education, and only (1.4%) had no formal education. This implies that beekeeping in the study areas was dominated by farmers who had the ability to read and write, which is expected to enhance the adoption of beekeeping technologies in the study areas. In addition, most (50.5%) had 6–15 years of experience, with an average of 10 years. This implies that experienced beekeepers dominate beekeeping in the studied areas, which could improve their adoption decision-making processes. Finally, most (43.9%) of beekeepers were civil servant, 38.7% were arable farmers while only 12.7% were beekeepers. This is due to their higher level of post-secondary education, which allows them to choose from a variety of paid jobs.

**Table 1 Distribution of beekeepers according to socio-economic characteristics**

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Frequency | Percentage | Average |
| Age |  |  |  |
| 30 and below | 1 | 0.5 |  |
| 31 – 40 | 24 | 11.3 |  |
| 41 – 50 | 103 | 48.6 |  |
| 51 – 60 | 58 | 27.4 | 50 |
| 61 and above | 26 | 12.2 |  |
| Level of education |  |  |  |
| Secondary | 41 | 19.3 |  |
| Tertiary | 168 | 79.3 |  |
| Non-formal | 3 | 1.4 |  |
| Beekeeping Experience |  |  |  |
| 1 – 5 | 63 | 29.7 |  |
| 6 - 10 | 58 | 27.4 | 10 |
| 11 – 15 | 49 | 23.1 |  |
| 16 – 20 | 42 | 19.8 |  |
| Primary occupation |  |  |  |
| Farming | 82 | 38.7 |  |
| Gathering | 3 | 1.4 |  |
| Civil servant | 93 | 43.9 |  |
| Artisan | 3 | 1.4 |  |
| Beekeeping | 27 | 12.7 |  |
| Agro-processing | 3 | 1.4 |  |
| Student | 1 | 0.5 |  |

**Source: Field survey, 2022**

**Rate of adoption of modern beekeeping technologies**

The result of survival analysis presented in Table 2 revealed that bee suits, baiting, Kenya top bars had 99%, 98% and 94%adoption rate respectively.

**Table 2: Survival function of adoption rate of beekeeping technologies**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Bee suit | | | | | Baiting | | | | Kenya Top Bars | | | | Water provision | | | | Hives inspection | | | | swarm and queen catcher | | | | |
| T | B T | F | NL | SF | B T | F | NL | SF | B T | F | NL | SF | B T | F | NL | SF | B T | F | NL | SF | B T | F | NL | SF |
| 1 | 209 | 111 | 0 | 0.47 | 208 | 94 | 0 | 0.54 | 199 | 28 | 0 | 0.86 | 189 | 16 | 0 | 0.92 | 169 | 8 | 0 | 0.95 | 155 | 1 | 0 | 0.99 |
| 2 | 98 | 33 | 0 | 0.31 | 114 | 16 | 0 | 0.47 | 171 | 40 | 0 | 0.66 | 173 | 14 | 0 | 0.84 | 161 | 6 | 0 | 0.92 | 154 | 2 | 0 | 0.98 |
| 3 | 65 | 38 | 0 | 0.13 | 98 | 28 | 0 | 0.34 | 131 | 25 | 0 | 0.53 | 159 | 18 | 0 | 0.75 | 155 | 18 | 0 | 0.81 | 152 | 2 | 0 | 0.97 |
| 4 | 27 | 9 | 0 | 0.09 | 70 | 16 | 0 | 0.26 | 106 | 6 | 0 | 0.50 | 141 | 30 | 0 | 0.58 | 137 | 27 | 0 | 0.65 | 150 | 19 | 0 | 0.85 |
| 5 | 18 | 3 | 0 | 0.07 | 54 | 12 | 0 | 0.20 | 100 | 25 | 0 | 0.38 | 111 | 15 | 0 | 0.50 | 110 | 30 | 0 | 0.47 | 131 | 5 | 0 | 0.81 |
| 6 | 15 | 3 | 0 | 0.06 | 42 | 8 | 0 | 0.16 | 75 | 14 | 0 | 0.31 | 96 | 21 | 0 | 0.40 | 80 | 27 | 0 | 0.31 | 126 | 7 | 1 | 0.77 |
| 7 | - | - | - | - | 34 | 10 | 0 | 0.12 | 61 | 22 | 0 | 0.20 | 75 | 28 | 0 | 0.25 | 53 | 22 | 0 | 0.18 | 118 | 20 | 0 | 0.64 |
| 8 | 13 | 7 | 0 | 0.02 | 24 | 6 | 0 | 0.08 | 39 | 11 | 0 | 0.14 | 47 | 12 | 0 | 0.19 | 31 | 12 | 0 | 0.11 | 98 | 29 | 5 | 0.45 |
| 9 | 5 | 5 | 0 | 0.00 | 18 | 14 | 0 | 0.02 | 28 | 13 | 0 | 0.08 | 35 | 5 | 0 | 0.15 | 19 | 1 | 0 | 0.05 | 64 | 28 | 1 | 0.25 |
| 10 | - | - | - | - | 4 | 1 | 0 | 0.01 | 15 | 9 | 0 | 0.03 | 30 | 11 | 0 | 0.10 | 10 | 2 | 0 | 0.05 | 35 | 15 | 0 | 0.14 |
| 11 | - | - | - | - | - | - | - | - | 6 | 2 | 0 | 0.02 | 19 | 6 | 0 | 0.07 | 9 | 2 | 0 | 0.04 | 20 | 8 | 0 | 0.09 |
| 12 | - | - | - | - | - | - | - | - | 4 | 1 | 0 | 0.01 | 13 | 5 | 0 | 0.04 | - | - | - | - | 12 | 4 | 0 | 0.06 |
| 13 | - | - | - | - | 3 | 3 | 0 | 0.00 | - | - | - | - | 8 | 1 | 0 | 0.03 | - | - | - | - | 8 | 3 | 0 | 0.04 |
| 14 | - | - | - | - | - | - | - | - | - | - | - | - | 7 | 1 | 0 | 0.03 | 7 | 2 | 0 | 0.03 | 5 | 3 | 0 | 0.01 |
| 15 | - | - | - | - | - | - | - | - | 3 | 3 | 0 | 0.00 | 6 | 3 | 0 | 0.01 | 5 | 2 | 0 | 0.01 | 2 | 2 | 0 | 0.00 |
| 16 | - | - | - | - | - | - | - | - | - | - | - | - | 3 | 2 | 0 | 0.01 | 3 | 2 | 0 | 0.01 | - | - | - | - |
| 17 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | - | - | - | - | - | - | - | - | - | - | - | - | 1 | 1 | 0 | 0.00 | 1 | 1 | 0 | 0.00 | - | - | - | - |

**Source: Field survey, 2022. Note: T=Time; BT= Beginning Time, F=Fail, NL= Net Lost, SF=Survival Function**

While water provision, hives inspection and swarm and queen catcher had 89%, 80% and 73% adoption rate respectively. Although, supplementary feeding (30%), apiary cleaning (29%), queen breading (0%), pollen collection (0%), record keeping (22%), bee pollination service (0%), honey extractor (28%), thermometer (0%), hives shading (0%), pest and disease control (1%) had low adoption rate.

The Table revealed that bee suit had 111 failures (adoption) at time "1," with a survival rate of 47%, this implies that 53% of beekeepers adopt the technology (bee suit) within the first year of their beekeeping practice. Baiting had 94 failures (adoption) at time "1," with a survival rate of 54%. This implies that 46% of beekeepers adopt the technology (baiting) within the first year of their beekeeping practice. In time ‘2’ there were16 failures (adoption) with surviving rate of 47%. Kenya top bars had 28 failures (adoption) at time "1," with a survival rate of 86%. This shows that at time “1,” period about 24% of the observation (beekeepers) had failed (adopt) the technology. At time ‘2,’ period there were 40 failures (adoption) with surviving rate of 66%. However at time 3 and 4 periods, there were 24 and 6 failure respectively.

Water provision had 16 failures (adoption) at time "1," period with a survival rate of 92%. This implies that at time ‘1’ period 92% of the observations (beekeeper) were still thinking whether to adopt the technology or not. At time ‘2,’ period there were 14 failures (adoption) with surviving rate of 84%. However at time ‘3’, ‘4’ and ‘5’ periods, there were 18, 30 and 15 failures (adoption) respectively. Thus, about 50% of the observation (beekeepers) had fail during the ‘5’ time period. Hives inspection had 8 failures (adoption) at time "1," period with a survival rate of 95%. This Implies that at time ‘1’ period about 95% of the observations (beekeeper) were still nurturing whether to adopt the technology or not. At time ‘2,’ period there were 6 failures (adoption) with surviving rate of 92%. However at time ‘3’, ‘4’ and ‘5’ periods, there were 18, 27 and 30 failures (adoption) respectively. Lastly, swarm and queen catcher recorded one failure at time "1," period with a survival rate of 99%. At time ‘2,’ and ‘3’ period’s two failures were recorded each. However at time ‘4’ and ‘5’ periods, there were 19 and 5 failures (adoption) respectively. As at time ‘8’ 50% of the observations (beekeepers) had failed. In addition, at ‘6’ time period one lost was recorded, at time ‘8’ period five net losses were recorded while one lost was recorded at time ‘9’. This implies that, seven observations (beekeepers) discontinued the use of swarm and queen catcher which they attributed to lack of technical knowhow.

Level of utilization of bee products

Findings of the level of bee products utilization is presented in Table 3. The results showed that, aside honey, there was gross deficiency in bee product utilization, though bee wax was occasionally used.

Table 3 Distribution of respondent according to level of utilization of products

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Bee by-products | Weighted Sum | Weighted Mean | Remark | Rank |
| Bee wax | 515 | 2.4 | Occasionally | 2nd |
| Propolis | 254 | 1.2 | Never | 3rd |
| Bee venom | 258 | 1.2 | Never | 3rd |
| Honey | 636 | 3.0 | Always | 1st |
| Royal jerry | 212 | 1.0 | Never | 6th |
| Bee pollen | 212 | 1.0 | Never | 5th |

**Source: Field survey, 2022**

Due to their diverse industrial applications, bee wax and other bee products are in high demand on the international market. If all bee products are used efficiently, it has the potential to improve beekeepers' income and livelihood status and also lowering the unemployment rate in the study areas. Beekeepers who participated in wax processing, according to their responses, were unable to process wax to international standards, which has deterred many of them from doing so. Most of the respondents choose to sell their honey with comb or extract and trash the comb instead. Others extract honey without damaging the comb and return it to the hives, making it simpler for the bees to continue their honey making process. In respect to propolis, the study found poor method of opening of top bars either for inspection or harvesting destroys the propolis which is used by bees to seal opening within the hives. Also, the low utilization of propolis can be attributed to small hive size holding of most of the beekeepers which limit the quantity of propolis they can obtain. Bee venon, which is used to treat a wide range of ailments all over the world, necessitates a great deal of technical knowledge and medical supervision. This high technicalities and proper monitoring could be attributed to their low usage. In addition, bee pollen used by bees in producing bee bread requires a lot of technicalities for their usage too. Lastly, royal jelly as expected had low utilization rate due to lack of awareness

CONCLUSIONS AND RECOMMENDATION

From the study, it can be concluded that most of beekeepers were civil servant with low involvement of youth in beekeeping in the study areas. Also, bee suit has the fastest adoption rate followed by baiting and Kenya top bars while water provision, hives inspection had moderate adoption rate. Lastly, there is gross inadequacy in the utilization of bee products. Youth restiveness stemming from higher rate of unemployment has wreaked havoc in the study areas; therefore, the study recommended that policymakers and other relevant stakeholders should promote beekeeping among youth as their level of participation in beekeeping is low in the study areas.

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## ADOPTION OF RECOMMENDED COCOYAM PRODUCTION TECHNOLOGIES AMONG FARMERS IN ENUGU STATE, NIGERIA

1E. Nwafor; 2H. U. Muhammad; 2O. J. Ajayi and 2Y. Muhammed

1 National Examinations Council (NECO), Km 5, Bida Road, Minna, Niger State, Nigeria

2 Department of Agricultural Extension and Rural Development,

Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria.

Corresponding author’s e-mail: [ephraim4best@gmail.com](mailto:ephraim4best@gmail.com) Phone number: +2348033812973

ABSTRACT

*The study assessed adoption of recommended cocoyam production technologies among farmers in Enugu State, Nigeria. Multi-stage sampling procedure was used to select 245 cocoyam farmers. Structured questionnaire was used to collect primary data which was analyzed using descriptive statistics and adoption rate model. The results obtained showed that mean age of the farmers was 56 years. More than half (55.1%) of the farmers were male, while 82.4% were married and 84.1% acquired formal education. The mean household size of the farmers was 6 persons, mean farming experience was 24 years and mean farm size was 0.82 hectare. More so, only 20.4% of the farmers had access to credit facilities, while 48.6% had contact with extension agents and 26.1% were members of cooperative societies. Majority of the farmers adopted all the recommended cocoyam technologies such as fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May–June (99.2%), planting method through internodes at 1-2cm thickness (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%) among others. However, in terms of adoption level, 71.0% of the respondents indicated high level of adoption, while 29.0% of the respondents indicated partial adoption level. Most of the farmers agreed that the recommended cocoyam production technologies had relative advantages (=2.81) and compatible (=3.91) while some disagreed that it is complex to put into practice with mean score () of 2.89. The severe constraints identified by the farmers include high cost of labour (=2.85), problem of pests and diseases (=2.84), lack of fund (=2.80) and lack of improved varieties (=2.66) ranked 1st, 2nd, 3rd and 4th, respectively. It was therefore recommended that, drastic campaign should be carried out by relevant research institutes to scale-up full adoption of cocoyam technologies in production regions and beyond.*

**Keywords**: Adoption, Recommended technologies, Cocoyam production, Farmers

INTRODUCTION

Nigeria, like any other developing country is principally an agrarian nation that still face continuous food crisis as the level of food production is yet to keep pace with population demand (Amusa*et al*., 2011). Agriculture remains substantially a family business in Nigeria with low inputs and local technologies. The non-availability or inadequate use of modern agricultural technologies followed by low resource status of the farmers has made Nigeria’s agriculture to remain local (Adeniji, 2002; Ajayi*et al.,* 2017). However, the challenge of inadequate food production and shortage in the supply of raw materials has led to several innovations of improved technologies that will enhance production and living standard of farmers.

In spite of the various food crop production programmes initiated and implemented by Federal Government of Nigeria (FGN), there has been growing concern about the capability of Nigeria’s agriculture to satisfy the food requirement of a fast-growing population and to provide enough raw materials for the agro-based industries (International Institute for Tropical Agriculture (IITA), 2013). Emphasis therefore, is placed on production of tuber and root crops like cocoyam which has the potentials of alleviating poverty by improving the income earning capacity and food security of farmers in Nigeria. Root and tuber crops are among the most important groups of staple foods in many tropical African countries which constitute the largest source of calories for the Nigeria population (Olaniyan*et al*., 2013).

Among the root and tuber crops, cocoyam is the next in importance after cassava, yam and as well as sweet potatoes (National Root Crops Research Institute (NRCRI), 2012). Nigeria, Ghana and Japan are the world’s leading producers of cocoyam (Food and Agriculture Organization (FAO), 2014). The average production figure for Nigeria is 5.4 metric tonnes which accounts for about 37% of total world’s output of cocoyam (FAO, 2014). Cocoyam is regarded as a major crop especially in female headed households and has nutritional and industrial significance in flour industries (Onwubuja and Ajani, 2012). According to Chukwu*et al*. (2012), cocoyam is nutritionally superior to yam and cassava in terms of digestibility, crude protein content and essential minerals such as Calcium, Magnesium and Phosphorus.

Meanwhile, there has been decline in the yields of cocoyam in the past few years (National Agricultural Extension and Research Liaison Services (NAERLS, 2011). This is due to the usage of low-impact technologies available to the rural farmers, insufficient improved planting materials, weeds problems and poor soil that resulted to low productivity of cocoyam (Nwakor*et al*., 2015). The National Root Crops Research Institute (NRCRI), Umudike and extension agencies responsible to provides research-based information on improved cocoyam production technologies for adoption had been extending the frontier through various extension teaching methods to educate farmers (NRCRI, 2013).

It is against the backdrop of collaborative effort to prevent production of cocoyam in Nigeria from gradually going into extinction that this study was carried out, hence the following research objectives to describe the socio-economic characteristics of the cocoyam farmers; examine the recommended cocoyam production technologies and its level of adoption; assess the attributes of the recommended cocoyam production technologies and constraints associated with cocoyam production in the study area.

METHODOLOGY

Study Area

The study was conducted in Enugu State in South-East agro-ecological zone of Nigeria. The State lies between Latitude 7º 29' and 8º 55' North of the equator and Longitude 6º 26' and 7º 28' East of the Greenwich meridian with an altitude of 192 meters above sea level. Enugu State covers an estimated land area of 7,161-kilometre square (2,765sq mi) and ranks 29th out of the 36 States of Nigeria in terms of land area (Enugu State Ministry of Information (ESMI), 2019). The population is about 3,267,837 with population density of about 460-kilometre square (National Population Commission (NPC), 2006) and projected population of 5,078,975 as at 2020 using 3.2% growth rate (World Bank, 2019). The State is located in the tropical humid rain forest zone with derived savannah and experiences bi-modal rainfall pattern. Annual rainfall ranges between 1500mm – 2100mm, with mean temperature of 30.6°C (87.2°F) (ESMI, 2019). It has a well-drained fertile soil for agricultural purposes and the major occupation of the people is farming.

Sampling Procedure and Sample Size

A multi-stage sampling technique was used to select respondents for the study. In the first stage, Enugu-North agricultural zone was purposively selected due to preponderance of cocoyam farmers in the zoneout of the three Agricultural zones namely: Enugu-North, Enugu-East and Enugu-West. The zone consists of six Local Government Areas (LGAs) and eight extension blocks. In the second stage, four LGAs were randomly selected. Third stage involved selection of one extension block from each of the LGAs selected, while the fourth stage was random selection of two extension cells from each of the extension blocks to get eight extension cells. The fifth and last stage involved proportionate selection of two hundred and forty-five (245) cocoyam farmers using Taro Yamane (1967) formula based on the list of registered cocoyam farmers obtained from Enugu State Agricultural Development Programme (ENADEP).

Method of Data Collection

Primary data used for the study were collected by the researcher through the use of structured questionnaire complemented with interview schedule to obtain information on socio-economic characteristics of the farmers, recommended cocoyam production technologies, the adoption level, its attributes and constraints associated with cocoyam production.

Method of Data Analysis

Data collected was analyzed using descriptive statistics such as mean, standard deviation, frequency distribution count, percentage and charts. However, 5-point Likert rating scale of Strongly Agreed (5), Agreed (4), Undecided (3), Disagreed (2) and Strongly Disagreed (1) was used to categorized the attributes of recommended cocoyam production technologies with mean score of 3.0 as the decision rule, while 3-point Likert type rating scale of Very Severe (3), Severe (2) and Not Severe (1) was used to categorized the severity of the constraints with mean score of 2.0 as the decision rule. Also, the adoption rate model was used to generate the adoption score which was used to categorize the respondents’ level of adoption into Low adopters (less than 40%), Partial adopters (41 – 70%) and High adopters (greater than 70%).

**Model Specification**

The adoption rate model was used to measure the adoption score of the respondents as employed and modified from Zanu *et al.* (2012). The model is specified as:

AR = TAF 100 (1)   
Where;

AR = Adoption Rate

TAF = Total adoption score obtained by an individual farmer

MSO = Maximum score available

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

As revealed in the Table 1, about half (49.8%) of the respondents were within the age bracket of 51 – 70 years with a mean age of 56 years. This implies that most of the cocoyam farmers were aged but still engaged in productive activities. This finding is in contrast with the work of Uwandu*et al*. (2018) who reported that majority of farmers in their study area were within the youthful and middle age. More than half (55.1%) of the respondents were male, while 44.9% of them were female implying that male were more involved in cocoyam farming than female which could be due to the its tedious nature. Majority (82.4%) of the respondents were married, while 17.6% were not married (i.e. either singe, widowed or divorced). This implies that majority of the farmers were married with the main purpose for pro-creation of younger ones that could assist in farming activities. This finding agrees with Odoemekun and Anyim (2019) who reported that majority of farmers married purposely for pro-creation of young ones.

More so, more than half (56.3%) of the respondents had household size of between 5 – 10 people with a mean of 6. This implies that the farmers had relatively large household size which is an advantage in terms of farm labour supply. Majority (84.1%) acquired formal education (i.e. primary, secondary and tertiary) with a mean of 9 years of formal schooling. This implies that the farmers were literate which could help them to make better decisions as regards adoption of technologies. Educational level of an individual plays a significant role in sharpening the ability and mind of farmers for rational decision making.

Most (68.5%) of the respondents had farming experience between 11 – 40 years with a mean of 24 years of farming. This implies that the farmers had been into farming for long period of time which could enhance their favourable perception about adopting recommended cocoyam technologies. This agrees with Olaosebikan *et al*. (2019) who reported that majority of the respondents in their study area had long years of farming experience which help them to make sound decisions about their farms. Majority (88.6%) of the respondents had farm size of less than 1.1 hectares with a mean of 0.82. This implies that majority of the cocoyam farmers are operating small-scale farm holdings which could be due to competitive nature for farmland in the study area.

In terms of access to credit, majority (79.6%) of the respondents had no access to credit with only 20.4% who had access. This implies that majority of the farmers had no access to credit which could negatively affect adoption of technologies. Amount of credit available to farmers enhances the adoption of modern technologies. Access to credit is a catalyst for increased agricultural production and becomes imperative for adoption. About half (48.6%) of the respondents had contact with extension agents, while 51.4% had no contact. This implies that some of the respondents had contact with extension agents is expected to influence farmers’ decision to adopt recommended cocoyam technologies. Extension agents plays key role in dissemination of agricultural technologies that could improve production. More so, majority (73.9%) of the respondents were not members of cooperative societies while 26.1% of the respondents were members, implying low involvement of the farmers in cooperative societies. Membership of cooperative societies plays significant role in technology adoption behaviour of farmers.

Table 1: Distribution of the respondents based on their socio-economic characteristics (n = 245)

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Frequency | Percentages | Mean |
| Age (years) |  |  |  |
| < 31 | 9 | 3.7 | 56 |
| 31 – 50 | 84 | 34.2 |  |
| 51 – 70 | 122 | 49.8 |  |
| > 70 | 30 | 12.3 |  |
| Sex |  |  |  |
| Male | 135 | 55.1 |  |
| Female | 110 | 44.9 |  |
| Marital status |  |  |  |
| Married | 202 | 82.4 |  |
| Widowed | 32 | 13.1 |  |
| Single | 4 | 1.6 |  |
| Divorced | 7 | 2.9 |  |
| Household size |  |  |  |
| < 5 | 98 | 40.0 | 6 |
| 5 – 7 | 87 | 35.5 |  |
| 8 – 10 | 51 | 20.8 |  |
| > 10 | 9 | 3.7 |  |
| Educationalstatus |  |  |  |
| Primary | 102 | 41.6 | 9 |
| Secondary | 79 | 32.2 |  |
| Tertiary | 25 | 10.3 |  |
| Non-formal | 39 | 15.9 |  |
| Experience (years) |  |  |  |
| < 11 | 55 | 22.4 | 24 |
| 11 – 20 | 66 | 26.9 |  |
| 21 – 30 | 54 | 22.0 |  |
| 31 – 40 | 48 | 19.6 |  |
| > 40 | 22 | 9.1 |  |
| Farm size (hectares) |  |  |  |
| < 1.1 | 217 | 88.6 | 0.82 |
| 1.1 – 2.0 | 28 | 11.4 |  |
| Access to credit |  |  |  |
| Yes | 50 | 20.4 |  |
| No | 195 | 79.6 |  |
| Extension contact |  |  |  |
| Yes | 119 | 48.6 |  |
| No | 126 | 51.4 |  |
| Cooperativemembership |  |  |  |
| Yes | 64 | 26.1 |  |
| No | 181 | 73.9 |  |

**Source: Field Survey, 2022**

Adoption of recommended cocoyam technologies by the respondents

The result in Table 2 presents the recommended cocoyam technologies adopted by the respondents. The findings revealed that majority of the farmers adopted all the recommended cocoyam technologies such as fertilizer application (NPK 15:15:15) after planting (99.6%), timely planting between May – June (99.2%), planting method through internodes at 1-2cm thickness (98.8%) and harvesting by digging around cocoyam plant at about 30cm (98.8%) among others. This implies that the farmer adopted all the recommended cocoyam technologies in the study area. This is in corroboration with the report of National Root Crops Research Institute (NRCRI) (2013) that farmers adopted recommended cocoyam technologies developed and transferred to them to boost production.

Table 2: Distribution of the respondents based on recommended cocoyam technologies adopted

|  |  |  |
| --- | --- | --- |
| **Recommended cocoyam technologies** | **Adopted (%)** | **Not Adopted (%)** |
| Timely planting between May – June | 243 (99.2) | 2 (0.8) |
| Plant spacing of 1m x 1m | 204 (83.3) | 41 (16.7) |
| Planting method using heap/ridge top | 242 (98.8) | 3 (1.2) |
| Cocoyam intercropping technique | 228 (93.1) | 17 (6.9) |
| Cocoyam mini-sets of about 25g | 224 (91.4) | 21 (8.6) |
| Fertilizer application (NPK 15:15:15) after weeding | 244 (99.6) | 1 (0.4) |
| Weed control by herbicides | 240 (98.0) | 5 (2.0) |
| Mulching using crop residues | 222 (90.6) | 23 (9.4) |
| Pest control by pesticides | 240 (98.0) | 5 (2.0) |
| Harvesting by digging around cocoyam plant at about 30cm | 242 (98.8) | 3 (1.2) |

**Source: Field Survey, 2022 \*multiple responses**

**Note: Numbers in parenthesis are the percentages**

More so, Figure 1 shows the distribution of the respondents based on adoption level of recommended cocoyam technologies in the study area. The result revealed that in overall, majority (71.0%) of the respondents indicated high level of adoption, while 29.0% of the respondents indicated partial adoption level of recommended cocoyam technologies. The high adoption level implies that the technologies were useful and appropriate for the farmers to adopt for improved production and productivity. This finding is in agreement with Ogunwale (2012) who reported that research output do not serve any useful purpose until it is introduced to farmers, adopted by them and put into practice on their farms.

**Figure 1: Level of recommended cocoyam technologies adoption by respondents**

Perceived attributes of recommended cocoyam technologies by respondents

The perceived attributes of technologies considered in the study includes the relative advantage, compatibility and complexity (i.e. ease of understanding the innovation). As shown in Figure 2, most (69.0%) and 66.1% agreed that the recommended cocoyam production technologies had relative advantages and compatible with their existing practices with mean score () of 3.81 and 3.91, respectively. However, 38.4% of the respondents agreed and disagreed respectively that recommended cocoyam production technologies is complex to put into practise with mean score () of 2.89. Adoption of agricultural technologies is a function of a number of attributes and factors. This is in line with the work of Ayoade*et al.* (2011) who reported that the farmers’ perception on attributes of innovations are related to rates of innovations’ adoption.

**Figure 2: Perceived attributes of the recommended cocoyam technologies by respondents**

Constraints faced by the respondents in cocoyam production

Distribution of the respondents according to constraints associated with cocoyam production is presented in Table 3. Although, there was no general consensus on the constraints perceived by the farmers to hinder cocoyam production, however, the severe constraints identified by the respondents in the study area include high cost of labour (= 2.85),problem of pests and diseases (= 2.84), lack of fund (= 2.80) and inadequate improved varieties (= 2.66) ranked 1st, 2nd, 3rd and 4th, respectively. Labour as one of the important factors of production is usually in high demand especially where family labour is not available. Farmers therefore need to pay wages for hired labour at every stage of farming activities which is often on high price. Also, the role of credit to agricultural development cannot be over-emphasized as it enables farmers to advantageously utilize recommended production inputs for increased output. This finding is in agreement with that of Ogada*et al.*(2014) who reported that paucity of funds and lack of credit access constraints the adoption of improved technologies.

Other severe constraints as identified by the respondents were challenges of herdsmen (= 2.56), inadequate planting materials (= 2.40), high costs of technologies (= 2.22), poor extension services (= 2.13), complexity of cocoyam technologies (= 2.11) and inadequate farmland (= 2.66) ranked 5th, 6th, 7th, 8th, 9th and 10th, respectively. This is in line with the work of Acheampong*et al.* (2015) who reported that challenges to optimal production of cocoyam include decreasing rainfall and soil condition, loss of forests, weak technical and institutional support as well as high cost of inputs.

**Table 3: Distribution of the respondents based on constraints faced in cocoyam production**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Recommended cocoyam technologies** | **SC** | **LSC** | **NC** | **WS** | **WM** | **Rank** | **Remark** |
| High cost of labour | 209 | 35 | 1 | 698 | 2.85 | 1st | Severe |
| Problems of pests and diseases | 213 | 24 | 8 | 695 | 2.84 | 2nd | Severe |
| Lack of fund | 200 | 41 | 4 | 686 | 2.80 | 3rd | Severe |
| Inadequate improved varieties | 162 | 83 | 0 | 652 | 2.66 | 4th | Severe |
| Challenges of herdsmen | 187 | 9 | 49 | 628 | 2.56 | 5th | Severe |
| Inadequate planting material | 114 | 115 | 16 | 588 | 2.40 | 6th | Severe |
| High cost of technologies | 75 | 149 | 21 | 544 | 2.22 | 7th | Severe |
| Poor extension services | 75 | 128 | 42 | 523 | 2.13 | 8th | Severe |
| Complexity of the cocoyam technologies | 65 | 141 | 39 | 516 | 2.11 | 9th | Severe |
| Inadequate farmland | 90 | 88 | 67 | 513 | 2.09 | 10th | Severe |
| Poor soil condition | 47 | 130 | 68 | 469 | 1.91 | 11th | Not Severe |
| Cultural background of the people | 28 | 78 | 139 | 379 | 1.55 | 12th | Not Severe |
| Lack of ready market | 37 | 42 | 166 | 361 | 1.47 | 13th | Not Severe |

**Source: Field Survey, 2022**

**Note: SC=Severe Constraints (3), LSC=Less Severe Constraints (2), NC=Not a Constraints (1), WS=Weighted Sum, WM=Weighted Mean. Bench mean score is 2.00.**

CONCLUSION AND RECOMMENDATIONS

Based on the findings of the study, it was concluded that the cocoyam farmers were aged but still engaged in cocoyam production, married and educated with at least secondary education. However, there was poor access to credit, fair contact with extension agents and poor cooperative membership. The farmers adopted all the recommended cocoyam production technologies with little variation. Thus, adoption level was high. The recommended cocoyam production technologies has relative advantages and compatible with farmers’ practices but not complex. Major severe constraints are high cost of labour, problem of pests and diseases, and lack of fund. The study reported high level adoption of recommended cocoyam technologies, it was therefore recommended that more campaign should be carried out by relevant research institutes through extension agencies to ensure total adoption and scaling-up in other regions. The farmers should organize themselves into cooperative societies in order to harness benefits accrued from cooperative participation such as access to credit, extension services and training in relation to cocoyam production.

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## INNOVATIVE APPLICATION IN MANAGEMENT OF PROBLEMATIC SOIL (ACIDIC SOIL) UNDER MAIZE PRODUCTION IN NIGER STATE, NIGERIA

A. Abdullahi; M. Ibrahim; I.S. Umar

Department of Agricultural Extension and Rural Development, Federal University of Technology, Minna, Nigeria

\*Corresponding author E-mail: [abdulevuti061@gmail.com](mailto:abdulevuti061@gmail.com)

Phone number: +2348069559570

ABSTRACT

*The study examined effects of innovation application on management of problematic soil (acidic soil) in selected Local Government Area of Niger State. Multi-stage sampling techniques were used to select 180 project farmers on which primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage and mean) and OLS regression. The results obtained showed that majority (60.0%) of the project farmers in the study areas source their information on innovative means of managing problematic soil from radio, 64.8% from friends and family, and 48.0% from extension agent. Meanwhile, Agric. lime 3WBP (=4.0), Agric. lime +FYM+ NPK (=3.9), Agric lime + NPK (=3.8), Agric. Lime (=3.8) and FYM+NPK (=3.8) were the prevalent innovation application adopted by project farmers for maize production in the stud areas. The OLS regression result showed that farming experience (89.2786), relative advantage (46.0641), compatibility (1110.225) and seed rate (91.9084) had direct relation with maize output while complexibility (-353.614) and cost (-337.2121) had inverse relation with maize output. The study recommended that OCP Africa should be encouraged by the project coordinators to establish their “One Stop Shop” in the study area to enhance utilization of the technology (package).*

**Keywords:** Innovation, adoption, lime, problematic soil, management

INTRODUCTION

Land is an asset of enormous importance to billions of rural dwellers in the developing world. Right from creation, man depends on land for his basic needs of life. Martin (2010) describes land as a gift of nature to man which remains the most important factor of production. The rural dwellers depend on the environment, especially natural resources such as land, for the satisfaction of their basic needs. Land is essential natural resources, particularly land for agriculture (Umukoro, 2014). The economic development of most developing countries, including Nigeria, however, revolves, largely around the exploitation and use of land resources especially in the primary industry such as, agriculture (Titilola and Jeje, 2008). Nigeria is blessed with arable land and fresh water resources when viewed as a whole, with approximately 61 million hectares of land cultivable, while the total renewable water resource is estimated at about 280 km3 per year (Victor, 2018). Soil conditions and water availability, if effectively managed, will help boost food production and address the food crisis in the nation. Despite the vast arable land in Nigeria, food security is still a major challenge in the country. This is majorly due to socio-institutional constraints, types of farming systems and the nature of soil. Soil acidity, which is the major problematic soil particularly in the study area, poses serious land degradation thereby reducing yield of crops especially maize (Z*ea mays*). The acidification of soil may be a natural occurrence or aggravated by farmers' activities. Soil acidity is usually referred to because of its impact on crop yields as it make soil nutrients out of reach of the plant, leading to stunting of the root system. As a result, the plant also becomes less tolerant to drought (Jérôme *et al.,* 2019). As land deteriorates in quality, the poor become poorer due to low output. Therefore, proper management of the valuable resource is vital to sustain long-term agricultural productivity. Thus, the study evaluates the effects of innovation application on the management of problematic soil (acidic soil). Specifically, the study aimed to identify the sources of innovation of project farmers, determine level of innovation application by the project farmers, and examine the effects of innovation application on problematic soil by project farmers output

METHODOLOGY

The study was carried out in Niger State which is located within the Latitude 10°00′N and Longitude 6°00′E with annual rainfall varying from 1300mm in the North to 1600mm in the south. The State covers a total land area of 76,363 square km with a population of 3,950,249 according to 2006 Population Census.

Multi-stage sampling techniques were employed to select 180 respondents based on National Institute of Soil Scientist (NISS) descriptive. Primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (such as mean, frequency distribution count and percentages) and inferential statistics (such as OLS regression). The algebraic specification of the model is given as:

Y= (β1X1) + e, (1)

Where; Y = Maize output of the project beneficiaries measured in kilogram (ha); β1 = Vector of the parameter estimated hypothesized to influence the depending variables; X1= The vector of explanatory variables.

The model in its implicit form is specified as: Y= *f* (FM, LU, AC, SE, FE, AG, ED, FM, IF,EC, RA, CX, OB, TR, CP, AL, NPK, SR, S, FM, SSP, UR and CT) (2)

The explicit functional forms of the multiple regression model were expressed as:

Y = βo + β1FM+ β2LU+ β3AC+ β4SE+ β5FE+β6 AG + β7 ED + β8 FM + β9 MC + β10 AC + β12 IF + β12 IN + β13 EC + Ui (3)

Where; Y = Maize output (Kg); FM= Farm size (hectare); LU= Labour usage (mandays); AC= Agro-chemicals (Liters) ; SE= Seeds (kg); AG= Age (years); ED= Education (years); FM= Farming experience (years); EC = Extension contact (Numbers of contact); SR = Seed rate (kg); S = Spacing (cm); RA = Relative advantage(Dummy 1 if yes and 0 if otherwise); CX = Complexity (Dummy 1 if yes and 0 if otherwise); OB = Observability (Dummy 1 if yes and 0 if otherwise); TR = Triability (Dummy 1 if yes and 0 if otherwise); CP = Compatibility (Dummy 1 if yes and 0 if otherwise); CT = Cost ₦; *β*o = constant; *β*1*…β*16 = coefficients of the independent variables; Ui = Error term

ln = Natural log

RESULTS AND DISCUSSION

Sources of Information by the Project Farmers

The results presented in Table 2 revealed that radio (60.3%), friends and family (64.4%) and extension (48.0%) were the major sources of information to project farmer on improved problematic soil management in the study area. The low utilization of Television as a source of information in the study area could be attributed to epileptic power supply by Power Holding Company of Nigeria (PHCN). It could be attributed to the high cost of TV set.

Table 1: Distribution of respondent according to sources of innovation

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Pool | | Bosso | | Lapai | | Mokwa | |
| Sources | Freq. | % | Freq. | % | Freq. | % | Freq. | % |
| Radio |  |  |  |  |  |  |  |  |
| Yes | 108 | 60.3 | 32 | 53.3 | 43 | 71.7 | 37 | 62.7 |
| Television |  |  |  |  |  |  |  |  |
| Yes | 9 | 5.0 | 2 | 3.3 | 4 | 6.7 | 3 | 5.0 |
| Friends and family |  |  |  |  |  |  |  |  |
| Yes | 116 | 64.8 | 38 | 63.3 | 39 | 65.0 | 39 | 64.1 |
| Extension agent |  |  |  |  |  |  |  |  |
| Yes | 93 | 48.0 | 30 | 50 | 30 | 50.0 | 33 | 55.9 |

**Source**: Field Survey, 2021

Level of innovation application by the project farmers

From the result in Table 2 revealed that Agric. lime 3WBP (=4.0), Agric. Lime +FYM+ NPK (=3.9), Agric lime + NPK (=3.8), Agric. Lime (=3.8) and FYM+NPK (=3.8) were the prevalent innovation adopted by project farmers for maize production. The use of agricultural lime was generally adopted across the study areas to reduce the acidity of the soil. Majority of farmer’s cultural practices including bush burning, method of fertilizer application, clean clearing and crop removal among others leads to acidification of soil. Also, natural occurrences like leaching may also cause acidification of soil. Thus the agricultural liming introduced by the project met the felt needs of project beneficiaries which accounted for it general acceptance and adoption across the study areas. Agric lime + NPK was the second mostly adopted innovative practice across the study areas for maize production. Generally maize is a cereal crop which requires high Nitrogen for it growth and development. Thus proper combination of lime and nitrogen as exemplified by the project leads to their higher adoption across the study areas. NPK (Special blend (OCP) were also highly adopted across the study areas. The reason for this result could be attributed to the fact that NPK special blended OCP were specially formulated to enhance the productivity of nitrogen demanding crops. The result demonstration as shown by the project might likely be the reason for it adoption. Spacing 25 by 75cm was highly adopted across the study areas. Proper spacing help to reduce the competition for soil nutrient, enhance proper growth and facilitate weed control. It was gathered that across the study areas farmers planted randomly using legs this tends to reduce the planting density and invariably reduce the yield and productivity of farmers. This may likely be the reason for the adoption of proper spacing across the study areas.

**Table 2: Distribution of respondent according to Innovation application**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Bosso | | | | | | | Lapai | | | | | | | Mokwa | | | | | | | Pooled | | | | | | |
| Variable | A | I | E | T | A | WS | WM | A | I | E | T | A | WS | WM | A | I | E | T | A | WS | WM | A | I | E | T | A | WS | WM |
| Agric. Lime | 8 | 1 | 14 | 7 | 30 | 230 | 3.8\* | 9 | 0 | 18 | 4 | 29 | 224 | 3.7\* | 7 | 0 | 18 | 9 | 25 | 222 | 3.8\* | 24 | 1 | 50 | 20 | 84 | 676 | 3.8\* |
| Agric. lime 3WBP | 5 | 0 | 14 | 10 | 31 | 242 | 4.0\* | 6 | 0 | 20 | 8 | 26 | 228 | 3.8\* | 4 | 0 | 21 | 7 | 27 | 230 | 3.9\* | 15 | 0 | 55 | 25 | 84 | 700 | 3.9\* |
| NPK(Spec. blend (OCP) | 23 | 6 | 14 | 12 | 5 | 150 | 2.5 | 27 | 8 | 12 | 7 | 6 | 137 | 2.3 | 31 | 5 | 13 | 6 | 4 | 124 | 2.1 | 84 | 16 | 39 | 25 | 84 | 753 | 3.0\* |
| Urea 46% N | 4 | 4 | 23 | 16 | 13 | 210 | 3.5\* | 5 | 6 | 26 | 8 | 15 | 202 | 3.4\* | 3 | 7 | 30 | 4 | 15 | 198 | 3.4\* | 12 | 17 | 79 | 28 | 43 | 610 | 3.4\* |
| farmyard manure | 4 | 6 | 24 | 12 | 14 | 206 | 3.4\* | 8 | 4 | 24 | 7 | 17 | 201 | 3.4\* | 7 | 5 | 23 | 4 | 20 | 202 | 3.4\* | 19 | 15 | 71 | 23 | 51 | 609 | 3.4\* |
| Farmer practice (NPK only) | 5 | 6 | 24 | 11 | 14 | 203 | 3.4\* | 5 | 3 | 20 | 11 | 21 | 220 | 3.7\* | 4 | 2 | 26 | 7 | 20 | 214 | 3.6\* | 14 | 11 | 70 | 29 | 55 | 637 | 3.6\* |
| Agric lime + NPK | 4 | 4 | 14 | 16 | 22 | 228 | 3.8\*| | 4 | 2 | 11 | 12 | 31 | 244 | 4.1\* | 3 | 2 | 11 | 12 | 31 | 243 | 4.1\* | 11 | 8 | 36 | 40 | 84 | 715 | 4.0\* |
| Agric. Lime +FYM+ NPK | 5 | 2 | 15 | 10 | 28 | 234 | 3.9\* | 4 | 1 | 15 | 11 | 29 | 240 | 4.0\* | 3 | 5 | 16 | 11 | 24 | 225 | 3.8\* | 12 | 8 | 46 | 32 | 81 | 699 | 3.9\* |
| FYM+NPK | 3 | 2 | 22 | 13 | 20 | 225 | 3.8\* | 9 | 0 | 18 | 4 | 29 | 224 | 3.7\* | 7 | 6 | 22 | 8 | 16 | 197 | 3.3\* | 18 | 9 | 66 | 33 | 53 | 631 | 3.5\* |
| Seed rate 290kg per ha | 9 | 4 | 13 | 15 | 19 | 211 | 3.5\* | 6 | 6 | 10 | 19 | 19 | 219 | 3.7\* | 5 | 8 | 11 | 17 | 18 | 212 | 3.6\* | 20 | 18 | 34 | 51 | 56 | 642 | 3.6\* |
| Spacing 25by 75cm | 7 | 5 | 11 | 13 | 24 | 222 | 3.7\* | 5 | 5 | 13 | 14 | 23 | 225 | 3.8\* | 4 | 4 | 13 | 16 | 22 | 225 | 3.8\* | 16 | 14 | 37 | 43 | 69 | 672 | 3.8\* |

**Source**: Field survey, 2021 Note: A= Awareness, I= Interest, E=Evaluation, T=Trial, A=Adoption and \*= significant.

Effects of innovation application on problematic soil by project farmers output

The OLS regression estimate result presented in Table 3 revealed coefficient of determination (R2) value of 0.8750. This implies that approximately about 88% variation in maize output of project farmers were explained by the independent variables included in the model, while the remaining 12% unaccounted variation could be due to error or other variables not captured in the model. The F – ratio is statistically significant at 1% probability level implying the perfect fit of the model and good at predicting the observed data.

The coefficient of farming experience (89.2786) was positive and significant at 5% probability level. This implies that a unit increase in farming experience may leads to 89.28 increases in the maize output of project farmers. The coefficient of relative advantage (46.0641) was positive and significant at 1% probability level. This implies that a unit increase in relative advantage may leads to 46.06 increases in the maize output of project farmers. The coefficient of compatibility (1110.225) was positive and significant at 5% probability level. This implies that a unit increase in compatibility may leads to 1110 increases in the maize output of project farmers. The coefficient of seed rate (91.9084) was positive and significant at 1% probability level. This implies that a unit increase in seed rate may leads to 91.9 increases in the maize output of project farmers. The coefficient of complexity (-353.614) and cost (-337.2121) were negative and significant at 5% and 10% probability levels, respectively. This implies that a unit increase in complexity and cost of innovation may leads to 353 and 337 decreases in the maize output of project farmers.

Table 3: Regression estimate on effects of innovation application on problematic soil by project farmers

|  |  |  |
| --- | --- | --- |
| Variables | Coefficient | t-value |
| Farm size | -606.5399 | -1.47 |
| Labour usage | 282.8499 | 0.96 |
| Agro-chemicals | 4.1506 | 0.35 |
| Seeds | 3.5124 | 0.17 |
| Age | 79.8519 | 0.71 |
| Education | -4.9218 | -0.44 |
| Farming experience | 89.2786\*\* | 2.36 |
| Extension contact | -21.4512 | -0.11 |
| Relative advantage | 46.0641\*\*\* | 3.94 |
| Complexity | -353.614\*\*\* | -2.50 |
| Observability | 123.9014 | 0.58 |
| Triability | 437.5892 | 0.44 |
| Compatibility | 1110.225\*\* | 2.15 |
| Cost | -337.2121\* | -1.93 |
| Seed rate | 91.9084\*\*\* | 4.03 |
| Spacing | .3240 | 0.06 |
| Constant | -1254.841 | -1.15 |
| R-squared | 0.8750 |  |
| Adjusted R-squared | 0.8301 |  |
| F-ratio | 0.0000 |  |

**Source:** Field Survey**, (2021)** \*Note figures in parenthesis are the T-values \*\*\* significant 1% probability level, \*\* significant 5% probability level and \* significant 10% probability level

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## EFFECTS OF RISK MANAGEMENT STRATEGIES ON POVERTY STATUS OF RICE FARMERS IN NIGER STATE, NIGERIA

\*Abdullahi, M1, Abdullahi, A2 and Abdullahi. M3

**1**Department of Agricultural Economics and Extension, Kaduna State University, Kaduna.

2Department of Agricultural Economics, Ahmadu Bello University, Zaria.

3Division of Agricultural Colleges, Ahmadu Bello University, Zaria.

\* Corresponding Author: [abdullahiman84@gmail.com](mailto:abdullahiman84@gmail.com). GSM: 08144889869

ABSTRACT

*This paper examined the effects of risk management strategies on poverty status of rice farmers in Niger State. Primary data were used, collected using semi-structured questionnaire. A multistage sampling procedure was employed to select 377 respondents for this study. Data were analysed using Tobit Regression Model. The objective was to assess how farmers’ risk management strategies affect their poverty status in the study area. The results revealed that contract farming improved productivity in the contracted crop resulting in additional increase in income for the farmers. The additional income from off-farm employment was found to reduce poverty levels through its positive contribution to welfare indicator. Thus, farmers that participated in this aspect of farming are better off due to the additional income from their involvement in these activities. The study also revealed that the poverty status of the farmers in the study area was significantly influenced by the risk management strategies they adopted. Thus the farmers were generally not poor as most of them engaged in production diversification which led to reduction in the risk situations they faced. Farmers are therefore encouraged to adopt more risk-management strategy especially production diversification as it would lead to reduction in the probability of the farmers becoming poor.*

**Keywords:** Poverty,Risk,Management Strategies, Diversification, Rice Farmers.

INTRODUCTION

Poverty remains widespread within farmers in Nigeria. This is no longer a controversial issue. What is controversial is the choice of appropriate risk management strategies for poverty reduction (Nguezet, *et al.,* 2011).Despite the numerous programmes embarked upon by the Nigerian government over the years to improve the livelihood of the rice farmers; the average Nigerian rice farmer remains poor. The uncertainties inherent in weather, yields, prices, government policies, and other factors that impact on farming can cause wide swings in farm income. (USDA, 2022).

Statistics indicate that over 60 percent of the population of Niger state are farmers engaged in production of rice, yam, melon and groundnut (Niger State Agricultural and Mechanisation Development Authority (NAMDA), 2015). These farmers operate mainly within the limits of their insufficient resources which tend to constrained their capacity to employ most recommended risk management technologies. This diminishes their ability to optimize crop production for both domestic consumption and income generation.

There have been studies on poverty and risk management strategies in Nigeria. The closest study to this present study is the work of Akosua (2012), which addressed poverty, risk and management strategies of rice farmers in selected local government areas of Plateau state. The studies however did not relate risk attitudes to rice farmer's poverty. However, this study assessed the effects of risk management strategies on poverty status of rice farmers in the study area. Niger State is one of the major food producers in Nigeria. In 2017, the state was ranked the leading rice producer in the country (National Agricultural Extension and Research Liaison Services (NAERLS), 2017). Yet, the poverty level in the state rose to 61.2% in the same year (National Bureau of Statistic (NBS, 2017).

RESEARCH METHODOLOGY

Primary data were used for this study. The data were collected using semi- structured questionnaire administered to rice farmers in Niger state. The state lies on latitude 3.20° East and longitude 11.30° North. The estimated land area is 76,363 square kilometres with a population of 3,950,249 people (NPC, 2006). The state consists of 25 Local Government Areas (LGAs) with three major ethnic groups (Nupe, Gbagyi and Hausa) and three Agricultural zones namely I, II and III (NAMDA, 2015). Six (6) LGAs, 2 from each agricultural zone were purposively selected due to high concentration of rice farmers in these areas. Thirty (30) villages, 5 from each LGA were randomly selected. Finally eighteen percent (18%) of the sample frame (1885) was used as the sample size. In all, 377 rice farmers were randomly selected. Tobit regression was used to determine the effect of the explanatory variables on the probability of being poor. The empirical model is specified as follows:

Yi = P0 X0 + P1 X1 + P2 X2 + P3 X3 + P4 X4 + P5 X5 + P6 X6 + P7 X7 + P8 X8 + P9 X9 + P10 X10 + P11 X11 + P12 X12

+ P13 X13 + P14 X14 + P15 X15 + ei..............................1

Where:

Yi = Poverty gap

ei = Truncated error term

P0  =Intercept term

P1 - P15 = Slope coefficients

X1 = Sharing in crops

X2 = Contract farming

X3 = Spread of sales

X4 = Off-farm employment income

X5 = Risk management training

X6 = Production diversification

X7 = Gender of farmer

X8 = Age of farmer in years

X9 = Educational level in years

X10 = Marital status

X11 = Number of household size

X12 = Years of farming experience

X13 = Number of years in cooperative membership

X14 = Farm size in hectares

X15 = Number of contact with extension agent

RESULTS AND DISCUSSION

**Table 1: Effects of risk management strategies on farmers’ poverty status**

|  |  |  |  |
| --- | --- | --- | --- |
| Poverty status | Coef. | Std. Err. | P-Value |
| Sharing in crops | 0.501 | 0.396 | 0.207 |
| Contract farming | -0.199 | 0.378 | 0.598\*\*\* |
| Spread of sales | 0.113 | 0.412 | 0.007 |
| Off farm employment income | 0.391 | 0.526 | 0.133\*\* |
| Risk management training | 0.0075 | 0.0142 | 0.53 |
| Production diversification | -0.0061 | 0.0481 | 0.05\* |
| Gender | 0.407 | 0.363 | 0.264 |
| Age | 0.022 | 0.024 | 0.364 |
| Educational level | -0.055 | 0.039 | 0.163\*\* |
| Marital status | -0.594 | 0.614 | 0.334 |
| Household size | 0.048 | 0.138 | 0.725 |
| Farming experience | -0.076 | 0.044 | 0.084\* |
| Membership | -0.052 | 1.461 | 0.972 |
| Farm size | 0.047 | 0.081 | 0.559 |
| Access to extension | -0.123 | 1.361 | 0.928 |
| Constant | 5.233 | 4.646 | 0.261 |
| /Sigma | 2.717 | 0.144 |  |
| Log likelihood | -549.546 |  |  |
| LR chi2 (15) | 647.32 |  |  |
| Pseudo R2 | 0.3796 |  |  |
| Prob > chi2 | 0.0000 |  |  |
| Marginal effects after tobit |  |  |  |
| y= effects (predict) | 0.604 |  |  |

\*\*\*Significant at 1% level \*\*Significant at 5% level \*Significant at 10% level

The result of the Tobit model is presented in Table 1. The result shows that 5 out of 16 variables included in the model are statistically significant with farmer’s poverty status. The estimated coefficient (-0.199) of contract farming is negative and statistically significant (p < 0.01) in influencing farmer’s poverty status. This implies that, an increase in contract farming as risk management strategy reduces the farmer’s probability of being poor. Engaging in contract farming improved productivity in the contracted crop and could spill over to other crops, resulting in additional increase in income. The result corroborated with the findings of Diagne & Zeller (2001) that there is a negative relationship between contract farming and farmer’s poverty in Malawi.

Similarly, the coefficient (0.391) of off-farm employment income is positive and significant at (p < 0.05) level. This implies that, an increase in off-farm employment as risk management strategy among rice farmers, would lead to an increase in the probability of the farmers becoming poor in the study area. Although, this finding is at variance with the *a priori* expectation where increase in off-farm activities should reduce the poverty level. This finding is at variance with the findings of Oladimeji *et al*., (2015) who asserted off – farm income as an important determinant of poverty and reported that an increase in off farm activities will lead to extra household income which could reduce the poverty level of the farmers. Furthermore, the coefficient (-0.0061) of productions diversification was found to be negative and significant at (p< 0.10) level. This implies that, an increase in productions diversification as risk management strategy among rice farmers will lead to reduction in the probability of the farmers becoming poor by 0.6%.

The coefficient of socioeconomic variables revealed that the level of education is significant (p < 0.05) and inversely related with the poverty status of the rice farmers in the study area. This implies that as the level of education of the farmers increase the poverty status of the farmers decrease. The coefficient of farming experience was also found to be negative and statistically significant (p < 0.10) with the poverty status of the farmers. This means that an increase in the level of education reduces the probability of the farmers becoming poor.

CONCLUSION AND RECOMMENDATION

Essentially, farmers in the study area are conscious of the risk management strategies as most of them adopted one or more risk management strategies which affect their poverty status at various significant levels. Hence, production diversification, off-farm employment and contract farming have attracted attention in the study area as a potential catalyst for mitigating risk situations in farming and improving poverty status of the farmers. Therefore, to achieve high livelihood and more stable income efforts should be geared towards training the farmers on the appropriate management strategies with emphasis on in production diversification in the study area.

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## EFFECTS OF FARMER-HERDER’S CONFLICT ON THE FARMERS PRODUCTIVITY IN ADAMAWA STATE, NIGERIA

Enock; I. Ojo; M. A. Osaghale A. I.

Department of Agricultural Economics and Farm Management, Federal University of Technology Minna, Niger State, Nigeria

\*Corresponding author E-mail and Phone number: [nunayahyel@gmail.com](mailto:nunayahyel@gmail.com) +2347035222230

ABSTRACT

*The study examined the effects of farmer-herder conflict on the productivity of farmers in Adamawa State, Nigeria. Multistage sampling technique was used to select 300 food crop farmers from 180 conflict-affected areas and 120 less affected areas. Primary data were collected from the respondents using a structured questionnaire supplemented with an interview schedule. Data were analyzed using descriptive and inferential statistics. The result showed that loss of human life/properties, reduction of social activities, high cases of rape, theft and robbery, overdependence and begging, acquiring of weapons/arms and sexual harassment of women were the major effects conflicts of on socio-economic lifestyle of the farmers. Also, households size (3333), labour inputs (3.3391) and conflict (-5746) were the major factors influencing the productivity of food crop farmers in the study area. The study recommended that Federal and State government should involve conflict resolution expertise for peace building dialogue and also involve local leaders in peace building policies.*

**Key words:** Conflict; Productivity; Herder; Farmer; Local leaders

INTRODUCTION

Agriculture is the backbone of Nigeria economy which serves as sources of livelihood and economic sustenance for the majority of Nigeria’s teeming population, (Heady and Hodge, 2009). About 70% of the Nigeria’s populations are farmers. Farmers and herders are the major players in agricultural activities that significantly contribute to meeting the nutritional needs of the country and thus contributing to national food security and economic development (Onuoha and Ezirim, 2015). The herdsmen and farmers represent one of the most highly populated groups in Adamawa State, (Bello, 2013). It is worthwhile to note that in the past, agricultural farmers and pastoralist groups had a cordial and stable relationship that enabled the people to work side by side for decades, though there were usually points of contention between the two groups that were normally resolved peacefully (Christopher and Ademola-Adelehin 2017). This type of relationship, which has existed for many centuries, has sadly been cut short by numerous conflicts that have broken out across the various regions and resulted in extensive violence, fatalities, and internal displacement of people. Farmers and Fulani pastoralists continue to engage in violent clashes as a result of social and economic issues, these conflicts have constituted serious threats to the means of survival and livelihoods of both the farmers and herders with what both groups are tenaciously protecting. Farmers-herders’ conflicts do not only have a direct impact on the lives and livelihoods of those involved; they also disrupt and threaten the sustainability of agriculture, especially food production and security in Nigeria. It also results in hunger and a shortage of nutritious, safe food, which consequently affect the gross domestic product of the country at large. Since the incessant conflict between farmers and herders in Nigeria, few studies have been conducted to determine the effects of farmer–herder conflicts in Adamawa State. This has created a gap in knowledge that needs to be filled. This study, therefore, seeks to examine the effects of the conflicts between farmers and herders on the productivity of farmers within the affected areas of the state. Specifically, the study aimed to determine the effects of farmer-herder’s conflicts on socio-economic lifestyle of the farmers in the study area; and determine the effects of farmer-herder’s conflict on the productivity of food crop farmers in Adamawa State.

METHODOLOGY

The study was carried out in Adamawa State. Adamawa State lies between longitudes 12°30'E of the Greenwich Meridian and latitude 9°20'N of the Equator. The state has a human population of 3,178,950 according to the 2006 population census, which was projected to be about 4,763,070 in 2020 at a 2.9% growth rate per annum (National Bureau of Statistics (NBS), 2020), and it covers an estimated land area of **39,940** square kilometers.

Sampling techniques and sample size

A multi-stage sampling technique was used to select the 180 most affected and 120 least affected farmer-herder conflict zones. A total of 300 respondents were used as the sample size for the study.

Method of data collection

Primary data were used for the study, which were obtained using a structured questionnaire and interview schedule.

Analytical techniques

Descriptive and inferential statistics were used to analyze the collected data.

Model specification

Total Factor Productivity index

The total factor productivity is expressed as follows:

Total Factor Productivity (TFP) = *VOP/VIE;* Let (TFP) index be Y; VOP= Value of Output in Naira; VIE= Value of Inputs Employed in Naira.

Multiple Regressions

The model is implicitly specified as follows;

**Linear:**Y = f(β0+ β1X1+β2X2+β3X3+β4,X4+β5X5+β6X6+Β7X7+β8X8+β9X9+β10X10+β11X11+β12X12+β13X13+β14X14)

**Double log:**lnY = f(β0+ β1lnX1 + β2lnX2+ β3lnX3+β4lnX4+β5lnX5+β6lnX6+β7lnX7+β8lnX8+β9lnX9+β10lnX10+β11lnX11+β12lnX12+β13lnX13+β14X14…)

**Semi log:**Y = f(β0+ β1lnX1 +β2lnX2+β3lnX3+β4ln,X4+β5lnX5+β6lnX6+Β7lnX7+β8lnX8+β9lnX9+β10lnX10+β11lnX11+β12lnX12+β13lnX13+β14X14….)

**Exponential:**lnY = f(β0+ β1X1 + β2X2+β3X3+β4,X4+β5X5+β6X6+Β7X7+β8X8+β9X9+β10X10+β11X11+β12X12+β13X13+β14X14…)

Where: Y = Total Factor productivity Index; X1= Conflict (no of attacks); X2 = Age of farmers (years); X3 = Deaths Recorded by a household (no of persons killed); X4 = Distance to the market, (kilometer); X5 =Extension Contact (numbers of visit in a year); X6 = Seed used (Kg); X7 = Family size (Number of people); X8= Level of education (Years); X9= Farming experience (Years); X10= Farm size (Ha); X11= Labor input (Man-day); X12= Agrochemicals (liters); X13= Loan facilities received (Naira); X14= Health Status of farmer as a result of injuries sustained by conflict (amount spent on drugs in Naira).

RESULTS AND DISCUSSION

Effects of farmer-herder’s conflicts on socio-economic lifestyle of the farmers

The results of likert rating scale in the Table 1 reveals that loss of human life, reduction of social activities were ranked the most important of effects of farmer-herders clash on the life style of farmers. This is similar to the study of Ofuoku and Isife (2010) who opined that loss of life, displacement of farmers and land degradation were some of the effects of farmer-herders conflict in Nigeria. The study found that a lot of killings were recorded by the herders in the host communities due to the lingering conflict between the two groups. In retaliation for the colossal damage by the herders, a reprisal killing of nomads by the host communities was recorded too. It was discovered that some of the victims were badly injured while others were maimed. The implication of this finding is that there will be a reduction in the number of able-bodied farmers to carry out agriculture. Also, some of the victims may be depressed for the rest of their lives, and farmers may face a drop in labor availability.

High cases of rape, overdependence, and begging, as well as theft and robbery, were ranked the third perceived effects of farmer-herder conflict. Most nomads are single and mostly migratory. Therefore, in a bid to satisfy their sexual desire (thirst), during conflict, they resort to raping and sexually harassing females (the underage ones, married and unmarried, as well as the widowed). This usually leaves a scar in the hearts of the victims, intensifying the hostility between farmers and herders. It was gathered that the acquisition of weapons by herders which they used on their victims had resulted in some members of host communities acquiring weapons in order to repel their attacks. This has accelerated the procurement of weapons in both the study areas and Nigeria as a whole. As a result of the high prevalence of weapon infiltration in the country, many incidents of societal vices have emerged (banditry, kidnapping, and theft). Finally, farmers were displaced as a result of house destruction, and those who remained stopped going to a distant farm for fear of being attacked. This has increased the rate of refugees in the study area. Thus, farmers have become burdens to other farmers, forcing them to rely on others for food for themselves and their families. As a result, many communities have become trapped in a cycle of poverty.

Table 1: Distribution of respondent according to effects of farmer-herder’s’ conflicts on socio-economic lifestyle of the farmers

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/n | Perceived effects | SD  (%) | DA  (%) | N  (%) | A  (%) | SA  (%) | WS | WM | Rank |
| 1 | Sexual harassment of women | 7  (2.3) | 61  (20.3) | 4  (1.3) | 97  (32.3) | 131  (43.7) | 1184 | 3.9\* | 8th |
| 2 | Acquiring of weapons/arms | 6  (2.0) | 21  (7.0) | 17  (5.7) | 140  (46.7) | 116  (38.6) | 1234 | 4.1\* | 6th |
| 3 | Loss of human life/properties | 2  (0.7) | 1  (0.3) | 7  (2.3) | 56  (18.7) | 234  (78.0) | 1419 | 4.7\* | 1st |
| 4 | High cases of rape | 9  (3.0) | 28  (9.3) | 9  (3.0) | 93  (31.0) | 161  (53.7) | 1244 | 4.2\* | 3rd |
| 5 | Reduction of social activities | 0  (0.0) | 0  (0.0) | 59  (19.7) | 80  (26.7) | 161  (53.7) | 1282 | 4.3\* | 2nd |
| 6 | Theft and robbery | 1  (0.3) | 16  (5.3) | 0  (0.0) | 166  (55.3) | 117  (39.0) | 1262 | 4.2\* | 3rd |
| 7 | Overdependence and begging | 1  (0.3) | 32  (10.7) | 0  (0.0) | 151  (50.3) | 116  (38.7) | 1249 | 4.2\* | 3rd |
| 8 | Increase in refugees | 3  (1.0) | 22  (7.3) | 57  (19.0) | 102  (34.0) | 116  (38.7) | 1206 | 4.0\* | 7th |

**Source: Field survey, 2021**

**Note:\*=Agreed, Decision rule: >3=Agree and < 3 =Disagree; SD= strongly disagree, D=Disagree, N= Neutral, A=Agree and SA= Strongly Agree; WS= Weighted Sum, WM= Weighted Mean**

Effects of farmer-herder’s conflict on the productivity of food crop farmers in Adamawa State

From the regression analysis result presented in Table 2 the coefficient of determination (R2) value was 0.4539 implying that about 45% variation in productivity of food crop farmers was explained by the independent variables included in the model. The coefficient for conflict (-5746) was negative and statistically significant at 0.01 probability level. This implies that a unit increase in numbers of conflict will lead to decrease in the productivity of farmers. This has the expected a *priori,* this is because increase in farmers-herders crises may likely leads to destruction of crops or displacement of farmers which will prevent them from going to maintain their farms thus their productivity is expected to reduce. The coefficient for household (3333) was positive and statistically significant at 0.01 probability level. This implies that a unit increase in household will increase the productivity of food crop farmers. The household size plays an important role in determining what occurs on the farm. It provides the human factor in farming through labour and management inputs. The household’s demands may motivate the adoption of recommended practices as a means to meet the increasing family demands. Thus, the productivity of farmer is expected to improve. Although, large households size may increase the expenditure of households thereby decreasing the amount of resources available to adopt new innovation that can improve their productivity. The coefficient for Labour input (3.3391) was positive and statistically significant at 0.01 probability level. This implies that a unit increased in labour input will lead to 3.3391 increases in productivity of food crop farmers. This has the expected *a priori,* this is because increase in availability of labour for carrying out varieties of farming operation will increase the productivity of the farmer. The reason for this result could be attributed to large household availability in the study areas.

**Table 2: Effects of farmer-herder’s conflict on the productivity of food crop farmers in Adamawa State**

|  |  |  |
| --- | --- | --- |
| Variables | Coefficient | t-value |
| Conflict | -5746\*\*\* | -8.08 |
| Age | 3349 | 0.81 |
| No of extension contact | 3507 | 0.23 |
| gender | 1135 | 1.44 |
| experience | 4968 | 1.01 |
| Households size | 3333\*\*\* | 4.41 |
| education | 7960 | 1.23 |
| Total farm size | 1277 | 0.46 |
| Total farm size | 1277 | 0.46 |
| Total agrochemical | 1125 | 1.27 |
| Labour input | 3.3391\*\*\* | 7.40 |
| fertilizer | 22.37 | 0.05 |
| Total credit | .0794 | 0.76 |
| Constant | 6843 | 3.56 |
| R- squared | **0.4539** |  |
| Adj R- squared | **0.4290** |  |
| F-ratio | **0.0000** |  |

**Source: Field survey, 2021 Note: \*\*\* implies statistically significant at 1%, \*\* implies statistically significant at 5%, \* implies statistically significant at 10%.**

CONCLUSION AND RECOMMENDATION

The study examined the effects of farmer-herder’s conflict on the productivity of farmers in Adamawa State, Nigeria. From the study, it can be concluded that loss of human life/properties, reduction of social activities, high cases of rape, theft and robbery, overdependence and begging, acquiring of weapons/arms and sexual harassment of women were the major effects conflicts on socio-economic lifestyle of the farmers While conflict households size and labour inputs were the major factors influencing the productivity of food crop farmers in the study area.

From the study the incessant Fulani herdsmen and Farmers conflict have negative implications on productivity and food security status of farmer which results to extreme poverty, therefore it is recommended that Federal and State government should involve conflict resolution expertise for peace building dialogue and also involving local leaders in peace building policies.

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## EFFECTS OF ADOPTION OF IMPROVED BEEHIVE TECHNOLOGIES ON INCOME AND WELFARE STATUS OF BEEKEEPERS IN EKITI STATE, NIGERIA

G. O. Olabode1; J. H. Tsado1; and T. I. Salihu1

1Department of Agricultural Extension and Rural Development, Federal University of Technology Minna, Niger State, Nigeria

\*Correspondent author’s E-mail and Phone number: [olorundageorge@gmail.com](mailto:olorundageorge@gmail.com) +2347068109374

ABSTRACT

*The study was carried out to assess the effects of the adoption of improved beehive technologies on beekeeper’s welfare status in Ekiti State, Nigeria. Four-stage sampling techniques were adopted to select 249 respondents for the study. Questionnaires complemented with interview schedule were used to collect primary data from respondents. Data were analyzed using descriptive (such as frequency count, percentage and mean) and inferential statistics (such as the Gini coefficient and Seemingly Unrelated Regression (SUREG)). The results revealed, the average age of respondents was 59 years, Most 82.0% had tertiary education, and also, majority (84.7%) and (90.0%) of the respondents had access to extension agents and credit facilities, respectively. The result of the Gini coefficient showed inequality in income distribution with a GI of 0.70 among the respondent. The result of the SUREG showed baiting (67269.73), hive management (410907.1), harvesting and removal of comb (2685.697) and marketing of bee products (14049.11) had a positive influence on the income of beekeepers, while baiting (0.9928245), hive management (1.999738), monitoring of hives (.0399083) and marketing of bee products (.0274556) had a positive influence on the welfare status of beekeepers. The study recommended that beekeeper associations across the study areas and other relevant stakes should intensify training on the efficient use of bee technologies to improve their income and welfare status.*

**Keywords:** Adoption; income; welfare; bee hives; technologies

INTRODUCTION

Food and Agriculture Organization ((FAO), 2009) projected that feeding the world population of about 9 billion people in 2050 would require raising overall food production by at least 70%. But the State of Nigeria agriculture and food production, the future challenges and potential solutions require specific agricultural development pathways and technology that must work towards eradicating poverty, hunger and malnutrition in the nearest future (Oladimeji *et al.,* 2015).

Bee keeping is the art and science of raising honeybees for man to benefit economically. According to Tew (2016), there is evidence that humanity first engaged in the activity of beekeeping, also known as apiculture, more than 15,000 years ago. Beekeeping is an enterprise that provides the ability for economically marginalized groups, such as landless poor and rural people, to access income without exacerbating environmental and land tenure problems (Schouten and Lloyd, 2019). Honey bees have great potential to be developed as a smallholder niche industry with low input costs and the ability to scale-up quickly. Bee products can be marketed through existing networks and bees in many cases improve productivity of crop-farming systems through improved pollination.

Beekeeping has evolved to be a very lucrative agricultural practice for local people in developing countries of the world. As an agricultural activity that may generate income all year round under suitable climate conditions of which Nigeria is one of the best country due to its vegetation and weather condition. Apiculture provide more advantages for the producers when compared with other agricultural activities. It can be carried out easily with relatively low capital investment and provides a continuous cash flow into farm budgets since it generates income in a rather shorter period. Apiculture, which is one of the important livestock subsectors, contributes significantly to the improvement of the livelihoods of the nation’s population (Aklilu, 2002). Besides production of honey, bees are also kept for sale to other beekeepers and other bee by-products such as beewax, propolis, pollen, and royal jelly (Van Huis, 2013). If the improved beehive technologies are taking into consideration as part of our agricultural activities in Nigeria it will create more job opportunities to the teaming youths and will reduce poverty among rural people. Hence this study investigates the effects of the adoption of improved bee hive technologies on beekeeper’s income and welfare status in Ekiti State, Nigeria. Specifically the study aimed to

1. describe the socio-economic characteristics of beekeepers
2. examined the income distribution among beekeepers and
3. assess the effects of adoption of improved beehive technologies on farmer’s income and welfare status

METHODOLOGY

The study was carried out in Ekiti State, Nigeria. The State is located within the Latitudes **7.621111** and Longitudesof **5.221389.** The State covers a total land area of 5887.890 square km. The population of Ekiti State as at 2006 census was 2,384,212 (NPC, 2006), however, with the annual growth rate of 3.6%, the Ekiti State population was projected to be 4,301,374 as at 2020 (National Bureau of Statistics (NBS), 2021). Some of the agricultural products in the state include cash crops (such as cocoa, oil palm, kola nut, plantain, bananas, cashew, citrus, and timber) and arable/food crops are rice, yam, cassava, maize, and cowpea.

Four stage sampling technique was used to select 249 respondents for the study. Primary data were elicited from respondents using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive and inferential statistic. Objective i was achieved using descriptive statistics while objective ii and iii were achieved using Gini coefficient and Seemingly Unrelated Regression (SUREG)

RESULT AND DISCUSSION

Socioeconomic Characteristics of the Respondents

Results in Table 1 revealed that most (31.7%) were within the age 60 years and above with an average age of 59 years. This depicts that beekeepers in the study area were gradually out of their productive age. Also, most (82.0%) of the beekeepers in the study area had tertiary education. This implies that beekeepers in the study area were well-educated which attributed for the higher adoption of beekeeping technologies across the study areas. Table 1 also indicated that majority (89.0%) of beekeepers had beekeeping experience within the range of 1 – 5 years with an average experience of 4 years. More also, majority (84.7%) of the beekeepers had access to extension contact and 90.0% had access to credit

Table 1: Socio-economic characteristics of beekeepers

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Frequency | Percentage | Average |
| Age |  |  |  |
| 30 – 39 | 74 | 29.72 |  |
| 40 – 49 | 52 | 20.88 |  |
| 50 – 59 | 44 | 17.67 | 59 |
| >60 | 79 | 31.73 |  |
| Level of education |  |  |  |
| Primary | 4 | 1.61 |  |
| Secondary | 28 | 11.24 |  |
| Tertiary | 203 | 81.53 |  |
| Non-formal | 11 | 4.42 |  |
| Others (Quranic) | 3 | 1.20 |  |
| Beekeeping experience |  |  |  |
| 0 -1 | 98 | 39.36 |  |
| 3 – 5 | 124 | 49.80 | 4 |
| 6 – 8 | 27 | 10.84 |  |
| Extension contact | 211 | 84.74 |  |
| Access to credit | 224 | 89.96 |  |

**Source: Field survey, 2022**

Income Distribution among the Beekeepers

The results in Table 2 revealed the calculated Gini-coefficient to be approximately 0.70 which is close to one which implies that there was inequality in the income distribution among the beekeepers in the study area. This could be attributed to under-utilization of adopted beehive technologies and incident of theft which reduce the yields of beekeepers significantly. In addition, lack of centralized marketing system for bee products contributed to the inequality in income among the respondent in the study area.

Table 2: Income distribution among beekeepers

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Income range (₦) | Frequency | Proportion of respondents (X) | Cumm. Proportion of incomes (Y) | XY |
| <60001 | 3 | 0.012 | 0.003 | 0.000036 |
| 60001-120000 | 11 | 0.044 | 0.021 | 0.000924 |
| 120001-180000 | 42 | 0.169 | 0.111 | 0.018759 |
| 180001-240000 | 97 | 0.390 | 0.381 | 0.14859 |
| 240001-300000 | 82 | 0.329 | 0.391 | 0.128639 |
| >300000 | 14 | 0.056 | 0.093 | 0.005208 |
| Total | 249 | 1.000 | 1.000 | 0.302156 |
| Minimum income | 55200 |  |  |  |
| Maximum income | 450000 |  |  |  |
| GI |  |  |  | 0.697844 |

**Source: Field survey, 2022**

Effects of Adoption of Improved Beehive Technologies on Farmer’s Income and Welfare Status

The results of the SUREG models on the relationship between income and welfare status of beekeepers are presented in Table 3. The non-zero cross-correlation estimated equations error terms, the Breush-Pagan (Chi2) which is highly significant at the 1% probability level, implies that the use of SUREG is suitable for the two (2) equations. The Root Mean Square Error (RMSE) is used to aggregate the magnitudes of the error. The equations tended towards zero indicating a perfect fit of the model and good at predicting the observed data.

Income model

In the income model, the coefficient for baiting (67269.73) was positive and statistically significant at 5% probability level, which implies that a unit increase in adoption of baiting will increase the income status of the beekeeper. This is because proper baiting is expected to promote the rate of colonization and invariably improve the output. Also, the coefficient for hive management (410907.1) was positive and statistically significant at 1% probability level. This met the *a* priori expectation. This is because proper hive management is expected to bring about healthy and strong bee colonies that will improve the yields of beekeepers. The coefficient for apiary cleaning (-105769) was negative and statistically significant at 1% probability level, which implies that an increase in apiary cleaning adoption will reduce the income of beekeepers. This negates the a priori expectation; this result could be attributed to poor methods utilized in cleaning the apiary, which include using force to open the hive and use of herbicide to control the apiary environment. The coefficient for harvesting and removal of comb (26685.697) was positive and statistically significant at 1% probability level, which implies an increase in harvesting and removal of comb adoption will increase the income of beekeepers. Also, the coefficient for marketing of bee products (14049.11) was positive and spastically significant 10% probability level, which implies that an increase in marketing bee products will increase the income of beekeepers. This met the a priori. *expectation* this is because selling bee products in a well-organized marketing system where there is price regulation will significantly improve the income of beekeepers.

Welfare status model

The coefficient of baiting (0.9928245) was positive and statistically significant at 1% probability level implying that increase in baiting adoption will increase the welfare status of beekeepers. The coefficient of hives management (1.999738) was positive and statistically significant at 1% probability level implying that increase in hives management will leads to increase in welfare status of beekeepers. The coefficient for monitoring of hives (.0399083) was positive and statistically significant at 5% probability level implying that increase in hives monitoring will leads to increase in welfare status of beekeepers. More also, the coefficient for marketing of bee products (.0274556) was positive and spastically significant at 5% probability level, which implies that an increase in marketing bee products will leads to an increase in the welfare status of beekeepers.

Table 3: Effects of adoption of improved beehive technologies on farmers’ income and welfare status

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Income |  |  | Welfare |  |  |
| Variables | Coefficient | Standard error | z-values | Coefficient | Standard error | z-values |
| Baiting | 67269.73\*\* | 28219.25 | 2.38 | .9928245\*\*\* | .0961703 | 10.32 |
| Hive management | 410907.1\*\*\* | 90784.01 | 4.53 | 1.999738\*\*\* | .1279804 | 15.63 |
| Apiary cleaning | -105769\*\*\* | 36834.66 | -2.87 | .0000872 | .0519267 | 0.00 |
| Monitoring of hives | 8442.676 | 11032.9 | 0.77 | .0399083\*\* | .0183724 | 2.17 |
| Separation of Honey and combs | -26452.36 | 44926.14 | -0.59 | .0000872 | .0633334 | 0.00 |
| Colony multiplication | -33360.12 | 26164.38 | -1.28 | -.0124873 | .0368845 | -0.34 |
| Honey extractor machine | 563.4224 | 10281.18 | 0.05 | .0035529 | .0144936 | 0.25 |
| Harvesting and removal of honey combs | 26685.697\*\*\* | 8367.15 | 3.20 | .0000872 | .0371704 | 0.00 |
| Refining honey for packing honey | 3964.067 | 8970.331 | 0.44 | .0161971 | .0126457 | 1.28 |
| Marketing of the by-products and | 14049.11\* | 8244.472 | 1.70 | .0274556\*\* | .013729 | 2.00 |
| R2 | 0.4435 |  |  | 0.3373 |  |  |
| Chi2 | 3175.70 |  |  | 281935.25 |  |  |
| Prob>Chi2 | 0.00 |  |  | 0.00 |  |  |

**Source: Field survey, 2022**

Values in parentheses are the z-values. \*\*\* P<0.01, \*\*P<0.05 and \*P<0.10.

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## ASSESSMENT OF OUT-MIGRATION AMONG ARABLE CROP FARMERS IN KOGI STATE, NIGERIA: GENDER DYNAMIC APPROACH

I. O. Ibrahim, J. H. Tsado, I. T. Salihu and Y. Muhammed

Department of Agricultural Extension and Rural Development,

Federal University of Technology, Minna. P.M.B. 65, Minna, Niger State, Nigeria

Corresponding author’s e-mail: [isohab@yahoo.com](mailto:isohab@yahoo.com) Phone number: +2348036980102

ABSTRACT

*The study* assessed out-migration among arable crop farmers in Kogi State, Nigeria: Gender dynamic approach. *Multi stage Sampling technique was used to select 217 households comprising of 137 male and 80 female-headed households. Primary data were collected with aid of semi-structured questionnaire complimented with an interview schedule and analyzed using descriptive statistics. The results obtained showed that most (male 60.6% and female 55.0%) of the households were in their middle age between 31 – 50 years with mean ages of 47 and 48 years, respectively. The mean farm size for the male and female headed households were 2.5 and 1.5 hectares, respectively. The female headed households (18.7%) had less access to extension services as compared to the male headed household (30.7%). Out-migration is common to both households as the male (39.4%) and female (43.8%) headed households indicated moderate level of out-migration. Major reason for out-migration as indicated by the male (57.7%) and female (60.0%) headed households was for remittances back home. Meanwhile, the strategies adopted by the households to mitigate the effect of out-migration include among others engaging in community activities (= 2.62), application of modern farming technologies (= 2.55) and development of entrepreneurial skills (= 2.50) ranked 1st, 2nd and 3rd, respectively. All factors enumerated were perceived to have significant influence on out-migration with lack of social amenities (= 2.96), problem of unemployment (= 2.95) and poverty (= 2.80) ranked top most. Therefore, the study recommended that Government and other funding organizations should promote skills acquisition and provide infrastructural facilities among household along gender dynamics to cushion the effects of out-migration particularly in the study area.*

**Keywords:** Out-migration, arable crop, farmer, gender, dynamics

INTRODUCTION

Agriculture has been the major source of livelihood of the rural people in most African communities including Nigeria. The importance of agricultural sector in the overall Nigerian economy cannot be over-emphasized. Agriculture remains the key sector in the rural areas of Nigeria where over 70% of its population reside. Agriculture contributes about 27.68% to the Gross Domestic Products (GDP) and provides livelihood for about 70% of the population (National Bureau of Statistics (NBS), 2017). As a leading contributor to household food supply and other natural resources, agriculture is affected by out-migration along gender dynamics, particularly in the area of sustainable arable crop production.

Movement of people from place to place has been a recurrent decimal phenomenon since the era of human history (Ibrahim and Danjunma, 2012). However, its form has changed but it remains a very dominant issue in the global social system. In recent time, people migrate from under-developed areas to the developed ones in search of better employment and opportunities. Thus, surplus labour from low productive agriculture in rural areas is transferred to high industrial areas (Liu *et al.*, 2016). The drastic decrease in rural labour due rural-urban migration has led to reduction in total cropped area and output giving rise to reduced food production in the rural areas.

The impoverishment of rural areas in Nigeria is partly explained by economic isolation and out-migration of youths in search of employment in cities, which affects the labour force for agricultural production, with males more proned to migration than females (Ofuoku, 2015). Out-migration leads to labour shortage and decline in the average quality of labour which adversely affects output and productivity in native places. The new economics of out-migration explains that the decision to migrate is taken by larger association of related people, households or families rather than autonomous individuals (Liu *et al.*, 2016).

According to Fasoranti (2019), out- migration has become of utmost importance as it impact both place of origin and destination. Though out-migration is not limited to a particular group yet the effects is significantly noticed on the agricultural activities and household livelihood. Meanwhile, there are far reaching consequences of out-migration on demand for labour force in place of origin. Keeping in view the anticipated consequences of out-migration in place of origin, this study was undertaken to examine the effects of out-migration along gender dynamics on arable crop production and households’ livelihood.

López-Carr and Burgdorfer (2013) posited that various researchers have seen out-migration as setback to increase arable crop production arguing that even with increase in technology able-bodies men and women are needed to drive those technologies. Hence, development should involve empowering rural population mostly women to engage in sustainable means of livelihood such as crop farming and aquaculture (Nwabueze, 2010). In view of the foregoing, the study therefore sought to assess out-migration among arable crop farmers in Kogi State, Nigeria. Specifically, the study described the socio-economic characteristics of the arable crop farming households along gender dynamics: examine the level of out-migration; assess perceived factors influencing out-migration and examine strategies adopted to mitigate the effects of out-migration along gender dynamics.

METHODOLOGY

Study Area

The study was conducted in Kogi State which is located in the North central region of Nigeria. Kogi state is popularly called the Confluence State owing to the confluence of River Niger and Benue at the capital in Lokoja. It is located between Latitude 70 481 and 80 351 North and Longitude 60 441and 70 491 East. It has a land mass of 30,354.74 square kilometers (11,519 square miles) with population of about 3,278,487 people according to the 2006 National census (Sunday, 2014). However, with a growth rate of 3.2%, the population was projected to 4,636,071 in 2017 (National Bureau of Statistics (NBS), 2017).

The State comprises of twenty-one (21) Local Government Areas (LGAs) divided into four Agricultural zones. The State experience two distinct seasons, wet and dry. The wet season begins in March and ends in October while the dry season spans between November and early March. The annual rainfall is between 1016mm and 1524mm, while the mean daily temperature ranges from 240C and 270C (NBS, 2018). Kogi State has a wide stretch of Forest and arable land for farming, good grazing land for livestock production and large bodies of water for fishing and irrigation. Food and cash crops commonly grown in commercial quantities include yam, cassava, rice, maize, beni-seed (Sesame) guinea corn, cashew, oil palm and vegetables.

Sampling Procedure and Sample Size

Multi-stage sampling procedure was adopted for this study. The first stage was the selection of one Local Government Area (LGA) from each of the agricultural zones to get four LGAs. The second stage was the random selection of one extension block from each of the selected LGAs to get four extension blocks. The third stage was the selection of three extension cells which gave 12 villages. Stage four involved stratification of the registered rural households (2,169) in the study area as obtained from Kogi State Agricultural Development Programme (KADP) into male (1,367) and female (802) headed households. The final stage was the proportionate sampling of the rural households using 10% which produced sample size of 137 male and 80 female headed households and grand total of 217 respondents.

Method of Data Collection

Primary data were used for this study which was collected using semi-structured questionnaire complemented with interview schedule. Information obtained from the rural households include socio-economics characteristics, household out-migration, factors influencing out-migration and the mitigating strategies adopted to ameliorate out-migration.

Method of Data Analysis

Data collected were analyzed using descriptive statistics such as frequency count, percentages and means scores. However, 3-point Likert rating type scale was used to measure respondents’ perception on the factors influencing out-migration and strategies adopted to mitigate the effects of out–migration on arable crop production. Level of out-migration was categorized based on the number of household out-migrants such as < 3 (low level), 3 – 5 (moderate level) and > 5 (high level).

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

As revealed in Table 1, about 32.1% of the male household heads and 45.0% of the female household heads were within the age bracket of 41 – 60 years with mean ages of 47 and 48 years, respectively. This implies that the respondents in the study area were in their middle age but still in their productive stage of life. Majority (92.1%) of the male were married, while 75% of the female-headed household were widowed. This indicate that the respondents particularly the female households had much responsibility to handle as widows hence will embrace various coping strategies especially household migration. This is in corroboration with the findings of Egwu *et al.* (2008) who reported that married individual play active role in agricultural production based on poverty levels. The study further revealed that most (46.4% of the male headed households and 38.8% of the female headed household) had acquired secondary education as a formal schooling. Education help to liberate individuals from ignorant implying that gender had certain level of education that could assist them in making an informed decision in order to have a better livelihood.

More so, Table 1 revealed that 37.2% of the male and 41.3% of the female headed households had farming experience of between 11-20 years with a mean of 17 years respectively. This implies that gender engaged in farming activities are experienced in arable crop production. This is in corroboration with the finding of Rubin and Manfre (2012) who reported that stated that women contribute more than half of the food produced in developing countries. Most (67.7%) of the male and 45.7% of the female headed households had household size of less than 6 persons with a mean household size of 5 and 4 persons, respectively. This implies that both gender had a fairly large family thus the need to seek various coping strategies including out-migration to cope with family expenditure.

Table 1 revealed that the majority (83.9% and 96.3%) of the male and female headed households had farm size of less than three hectares with a mean value of 2.5 and 1.5 hectares, respectively. This implies that both genders were small-scale farmers with the male having more access to land than their female counterpart. This study is in corroboration with the findings of Sharon (2008) that rural women were highly disadvantaged in with respect to the ownership and control of assets such as land. Also, most (57.7%) of the male headed households were member of cooperative societies, while 42.5% of the female headed households were member of cooperative societies. This implies that both genders belong to one cooperative group or the other, which can better their living standard. Thus, cooperative membership could bring in a lot of benefits to rural farmers.

Also, most (69.3%) of the male and 81.3% of the female-headed households had no extension contact. This implies that there was poor contact with extension agents as majority had no contact. However, among those that had extension contact, the number of male were higher than the female. Contact with extension agent usually exposes farmers to innovations for improved production. This is in line with the finding of FAO (2017) who reported that it was a common practice to direct extension and training services primarily towards men. Furthermore, 33.6% of the male and 31.3% of the female headed households had access to credit. This implies that there was poor access to credit facilities among the gender with the male having more access to credit than the female. Access to credit facilitates adoption of technology among rural households. The results also corroborate the finding of FAO (2017) that male had more access to credit than their female counterpart.

Table 1: Distribution of respondents based on their socio-economic characteristics

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Male (n = 137) | | Female (n = 80) | |
| **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| Age(years) |  |  |  |  |
| < 21 | 13 | 9.50 | 8 | 10.00 |
| 21-30 | 30 | 21.90 | 6 | 7.50 |
| 31-40 | 39 | 28.50 | 8 | 10.00 |
| 41-50 | 44 | 32.10 | 36 | 45.00 |
| 51-60 | 11 | 8.00 | 22 | 27.50 |
| Mean | **47** |  | **48** |  |
| Marital status |  |  |  |  |
| Single | 6 | 4.40 | 4 | 5.00 |
| Married | 125 | 91.20 | 6 | 7.50 |
| Divorced | 4 | 2.90 | 10 | 12.50 |
| Widowed | 2 | 1.50 | 60 | 75.00 |
| Education status |  |  |  |  |
| Primary | 24 | 17.50 | 22 | 27.50 |
| Secondary | 61 | 44.50 | 31 | 38.80 |
| Tertiary | 41 | 29.90 | 15 | 18.70 |
| Non-formal | 11 | 8.10 | 12 | 15.00 |
| Mean | **12** |  | **10** |  |
| Farming experience (years) |  |  |  |  |
| < 11 | 48 | 35.00 | 23 | 28.75 |
| 11-20 | 51 | 37.30 | 33 | 41.25 |
| 21-30 | 24 | 17.50 | 17 | 21.25 |
| > 40 | 14 | 10.20 | 7 | 8.75 |
| Mean | **17** |  | **17** |  |
| Household size (Number) |  |  |  |  |
| < 6 | 93 | 67.90 | 42 | 52.50 |
| 6-10 | 38 | 27.70 | 38 | 47.50 |
| > 11 | 6 | 4.4 | - | - |
| Mean | **5** |  | **4** |  |
| Farm size (Hectares) |  |  |  |  |
| < 3.1 | 115 | 83.90 | 77 | 96.30 |
| 3.1-5.0 | 12 | 8.80 | 3 | 3.70 |
| > 5.0 | 10 | 7.30 | - | - |
| Mean | **2.5** |  | **1.5** |  |
| Cooperative membership |  |  |  |  |
| Yes | 79 | 57.70 | 34 | 42.50 |
| No | 58 | 42.30 | 46 | 57.50 |
| Extension contact |  |  |  |  |
| Yes | 42 | 30.70 | 15 | 18.70 |
| No | 95 | 69.30 | 65 | 81.30 |
| Access to credit |  |  |  |  |
| Yes | 46 | 33.60 | 25 | 31.25 |
| No | 91 | 66.40 | 55 | 68.25 |

**Source: Field Survey, 2021**

Level of out-migration among the respondents

Table 2 shows that both male (43.8%) and female (50.0%) headed households indicated both gender were involved in out-migration. This finding agrees with that of Ofuoku (2015) who reported that with growing social acceptance of female independence and mobility, girls and women are now the majority of Ghana’s internal migrants. Most out-migrants leave their community majorly in pursue of education as indicated by male (42.3%) and female (35.0%) headed households. This substantiates the finding of Afolayan (2008) who reported that the search for Western and Islamic education has induced quite a lot of migration. Most (67.2% of male and 58.8% female) of the households revealed that out-migration is mostly from rural to urban area in anticipation for better opportunities. This is in line with the findings of Ibrahim and Danjumoh (2012) who found most migrations to be toward the urban centres where better livelihood are abounds. The out-migrants contribute toward their origin in terms of remittance as indicated by 57.7% of male and 60.0% of female- headed households. This agrees with the finding of FAO (2016) that most migrants contribute to their home through remittances.

Table 2: Distribution of respondents based on out-migrants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Male (n = 137) | | Female (n = 80) | |
| **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| Gender of household migrants |  |  |  |  |
| Male | 56 | 40.9 | 23 | 28.7 |
| Female | 21 | 15.3 | 33 | 41.3 |
| Both | 60 | 43.8 | 24 | 30.0 |
| Reason for out-migration |  |  |  |  |
| Education | 58 | 42.3 | 28 | 35.0 |
| Government employment | 20 | 14.6 | 13 | 16.3 |
| Health challenges | - | - | 21 | 26.2 |
| Private worker | 21 | 15.3 | 2 | 2.5 |
| Apprenticeship | 9 | 6.6 | 6 | 7.5 |
| Wage labour | 29 | 21.2 | 10 | 12.5 |
| Pattern of out-migration |  |  |  |  |
| Rural-rural | 33 | 24.1 | 17 | 21.3 |
| Rural-urban | 92 | 67.1 | 47 | 58.7 |
| Seasonal | 12 | 8.8 | 12 | 15.0 |
| Permanent | - | - | 4 | 5.0 |
| Contribution of out-migrants |  |  |  |  |
| Remittance | 79 | 57.7 | 48 | 60.0 |
| Modern technologies | 20 | 14.6 | 9 | 11.3 |
| Information sources | 38 | 27.7 | 23 | 28.7 |

**Source: Field Survey, 2021**

As revealed in Table 3, more than half (51.8%) of the male and 50.0% of the female headed households indicated low level of out-migration, while 39.4% of the male and 43.8% of the female headed households indicated moderate level of out-migration. This implies that there was low to moderate level of out-migration in the study area which could become necessary in order to attract favourable opportunities lacking in the rural areas.

Table 3: Distribution of respondents based on level of household out-migrants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variables | Male (n = 137) | | Female (n = 80) | |
| **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| Low | 71 | 51.80 | 40 | 50.00 |
| Moderate | 54 | 39.40 | 35 | 43.80 |
| High | 12 | 8.80 | 5 | 6.20 |

**Source: Field Survey, 2021**

Strategies adopted to mitigate out-migration by the respondents

Table 4 show the strategies adopted by the male-headed households include application of modern farming technologies (= 2.66), development of entrepreneur skill (= 2.56) and engagement in community activities (= 2.49) ranked 1st, 2nd and 3rd, respectively. Also, the female-headed households adopted strategies include engagement in community activities (= 2.62), application of modern farming technologies (= 2.55) and development of entrepreneur skill (= 2.50) ranked 1st, 2nd and 3rd, respectively. This implies that the rural households adopt several strategies to mitigate out-migration which help them to achieve improved livelihood. This agrees with the finding of Beegle and Poulin (2013) who posited that out-migration enhances progress and foster better livelihood.

Table 4: Distribution of respondents’ based on strategies adopted to mitigate out-migration

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Female (n=80) | | | | Male (n=137) | | | |
| Variables | **WS** | **WM** | **Decision** | **R** | **WS** | **WM** | **Decision** | **R** |
| Engagement in community activities | 210 | 2.62 | Adopted | 1st | 341 | 2.49 | Adopted | 3rd |
| Application of modern farming technologies | 204 | 2.55 | Adopted | 2nd | 364 | 2.66 | Adopted | 1st |
| Development of entrepreneur skill | 200 | 2.50 | Adopted | 3rd | 351 | 2.56 | Adopted | 2nd |
| Reduced area of land cultivated | 201 | 2.51 | adopted | 4th | 323 | 2.36 | Adopted | 5th |
| Market development and services provision | 196 | 2.45 | Adopted | 5th | 334 | 2.44 | Adopted | 4th |
| Practicing of communal farming | 158 | 1.98 | Not Adopted | 6th | 267 | 1.95 | Not Adopted | 6th |

**Source: Field Survey, 2021**

**Note: WS = Weighted Sum, WM = Weighted Mean, R = Rank & Bench Mean Score = 2.0**

Perceived factors influencing out-migration by the respondents

Table 5 revealed the perceived factors influencing out-migration in the study area. All the factors enumerated were perceived to influence out-migration for both gender. However, the male-headed households indicated problem of unemployment (= 2.86), problem of poverty (= 2.80) and inadequate social amenities (= 2.79) ranked 1st, 2nd and 3rd as the major factors. Also, the female-headed households perceived inadequate social amenities (= 2.96), problem of unemployment (= 2.95) and problem of poverty (= 2.80) ranked 1st, 2nd and 3rd, respectively as the major factors influencing out-migration. This implies that several factors influences the quest for a better living standard which is a major driver for out-migration. This finding is in agreement with that of FAO (2016) that major driver for out-migration is economy reasons.

Table 5: Distribution of respondents based on perceived factors influencing out-migration

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Female (n = 80) | | | | Male (n = 137) | | | |
| Variables | **WS** | **WM** | **Decision** | **Rank** | **WS** | **WM** | **Decision** | **Rank** |
| **Lack of social amenities** | 237 | 2.96 | SI | 1st | 382 | 2.79 | SI | 3rd |
| **Problem of unemployment** | 236 | 2.95 | SI | 2nd | 392 | 2.86 | SI | 1st |
| **Problem of poverty** | 224 | 2.80 | SI | 3rd | 384 | 2.80 | SI | 2nd |
| **Problem of safety and insecurity** | 218 | 2.72 | SI | 4th | 360 | 2.63 | SI | 4th |
| **Crop failure** | 209 | 2.61 | SI | 5th | 332 | 2.42 | SI | 7th |
| **Community crisis** | 208 | 2.60 | SI | 6th | 333 | 2.43 | SI | 6th |
| **Problem of potential for employment** | 198 | 2.47 | SI | 7th | 335 | 2.45 | SI | 5th |
| **Attractive climatic environment** | 190 | 2.38 | SI | 8th | 306 | 2.23 | SI | 11th |
| **Attractive quality of life** | 190 | 2.38 | SI | 8th | 319 | 2.33 | SI | 8th |
| **Political instability** | 188 | 2.35 | SI | 10th | 295 | 2.15 | SI | 14th |
| **Problem of drought and flooding** | 187 | 2.34 | SI | 11th | 315 | 2.30 | SI | 9th |
| **Farmland infertility** | 184 | 2.30 | SI | 12th | 311 | 2.27 | SI | 10th |
| **Safer atmosphere** | 173 | 2.16 | SI | 13th | 304 | 2.22 | SI | 12th |
| **Less risk of natural Hazard** | 171 | 2.14 | SI | 14th | 295 | 2.15 | SI | 14th |
| **Low crime rate** | 171 | 2.14 | SI | 14th | 296 | 2.16 | SI | 13th |

**Source: Field Survey, 2021**

**Note: SI = Significant Influence, WS = Weighted Sum, WM = Weighted Mean, Bench Mean Score = 2.0**

CONCLUSION AND RECOMMENDATIONS

The research showed that farmers of both genders are in their mid-age but still active, they have migrants from their various household. The findings showed factors that encourages out-migration to include unemployment, insufficient social amenities and conflicts. The strategies employed by the respondents to militate out-migration are adoption of modern farming technologies, promotion on community conflict resolution and development of market and services. The result shows both genders had migrants. The following recommendations were proffered: Government and funding partners should step up social amenities delivering agency specifically for rural areas. Also, entrepreneurship skills should be highly promoted among households by relevant stakeholders along gender dynamics and good marketing network is a key to mitigating out-migration.

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## THE EFFECT OF AGRITECH STARTUPS ON PARTICIPATION AND POVERTY STATUS OF ADOPTERS IN OGUN STATE, NIGERIA

T. Obafemi: G. Akinsola: A. Falola: E. Ayinde

Department of Agricultural Economics and Farm Management, University of Ilorin. P.M.B 1515, Ilorin, Nigeria.

Email: Obafemitoluwanimi@gmail.com

ABSTRACT

*This research focused on soilless farming technology. The study compared the adopters and non-adopters of the technology, evaluating the effect of Agritech startups on participation and on poverty status of farmers in Ogun state, Nigeria. Primary data were obtained from 130 farmers, this number includes 50 adopters and 80 non-adopters of the technology. A well- structured questionnaire was used. Descriptive statistics, Foster-Greer-Thorbecke (FGT), Total factor productivity, and Logit regression model was used to analyze the data collected. The results revealed that the Agritech startup positively and significantly contributes to participation of farmers in agriculture. The results showed that the adopters were made up of young, educated farmers who recently ventured into farming and were fully aware of the technology. On the contrary, majority of the non-adopters were old, with less formal education and were not aware of the technology. Results of the FGT Poverty index revealed that 16% and 81.3% of the adopters and non-adopters were poor and living below the poverty line, respectively. In addition, age, education, and poverty status were the factors that influence farmers’ adoption of the technology.*

**Keywords:** Agritechnology: participation; poverty; adopters; Nigeria.

INTRODUCTION

Nigeria’s agriculture has had several challenges since the 1970’s, which have led to low yields and post-harvest losses. Small-scale farmers have a number of challenges, such as restricted access to land, slow adoption of technologies, a lack of storage space, an excessive reliance on rain-fed irrigation, and poor market access. Due to high costs of low-quality inputs and restricted access to financing facilities, agricultural productivity is low when compared to other countries. (Groupe Speciale Mobile Association, 2020).

Because of these challenges, Nigerians, especially the young ones have become deterred from engaging in agriculture, which has raised the unemployment rate. One of the main factors contributing to poverty is unemployment. Nearly 40% of Nigeria’s 200 million inhabitants, or roughly 86.9 million people, are believed to be living in absolute poverty (Sustainability, 2021).

Agritech startups have increased significantly during the past few years. This Agritech businesses have been offering online solutions to Nigerian smallholder farmers who are struggling. They supervise farmer’s progress from the start of Agricultural season till harvest, offering solutions that enhance farming techniques and introducing the best practices. Farmers can now enter the market, thanks to the new digital technologies that connect the market with buyers of their produce, Numerous Agritech companies are currently based in Nigeria. Like Soilless Farm Lab, FarmCrowdy, HelloTractor, Thrive Agric, AgroMall and a plethora of more businesses. In Nigeria, agriculture continues to be the largest industry, accounting for an average of 24% of the country’s GDP for the previous eight years (2013-2020).

Additionally, the sector employs more than 36% of the workforce in the nation, making it the biggest employer of labor in the nation. Growth in the agricultural sector is at least twice as effective as growth in other economic sectors at reducing poverty and increasing income for the most vulnerable.

This research therefore assesses the effect of Agritech startups on participation in Agricultural activities and poverty status of adopters in Nigeria, focusing mainly on Soilless farming technology.

MATERIALS AND METHODS

This study was carried out in Ogun State, South-Western Nigeria. The State was created in February 1916 from the former Western State. Abeokuta is the capital city of Ogun State. Other notable cities in the State include Sagamu, Ijebu-ode, (The previous capital of Ijebu kingdom). It is covered predominantly by tropical rainforest and has a wood savanna in the north-west (Wikipedia, 2006). Agriculture is the economic mainstay of Ogun State. It produces cassava, yam, plantain, and Banana. The main cash crops produce is cocoa, kolanut, rubber, palm oil, tobacco, cotton, tuber, and palm kernel (Britannica, 2018). Ogun State is home to many AgriTech companies; Soilless Farm Lab, Groupfarma, Xtralarge farms, Farmcrowdy, Farmkart, Farmnow and many others (Britannica, 2018).

Sampling Techniques and Sample Size

The population of this study comprised of some farmers in the area. A reasonable number of about one hundred and thirty (130) farmers was selected randomly in the study area. This number includes 50 adopters and 80 non-adopters of the technology. Data was gathered through primary means to the respondents. The selection of samples was determined by the data that was provided by Soilless Farm Lab. A total number of 130 farmers was interviewed from the selected area.

Method of Data Collection

Well-structured questionnaire, consisting of open and close ended questions with personal interview design covered the aspects of production, resources, inputs, interest, perception about the technology, and socioeconomic characteristics.

Analytical Techniques

Descriptive statistics was used to determine the level of adoption. Total Factor Productivity (TFP) was used to measure the productivity of the respondents. Foster, Greer and Thorbecke (FGT) index and Logit regression were used to measure the poverty status of respondents and also to analyze the factors that influence farmers’ adoption of soilless farming technology in the study area.

RESULTS AND DISCUSSION

The results of the study revealed that the ages of the respondents range from 25 to 66 with a mean of 32.54 and 52.14 for adopters and non-adopters respectively. This shows that both the young and the old are involved in farming. The study revealed that 98% of the adopters have attained tertiary education, while only 17.5% of the non-adopters have tertiary education. The average years of experience were 4.12 and 31.69 for adopters and non-adopters respectively. Adopters had 100% level of technological awareness while non-adopters had only 10%.

Table 1: The level of adoption of Soilless Farming Technology among Adopters in the study area

|  |  |  |
| --- | --- | --- |
| **Soilless Farming Methods** | **Adoption Status** | **Percentage Adoption** |
| Hydroponics | Yes | 50 |
| Aeroponics | No | 50 |
| **Total** | **50** | **100** |

Source: Field Survey, (2022)

Table 2: Hydroponics

|  |  |  |
| --- | --- | --- |
| **Adoption status** | **Frequency** | **Percentage** |
| Yes | 50 | 100.0 |

Source: Field Survey, (2022)

Table 3: Aeroponics

|  |  |  |
| --- | --- | --- |
| **Adoption status** | **Frequency** | **Percentage** |
| No | 50 | 100.0 |

Source: Field Survey, (2022)

The tables above (Table 1, 2 &3) show the result of the level of adoption of the soilless farming technology. 100 percent of the adopters have adopted the Hydroponics farming system. On the other hand, 100 percent of the adopters have not adopted the Aeroponics farming system. This indicates that only Hydroponics soilless farming system has been adopted while Aeroponics has not been adopted in the study area. Hence, the adoption of soilless farming system is only 50 percent. This shows that soilless farming system is yet to be fully adopted.

Awareness of Soilless Farming Technology

Table 4: Distribution of Respondents by awareness of Soilless Farming Technology

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Adopters of Soilless Farming Technology** | | **Non-adopters of Soilless Farming Technology** | |
|  | **Frequency** | **Percentage** | **Frequency** | **Percentage** |
| **Awareness of Soilless Farming Technology**  Aware | 50 | 100.0 | 8 | 10.0 |
| Not aware | 0 | 0.0 | 72 | 90.0 |
| **Source of Information about Soilless Farming Technology**  Friends | 24 | 48.0 | 1 | 12.5 |
| Mass media | 6 | 12.0 | 7 | 87.5 |
| Family | 20 | 40.0 |  |  |
| Total | 50 | 100.0 | 8 | 100.0 |

Source: Field Survey, (2022)

The level of awareness of Soilless Farming Technology by the respondents is presented in Table 4. The table shows that the level of awareness of the technology is low among the respondents, with a 100% level of awareness for adopters and 10% for non-adopters. 48% of the respondents got the information from friends as against 12.5% of the non-adopters who were aware of the technology. 12% of the adopters sourced their information from the mass-media as compared to 87.5% of the non-adopters. Also, 40% of the adopters were aware of the technology through family. These results indicate that friends and mass media are important sources of information on agricultural innovations.

Table 5: Percentage distribution of productivity indices of the respondents

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Indices | Adopters of Soilless Farming Technology | | Non-adopters of soilless farming Technology | |
|  | Frequency | Percentage | Frequency | Percentage |
| <=.010000 | 42 | 92.0 | 58 | 72.5 |
| .010000 - .060000 | 4 | 8.0 | 20 | 25 |
| .060000+ |  |  | 2 | 2.5 |
| Total | 50 | 100.0 | 80 | 100.0 |

Source: Field Survey, (2022)

**Table 6: Total Factor Productivity of the respondents**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Total Factor Productivity | N | Minimum | Maximum | Mean | Std. Deviation |
| Adopters | 50 | .002290 | .018875 | .00483618 | .003453177 |
| Non-adopters | 80 | .000212 | .067308 | .01073490 | .013820868 |

Source: Field Survey, (2022)

From table 5&6, it can be seen that 92% of the adopters have the total factor productivity <=.010000 as against 72.5% of the non-adopters. The TFP of 8% of the adopters falls between .010000 and .060000 as against 25% of the non-adopters. Also, in table 5, 2.5% of the non- adopters have their TFP greater .06000. The mean of the TFP of adopters is .00483618 while that of the non-adopters is .01073490. These results indicate that the productivity of non-adopters is slightly higher than that of adopters.

This can be caused by different factors such as:

* **High Input cost**: The total cost of input used by adopters is higher when compared to that of non-adopters. The tables below (7&8) help to explain this better.

Table 7: Total Input cost of the respondents

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Total cost of input (In Naira) | N | Minimum | Maximum | Mean | Std. Deviation |
| Adopters | 50 | 470000 | 19260000 | 10705740.00 | 5862867.641 |
| Non-adopters | 80 | 161000 | 12000000 | 2292578.38 | 2771236.948 |

Source: Field Survey, (2022)

Table 8: Total output produced by the respondents

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Total quantity produced (In kg) | N | Minimum | Maximum | Mean | Std. Deviation |
| Adopters | 50 | 5000 | 70000.00 | 37640.0000 | 17229.44798 |
| Non-adopters | 80 | 254.25 | 70000.00 | 30922.3294 | 102989.71079 |

Source: Field Survey, (2022)

The table shows that the mean cost of input for adopters is NGN10705740.00, this is far higher than that of the non-adopters, which is NGN2292578.38. The mean of output for non-adopters is 30922.3294kg. Despite the amount of money spent on input by adopters, the mean of output is 37640.0000kg, which is slightly higher than that of non-adopters. Marginally, the productivity of adopters is not higher than that of non-adopters.

* **Initial cost of investment**: In spite of how profitable soilless farming can be, it is capital intensive, especially for people who want to go on large scale production. The amount of capital required to venture into soilless farming technology is high when compared to that of traditional farming. This indicates that high cost of equipment investments causes a decrease in total factor productivity. This is supported by the reports of Sakellaris (2004) and Hugget and Ospina (2001) that total factor productivity drops sharply after adopting new technologies due to the adjustment cost, but it starts to recover afterwards.
* **Partial adoption**: From the results, it has been shown that adopters are yet to fully adopt the technology. Adopters of the technology are mainly practicing hydroponics. A combination of hydroponics and Aeroponics will help them to maximize their input in order to realize more income, thereby increasing their productivity.

Table 9: Estimated FGT Indices of the Respondents

|  |  |  |
| --- | --- | --- |
| **FGT Indices** | **Adopters** | **Non-adopters** |
| Poverty Incidence (P0) | 0.967062 | 0.735549 |
| Poverty depth (P1) | 0.936623 | 0.612075 |
| Poverty severity (P2) | 0.908328 | 0.542116 |
| Mean Per Capital Household Expenditure (NGN) | 112,049.336 | 112,049.336 |
| Poverty Line (NGN) | 74,669.557 | 74,669.557 |

Source: Field Survey, (2022)

FGT Indices was used to determine the poverty status of the respondents. The result in Table 9 shows that the mean per capital expenditure of the respondents was NGN112,049.336; the poverty line was constructed as two-third of the Mean Per Capital Expenditure (MPCHE), which was estimated as NGN74,669.557, thereby classifying the households into poor and non-poor. The study showed that only 16% of the adopters were poor as against 81.25% of the non-adopters.

Table 10: Determinants of Adoption of Soilless Farming Technology

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Coefficient** | **Standard error** | **P-values(p>z)** |
| Age | -1.134 | 0.537 | 0.035\* |
| Education (years) | 3.414 | 1.730 | 0.049\* |
| Poverty status | 12.198 | 5.830 | 0.036\* |
| Marital status | 4.672 | 5.225 | 0.371 |
| Primary occupation | 5.778 | 3.546 | 0.103 |
| Household Decision Maker | -1.735 | 2.551 | 0.409 |
| Constant | -23.330 | 22.199 | 0.293 |

Number of observations = 129

LR chi2(6) = 164.97

Prob >chi2 = 0.000

Pseudo R2= 0.9577

Source: Field survey, (2022)

\*\*Significant at 5%

Logit regression was adopted to analyze the factors that influence the adoption of the technology. Result of the analysis

(Table 10) showed that out of six variables, only three were significant which includes age, education (years) and poverty status.

Age has a negative coefficient and it is significant at 5% level. This shows that the older the farmer gets, the less likely he is to adopt the technology. Education has a positive coefficient and it is significant at 5% level. This indicates that the higher the level of education, the higher the chances of adoption. Poverty status also has a positive coefficient and it is significant at 5% level. This shows that the poorer a farmer is, the higher his chances of adoption. A poor farmer who wants to escape poverty is more likely to adopt the technology.

CONCLUSION

From the findings of the study, it can be concluded that the adoption of soilless farming technology has a significant and positive effect on the poverty status of adopters in Ogun state. The Agritech startup has also helped to increase participation of people; especially the youths in agriculture, as majority of the adopters are young people who recently ventured into farming.

The poverty line showed that the number of poor farming households of non-adopters below the poverty line was high. The productivity of non-adopters is higher than that of adopters.

The level of awareness of soilless farming technology is low. The adoption of soilless farming technology is partial. The significant determinants of adoption are age, education (years) and poverty status.

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## OUTCOMES OF WORK-FAMILY CONFLICT AMONG UNIVERSITY EMPLOYEES: CORRELATES OF TIME, STRAIN AND JOB SATISFACTION

\*Oose, M. O.,\*Adenuga, O. O., \*\*Olurin, T. K and \*Lamina, A. A.

\*Department of Agricultural Administration, Federal University of Agriculture, Abeokuta.

\*\*Child Development and Family Studies Units, Department of Home Science Management, Federal University of Agriculture, Abeokuta, [oosemo@funaab.edu.ng](mailto:oosemo@funaab.edu.ng); [oosematthew@gmail.com](mailto:oosematthew@gmail.com); 08060348644

ABSTRACT

*The recent waves of COVID-19 have brought about a phenomenon shift which suggest family structure moving from traditional-single income family to a double-income family, hence this allows couple to play multiple role such as employee, a spouse, father, mother and housework handler. However, it is more to bring role-conflict caused by limited time and vigour. This study assessed the outcomes of work-family conflict among University employees when Strain-Based Conflict (SBC), Time-Based Conflict (TBC) and job satisfaction are correlated. Multistage sampling procedure was used to select 107 employees for the study. Primary data were obtained using a structured questionnaire and analysed using frequency counts, percentages, mean, Pearson Product Moment Correlation (PPMC), Principal Component Analysis (PCA) and hierarchical regression. Results indicate that the mean age and work experience of the employees were 43.53 and 12.00 years respectively. About 50.54% of the employees were married and 57.90% were non-teaching employee. Correlation analysis revealed that age (-0.286\*\*) and marital status (-0.318\*\*) were negatively correlated while SBC (0.429\*\*) and TBC (0.493\*) were positively correlated with Work-Family Conflict. The exploratory PCA shows that three (3) items loading at ±0.70 and above accounted for 62.81% variability of the outcomes of WFC. The regression result revealed a significant association between SBC (t=4.37, p<0.05), TBC (t=3.37, p<0.05) and WFC. It was concluded that there was a positive correlation between strain, time and WFC. Based on this, the study recommends that work-family support from supervisor could help employees reduce their WFC and priorities should be given to practices such as parental leave, domestic leave, and flexible work in order to reduce the outcomes of WFC.*

**Keywords**: Work-Family Conflict, SBC, TBC, Job Satisfaction, Employees

INTRODUCTION

Over the years, most of the studies on Work-Family Conflict (WFC) have been conducted primarily in the western industrialized countries. However, the increase in number of male and female employees in non-western societies particularly Africa joining the workforce calls for attention and have become increasingly important to study. The recent wave of COVID-19 have made WFC increasingly essential in developing nations, the high level of female employees in the work force and their increased educational status have recently changed the way and manner family structure operates. The shift from a traditional single-income family to a double-income family where the couple play multiple roles causes conflicts due to limited time.

The construct WFC typically focuses on the difficulties employees have while balancing their work and family responsibilities. The interest in WFC studies has been fuelled by its negative consequences on employees and the organization (Thomas and Ganster, 1995). Previous works found that WFC affects employees’ self-development and career advancement (Jayaweere, 2005), causes absenteeism and poor work performance, enhance low level of job satisfaction (Adams, *et al*., 1996) and causes low performance and employees’ turnover (Kossek and Ozeki, 1998).

Work-Family Conflict is operationalized as the inter-role conflict in which the role pressure from the work and family domains are mutually incompatible, that is, the participation in the work (family) role is made more difficult by virtue of participation in the family (work) role. Netemeyer *et al.,* (1996) noted time-based conflicts, strain-based conflicts and behaviour-based conflicts as the three categories of WFC. Time-based conflict occur if employees cannot balance working time with family time while strain-based conflict arises when stress arising from work negatively affects family life or inability to separate work problems from personal problems. Furthermore, as captured by Netemeyer *et al.,* (1996), behavior-based conflict occurs when behaviours at work such as authoritative are applied to family life.

More significantly, Robbins and Judge (2013) accentuates that job satisfaction is often negatively related to work-family conflict. Employees who view their work as making it difficult for them to satisfy their family roles will likely be less satisfied with their job as it is seen as the source of the conflict. Herzberg’s Two-Factor Theory explained that job satisfaction includes achievement, recognition, work itself, responsibility, progress, and growth (Isfianadewi and Norrdiana, 2020). On the other hand, role theory explains the relationship between WFC and job satisfaction, the theory assumes that individuals with multiple identities tend to conflict because of an imbalance between identities (Rathi and Barath, 2013). It therefore becomes important to examine the outcomes of WFC and whether time-based conflict, strain-based conflict and job satisfaction positively or negatively correlates with WFC.

MATERIALS AND METHODS

The study was conducted at the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The Federal University of Agriculture, Abeokuta (FUNAAB) was established on January 1st 1988 (www.unaab.edu.ng) with the tripodal mandate of teaching, research and extension services. A simple random sampling technique was used to select 107 employees which comprises of teaching and non-teaching staff across departments, units and centres within the university. A structured and validated questionnaire was used to elicit information from the employees. Time-based Conflict (TBC) and Strain-Based Conflict (SBC) were measured using 5-items scales adopted from Carlso *et al*., (1998) such as my work keep me away from my family activities more than I would like” while SBC was “because of family responsibility, I do not concentrate at work’ the internal consistency reliability for the scale was 0.75 and 0.82 for TBA and SBC respectively. Also, supervisor support was measured on a 9-items scale using Cronbach alpha of 0.80 and Work-Family Conflict (WFC) was measured on 6-items scales adopted from Kopelman *et al.,* (1983). Cronbach alpha for the scale was 0.75. The responses on the scale items were ordered on a Likert scale of strongly agree (5), agree (4), undecided (3), disagree (2) and strongly disagree (1). Three biographical variables were included in the analysis. The biographical variables included age, sex and years of experience. Data were analyzed using Principal Component Analysis (PCA), correlation and hierarchical regression.

RESULTS AND DISCUSSION

Results in Table 1 are the descriptive statistics, alpha reliabilities and correlation of the study variables. The internal consistency reliabilities of the scales employed for the study ranges from .750 to .89 and are considered good (Hair, *et al*., 1992). Finding shows a positive correlation between time-based conflict (r = .493\*), strain-based conflict conflict (r = .429\*\*) and WFC. This finding implies that employees who spend greater amounts of time at work are more likely to face conflicts as family time is taken away by the work role. Also, it was noted that employees whose work role interferes with their family role cannot satisfy roles in the same time. Furthermore, employees with high levels of strains at work are more likely to have conflict when family responsibilities interfere with work roles. It therefore adduced that strain-based conflict in the workplace can impact on WFC and also spill-over to affect the employees’ family life.

Table 1: Inter-correlation of strain, time, job satisfaction, support supervisory and WFC

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Age | - |  |  |  |  |  |  |  |
| Sex | -.106 | - |  |  |  |  |  |  |
| Work experience | .751\*\* | .143 | - |  |  |  |  |  |
| Strain | -.066 | -.072 | -.220\* | **.820** |  |  |  |  |
| Time | -.020 | -.075 | -.130 | .363\*\* | **.759** |  |  |  |
| Job satisfaction | .183 | .047 | .113 | -.031 | .071 | **.894** |  |  |
| Support supervisory | .078 | -.235\* | -.060 | .065 | .099 | .391\*\* | **.808** |  |
| Work-family conflict | -.286\*\* | .033 | -.318\*\* | .429\*\* | .493\* | .067 | .154 | **.750** |
| Mean | 43.53 | - | 12.00 | 11.58 | 14.64 | 45.09 | 33.78 | 18.53 |
| sd | 9.220 | - | 8.714 | 4.626 | 4.174 | 8.874 | 5.921 | 4.732 |

\**p*< .05; \*\**p*<.001. Alpha reliabilities are in bold italics in diagonal. N=107

An exploratory principal component (PC) analysis was performed to test the hypothesis which states that factors that influence WFC are not significantly related. Table 2 show that 4 item loadings of ±0.70 and above were included in the factor and this accounted for 62.81% of the total variability with eigenvalue of equal to or greater than one, since one of the aim of factor analysis is the reduction of data, the significant items are, been irritable at home (0.71), tiredness at home (0.75), having much to do at work (0.75) and work interfering with family life (0.71). It was therefore noted that the PCA model transformed a 6-dimensional WFC items into 4-dimensions. It then implies that been irritable at home, tiredness at home, workloads and inter-role conflicts of work and family are the predominant outcomes of WFC experienced by employees. This corroborates Akintayo (2010) who noted that WFC is a strong predictor of work commitment and job satisfaction.

**Table 2: Principal Components Analysis of (Varimax) of Work-Family Conflicts**

|  |  |  |
| --- | --- | --- |
| Items | 1 | 2 |
| 1. Because my work is demanding, at times I am irritable at home | **.710** | .157 |
| 2. After work, I come home too tired to do some things I had like to do | **.753** | -.061 |
| 3. At work, I have so much to do that it takes away from my personal interest | **.757** | .377 |
| 4. My work takes up time that I would like to spend with my family | **.718** | -.433 |
| 5. I am too often tired at work because of things I do at home | .625 | .331 |
| 6. Others dislike how I am preoccupied with my personal life while at work | .432 | **.751** |
| Eigen value | 2.738 |  |
| Percent variation (%) | 7.18 |  |
| Cumulative (%) | 62.81 |  |

Source: computed from survey data, 2021; sig≥0.70; N=107

The result of the hierarchical regression analysis in Table 3 shows that the predictors of strain-based conflict (*β* = .38, *p*< .0001) and time-based conflict (*β* = .29, *p*< .0001) have a positive relationship with WFC. The result implies that strain-based conflict and Time-based conflict have made about .81% unfair treatment on employees WFC. The study posits that time is a major aspect of conflict. Consequently, an employee whose work role interferes with their family role cannot satisfy both role in the same time. In addition, potential sources of strain-based conflict such as emotional demands in workplace could affect WFC.

Table 3: Result of hierarchical regression analysis of predictors on WFC

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | beta | t-ratio | sig |
| Strain-based conflict | .38 | 4.37 | .00 |
| Time-based conflict | .29 | 3.58 | .001 |
| Job satisfaction | .94 | 0.60 | .54 |
| R-square | .81% |  |  |
| F | 23.74 |  |  |
| Sig F | .00 |  |  |
| Durbin Watson | 1.766 |  |  |

\**p*< .0001; N=107

CONCLUSIONS AND RECOMMENDATIONS

The study concluded that tiredness at home, workloads and inter-role conflicts of work and family are the predominant outcomes of WFC and there was a positive correlation between time-based conflict, strain-based conflict and WFC. Employees spending greater amounts of time at work are more likely to face conflicts as family time is taken away by the work role. It is therefore recommended that social support be provided to employees in order to manage time and strain related conflicts, also, practices such as domestic leave, annual leave, study leave and flexible work should be effectively implemented to make family life easier and therefore make work easier and managing WFC.

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## COMPARATIVE ANALYSIS OF THE EFFECT OF ANCHOR BORROWERS PROGRAMME (ABP) ON FOOD SECURITY STATUS OF RICE FARMERS IN EBONYI AND KEBBI STATES, NIGERIA

1Salisu, J., 2Adebayo, C.O., 2Jirgi, A. J. and 2Ojo, A. O.

1Department of Agricultural Extension and Management, Niger State College of Agriculture, Mokwa, Niger State, Nigeria

2Department of Agricultural Economics and Farm Management, Federal University of Technology, Minna, Nigeria

Corresponding Author’s email:[salisujibzago@gmail.com](mailto:salisujibzago@gmail.com) 09097000243

ABSTRACT

The study compared the effect of Anchor Borrowers’Programme (ABP) on food security status among beneficiary rice farmers in Ebonyi and Kebbi States, Nigeria. A multi-stage sampling procedure was used to select a total of 439 beneficiaries. This comprises of 218 respondents from Ebonyi and 221 from Kebbi States respectively. Primary data were collected through structured questionnaire administered to the sampled respondents by trained enumerators. The data were analyzed with the use descriptive statistics, food security index and Probit regression model. Results showed that the mean ages of the farmers were 49 and 46 years old, 69.27% and 92.31% of them were males, 92.20% and 93.21% were married, with an average farming experiences of 18 and 20 years and average household size of 9 and 14 persons, in Ebonyi and Kebbi States, respectively. Following the same sequence they had monthly income of ₦43,666.26 and ₦38,013.87 while 68.78% and 70.18% were food secured respectively. Similarly, ABP significantly influenced food security status of the respondents at p≤0.01 for both states. It was concluded that the farmers were moderately productive and food secured in the study area, while ABP performed relatively well in both Ebonyi and Kebbi States and thus has positive effect on the food security status of the beneficiaries. Based on findings, it is recommended that the government should consolidate on this performance by increasing funding for the programme and inclusion of more farmers in to the programme in order to boost rice production.

**Keywords:** Anchor Borrowers Programme, Food Security, Rice Farmers, Ebonyi, Kebbi.

INTRODUCTION

Rice is a staple food that provides more than one fifth of the calorie consumed worldwide by human species, though relatively lower in protein compared to other cereals, it contains a better balance of amino acids (Oyewole and Ebukiba, 2018). Nigeria is one of the leading consumer and largest producer of rice in Africa as well as largest rice importer in the world (National Bureau of Statistics (NBS), 2017).

Over decades, Nigeria has been grappling with food insecurity and its attendant consequences leading to hunger, massive importation, and social disorders among others (Osanyinlusi and Adenegan, 2016). The poor performance of the Nigerian rice sub-sector is characterized by low level of improved farm inputs usage, high cost of inputs, diversion of subsidized farm inputs, soil degradation, annual bush burning which destroys the soil organic matter, land issues, neglect of the agricultural sector, inadequate extension agents, market failures, insufficient technical know-how in the area, poor fertilizer application and inadequate essential inputs among the small scale rice farmers in the country (Ahmed et al., 2017).

Few empirical studies have been carried out to appraise the Central Bank of Nigeria (CBN) programmes and schemes geared towards agricultural development in Nigeria. For instance, Ayeomoni and Aladejana (2016) studied agricultural credit and economic growth nexus in Nigeria; Obasi (2015) looked at the efficiency of agricultural lending Scheme Fund (ACGSF) on production efficiency of rural farmers in Benue State .Obilor (2013) studied the impact of commercial banks’ credit on agriculture production in Nigeria. Babatunde 2019 study effect of Fadama programme on household food security in the North central region of Nigeria. In spite these endowments Agricultural sector has continued to record a decline in food security. The findings from these studies showed that agricultural developmental programmes in form of credit to the farmers performed sub-optimally on production in the study areas. It is against backdrops, therefore, that this research aimed at comparative assessment of effect of Anchor Borrower programme (ABP) food security status of rice farmers and kebbi states Nigeria and set at addressing the following specific objectives; describe the socioeconomic characteristics of ABP beneficiary rice farmers, determine the food security status of ABP beneficiary rice farmers and examine the factors influencing the food security of rice farmers in the study areas.

METHODOLOGY

The study was carried out in Ebonyi and Kebbi States, Nigeria. Ebonyi State is located in south Eastern region lies between Latitude 6o 15' N and 11o 30' North of the equator and Longitude 8o 05'E and 7o 20' East of the Greenwich Meridian. It has a total land mass of 5,533km2..

Kebbi State is located in North-West geopolitical zone of Nigeria. The State lies between Latitude 100 8ʹ and 13o 15ʹNorth of the equator and Longitude 3o 30ʹ and 6o 02ʹ East of the Greenwich Meridian. The State has a population of about. It covers an area of 36,800sqkm2. The land of both States allow for rice production and other agronomic activities.

Sampling Procedure and Sample Size

Multi-stage sampling procedure was used in the determination of sample size for the study. In the first stage, Ebonyi and Kebbi States were purposively selected as ABP participating States in Nigeria, due to high ABP beneficiary rice farmers. The Second stage involved purposive selection of two Local Government Areas (LGAs) with highest concentration of ABP rice farmers from each of the States while the third stage involved random selection of three villages from each of the selected LGAs to get a total of 12 villages. Taro Yamane formula was used to obtain 221 and 218 ABP beneficiary rice farmers giving a total of 439 sample size for the study (Yamane, 1973). The formula is presented in equation (1) as:

(1)

Where:

n = Sample size,

N=Finite population

e = Limit of tolerable error, 0.5%

1= Unit/Constant

Primary data on socio-economic profile of respondents, their food security status and factors influencing food security status of the rice farmers were collected with the aid of structured questionnaire. Analytical tools such as descriptive statistics was used to achieve objective 1, food security index was used achieve11 while Probit regression model was employed to determine objective 111. The food security index formula as used by Omonona et al. (2007) as expressed in equation (2):

 (2)

Where;

Fi= food security index

Thus, Fi ≥ 1 implied food secured household (those whose per capita food monthly expenditure fall above or is equal to two-third of the mean per capita food expenditure) while Fi<1 implied food unsecured household (Those whose per capita food expenditure falls below two-third of the mean monthly per capita food expenditure).In order to explained the factors that influenced food security status of farmers data were further subjected to probit regression model. The Probit regression model is empirically and explicitly specified as in equation (3):

Y=α+β0+ β1ABPCRE+β2OFI+ β3FSZ+ β4FIC+β5AGE+β6HHS+β7SEX+β8EXT+β9EXP+ β10EDU+ β11MC+ β12MS+ e (3)

Y= Food security status (food secure=1, otherwise= 0)

ABPCRE= ABP credit accessed (Naira)

OFI= Off-farm income (Naira)

FSZ= Farm size (ha)

FIC= Farm income (Naira)

AGE= Age (years)

HHS= Households size (number)

SEX= Sex (male=1, female=0)

EXT= Extension visits (number)

EXP= Farming experience (years)

EDU=Education (years)

MC= Membership of cooperative association (Member=1, otherwise=0)

MS= Marital status (Married=1, otherwise=0)

β0= Coefficient of intercept

β1– β12 = Coefficients of the explanatory variables

e = Error term

RESULTS AND DISCUSSION

The result on socio-economic characteristics of the farmers in the study area as presented in Table 1, showed that the mean ages of farmers were 49 and 46 years in the Ebonyi and Kebbi Sates, respectively. Although, the results revealed that ABP farmers in Ebonyi were slightly older than their counterpart in Kebb Statei, but they were still in their active and productive age, strong and agile which could serve as impetus for accessing additional funds that will enhance their production. This confirms the report of Ayinde et al. (2017) who revealed that majority of rice farmers that benefited from Federal Government intervention in Kwara State, Nigeria, were in their productive age.

The result further revealed that majority 92.20% and 93.21% of the farmers in Kebbi and Ebonyi States were married respectively while the pooled results revealed that majority (92.71%) of the farmers were married. This was an results indication that larger proportion of the farmers from both States were married. It is believed that married individuals usually have more responsibilities than unmarried which could make them seek for additional fund that will boosts their rice production and also enhance their livelihood. This that corroborates that that of Nwalieji (2016) who reported that larger percentage of Nigeria farmers were married. In Ebonyi State attained higher educational level than that of Kebbi State. The pooled results revealed that 89.52% rice farmers had formal education, which implied that most of the beneficiary rice farmers were knowledgeable which made the adoption of ABP easier. Adoption of innovation could enhance their livelihood and income levels. These finding agrees with the report of Ayinde et al. (2017) who reported that access to formal education had the tendency of improving the livelihood of rural farmers in Kwara State.

Food Security Status of the Respondents

The result of food security status of the ABP beneficiary rice farmers in the study areas as presented in Table 3 revealed that 68.78% and 70.18% of the famers in Kebbi and Ebonyi States, respectively were food secure. The pooled results revealed that 69.48% of the respondent were food secure. This implied that middling proportion of the respondents in the study were food secure, this might be due to availability and accessibility of ABP fund. This finding agrees with Owolabi et al. (2016) who stated that majority of crop farmers in Kaduna Sate, Nigeria were food secured.

Determinants of Food Security Status of Respondents ABP beneficiary rice farmers in the Study Area

The result of Probit regression estimates on determinants of the food security status of the rice farmers was presented in Table 4.In Kebbi State, the result revealed that the coefficient of ABP credit received was positive and significant at P ≤0.01 probability level. The implication of this is that an increased access to ABP credit by the rice farmers increased their likelihood of being food secured in the area. This further implied that ABP in Kebbi State had significant positive effect on the food security status of the rice farmers. The result further reveals that farm income at P ≤0.01, farm size at P ≤ 0.10, access to extension services at P ≤ 0.10 and membership of cooperative at P ≤ 0.10 probability levels respectively were positively significant in increasing the likelihood of being food secured among the respondents in the study area. However, household size was found to have a significant negative relationship at P ≤ 0.01 probability level with food security among the respondents in Kebbi State.

Similarly, the result of the amount of ABP credit received had significant positive relationship at P ≤ 0.01 probability level with food security among the ABP beneficiary rice farmers in Ebonyi State. This also implies that ABP in Ebonyi State is a huge success as it had significant positive effect on the food security status of the respondents. A further look at the result for Ebonyi showed that farm income at P ≤ 0.01, off-farm income at P ≤0.01 and education at P ≤ 0.01probability levels were positively significant. This implies that an increase in these variables could increases the likelihood of being food secured among the respondents in the study area. Meanwhile, the coefficient of household size was negatively significant at P ≤ 0.01probability level which implies that larger households are more likely to be food insecure.

The pooled result equally showed that the amount of ABP credit obtained by the farmers was positively significant at P ≤ 0.01 probability level, an indication that ABP in the study area had significant positive effect on the food security status of the respondents. The income earned from off-farm activities by the farmers at P ≤ 0.01 and their education at P ≤ 0.01 probability levels respectively were positively significant. The implication is that as the values of these variables increase, the probability of food security increases accordingly. Conversely, the coefficient of household size at P< 0.01 probability level was negatively significant. This implies that as household sizes increases, the probability of food security decreases.

CONCLUSION AND RECOMMENDATIONS

From the findings of this study, it was concluded that the farmers were moderately food secured in the study area. The ABP performed relatively well in both Ebonyi and Kebbi States. It had significant and positive effects on the food security status of the beneficiaries in the study areas. Based on the findings from this study, the following recommendations were made:

i. The Federal Government should consolidate on the performance of the Anchor Borrowers’ Programme by increasing funding for the programme and ensure more rice farmers benefit from it given that the programme has enhanced the food security status of the beneficiaries in the study areas.

ii. The Bank of Agriculture (BOA) and other financial institutions should also ensure timely and adequate disbursement of the loan to beneficiaries for timely purchase of the required production inputs. When this is done, more gains will be recorded in terms of ABP performance.

Table 1: Distribution of respondents according to socioeconomic characteristics

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Frequency distribution | | |
| **Ebonyi State(n=218)** | **Kebbi State(n=221)** | **Pooled(n=439)** |
| **Age (years)** |  |  |  |
| 21 – 30 |  | 7 (3.17) | 7 (1.59) |
| 31 – 40 | 32 (14.72) | 52 (23.53) | 84 (19.13) |
| 41 – 50 | 112 (51.38) | 116 (52.49) | 228 (51.94) |
| 51 – 60 | 49 (22.48) | 32 (14.48) | 81 (18.45) |
| >60 | 25 (11.04) | 14 (6.34) | 39 (8.88) |
| **Mean** | **48.73** | **45.73** | **47.18** |
| **Gender** |  |  |  |
| Male | 151 (69.27) | 204 (92.31) | 355 (80.87) |
| Female | 67 (30.73) | 17 (7.69) | 84 (19.13) |
| **Marital status** |  |  |  |
| Single | 11 (5.05) | 4 (1.81) | 15 (3.42) |
| Married | 201 (92.20) | 206 (93.21) | 407 (92.71) |
| Widow | 1 (0.46) | - | 1 (0.23) |
| Divorced | 5 (2.29) | 11 (4.98) | 16 (3.64) |
| **Level of education** |  |  |  |
| FSLC | 72 (33.03) | 83 (37.56) | 155 (35.31) |
| HND | 12 (5.50) | 3 (1.36) | 15 (3.42) |
| JSCE | 11 (5.05) | 20 (9.05) | 31 (7.06) |
| NCE | 76 (34.86) | 18 (8.14) | 94 (21.41) |
| OND | 7 (3.21) | 11 (4.98) | 18 (4.10) |
| Qura’anic | - | 46 (20.81) | 46 (10.48) |
| SSCE | 20 (9.17) | 31 (14.03) | 51 (11.62) |
| University Degree | 20 (9.17) | 9 (4.07) | 29 (6.61) |
| **Occupation** |  |  |  |
| Agro-processing | 15 (6.88) | 21 (9.50) | 36 (8.20) |
| Artisan | 7 (3.21) | 5 (2.26) | 12 (2.73) |
| Civil servant | 29 (13.30) | 11 (4.98) | 40 (9.11) |
| Farming | 150 (68.81) | 161 (72.85) | 311 (70.84) |
| Fisheries production | 9 (4.13) | 15 (6.79) | 24 (5.47) |
| Livestock production | 4 (1.83) | 7 (3.17) | 11 (2.51) |
| Trading | 4 (1.83) | 1 (0.45) | 5 (1.14) |
| **Farming experience (years)** |  |  |  |
| 1 – 10 | 5 (2.29) | 22 (9.95) | 27 (6.15) |
| 11 – 20 | 155 (71.10) | 137 (61.99) | 292 (66.51) |
| 21 – 30 | 44 (20.18) | 59 (26.70) | 103 (23.46) |
| >30 | 14 (6.42) | 3 (1.36) | 17 (3.87) |
| **Mean** | **18** | **20** | **19** |

**Source: Field Survey, 2019**

Table 2: Frequency distribution of rice farmers according to food security status

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Ebonyi State(n=218) | Kebbi State(n=221) | Pooled(n=439) |
| Food secure | 153 (70.18) | 152 (68.78) | 305 (69.48) |
| Food insecure | 65 (29.82) | 69 (31.22) | 134 (30.52) |

**Source: Field Survey, 2019**

Table 3: Probit regression estimates on effect of ABP on food security status of respondents

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **Kebbi State** | | **Ebonyi State** | | **Pooled result** | |
| **Coeff.** | **z-value** | **Coeff.** | **z-value** | **Coeff.** | **z-value** |
| ABP credit | 0.0002 | 3.45\*\*\* | 0.0003 | 3.31\*\*\* | 0.0002 | 5.39\*\*\* |
| Farm income | 4.99e-06 | 3.88\*\*\* | 1.83e-06 | 3.02\*\*\* | 7.34e-08 | 0.95 |
| Off-farm income | 2.94e-07 | 0.68 | 4.99e-06 | 5.16\*\*\* | 1.20e-06 | 4.04\*\*\* |
| Farm size | 0.4384 | 1.69\* | -0.3075 | -1.09 | -0.0435 | -0.37 |
| Age | 0.0094 | 0.38 | 0.0234 | 0.86 | 0.0180 | 1.31 |
| Household size | -0.2442 | -6.18\*\*\* | -0.2042 | -3.02\*\*\* | -0.1781 | -7.61\*\*\* |
| Gender | -0.0369 | -0.06 | -0.2075 | -0.31 | 0.0400 | 0.12 |
| Extension contact | 0.6893 | 1.66\* | -0.2840 | -0.55 | 0.3819 | 1.57 |
| Farm experience | -0.0391 | -1.18 | -0.0102 | -0.27 | -0.0186 | -1.05 |
| Education | -0.0342 | -0.87 | 0.2641 | 3.90\*\*\* | 0.0520 | 2.14\*\* |
| Cooperative membership | 0.7885 | 1.88\* | 0.2216 | 0.49 | 0.1250 | 0.62 |
| Marital status | 0.4407 | 0.56 | -0.0590 | -0.07 | 0.0609 | 0.17 |
| Constant | 0.6993 | 0.47 | -10.3700 | -2.96\*\*\* | -0.6584 | -0.74 |
| **Diagnostic statistics** |  |  |  |  |  |  |
| Log likelihood | -40.0105 |  | -25.5472 |  | -99.8252 |  |
| LR Chi-square | 159.66\*\*\* |  | 144.72\*\*\* |  | 249.71\*\*\* |  |

**Source: Field Survey, 2019**

\*\*\*, \*\* and \* implies p≤0.01, p≤0.05 and p≤0.10 probability levels of significance respectively.

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## EFFECTS OF LAND DEGRADATION ON CEREAL CROP PRODUCTION IN RURAL AREAS OF NIGER STATE, NIGERIA

M. I Kanko; I. T. Salihu; M. Ibrahim

Department of Agricultural Extension and Rural Development, Federal University of Technology, Minna, Nigeria

\*Corresponding author E-mail and Phone number: [mohammed\_kanko@yahoo.com](mailto:mohammed_kanko@yahoo.com) +2348039110819

ABSTRACT

*The study examined effects of land degradation on cereal crop production in rural areas of Niger State, Nigeria. Three stage sampling techniques were employed to select 227 respondents for the study on which primary data were elicited from the respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics (such as frequency, percentage, mean and Likert type rating scale). The results obtained showed that that majority (84.1%) of cereal crop farmers in the study areas had experienced one form of soil degradation or the other. Runoff (89.8%), waterlogging (78.9%) and soil structure destruction (75.3%) were the physical land degradation experienced by cereal crop farmers while low nutrient availability (96.5%) and increased soil acidity (72.1%) were the major chemical land degradation experienced by cereal crop farmers in the study area. Furthermore, soil nutrients loss (=4.5), occurrence of soil erosion and reduction of crop yield (=4.3) were the topmost effects of land degradation on the output of cereal crop farmers while terracing (87.2%), mixed farming (68.7%), organic manure (63.9%), inorganic fertilizer application and afforestation (55.5%) were the major adaptive strategies adopted by cereal crop farmers in the study area. The study recommended that that cereal crop farmers should be sensitized by relevant stakeholders (Governmental and Non-Governmental Organization) on the effects of their activities on the land which deplete soil nutrients and train on the best coping strategies for natural occurrences like flood.*

**Key words:** land degradation, cereal production, rural area, adaptive strategies

INTRODUCTION

Land degradation is a global phenomenon that alters the production function and sustainability of agriculture and induced farmers to convert farmland into lower-value uses. The main effect of land degradation is reduction in the productivity of agricultural output. Land degradation is a menace to the future generation and entire human existence. Onyerika (2016) posited that land degradation is a major aspect of environmental degradation, its various forms include; soil erosion, land pollution, flooding, bush burning, improper waste disposal, compaction and hard setting of soil. The resultant consequences of land degradation are; washing away of soil nutrients/particles, exposures of sub soil surfaces, exposure of roots of plants/trees and foundation of buildings, poor vegetative growth and low levels of crop yield as well as total crop failure. Increase cultivation resulting in the opening up of new lands exposes the top soil to the elements of degradation and alters the natural ecological conservatory balances in the landscape (Senjobi and Ogunkunle, 2010).Land degradation, which results to a decline in land quality caused by human activities, will remain high if not checked. In the developing countries like Nigeria where a large percentage of human population depends almost totally on land resources for their sustenance, there is increasing demand for land utilization suchas grazing, fish pond construction, quarrying, crop farming amongst others (Akinnagbe and Umukoro, 2011). The drive towards safeguarding food security should be channeled towards developing agricultural practices and system that will be environmental responsive and also focus on productivity on the long term rather than immediate production and ensuing returns (Bankole *et al.,* 2012). Growing food crops such as cereals to keep pace with population demand while retaining the quality of land and the ecological balance of the production system is a current challenge to agricultural research and policy in Nigeria. Increase in world population and other non-agricultural land use are putting extra pressure on land hence there is increasingly less land for food production due to degradation as demand for food and other agricultural products keeps increasing. Increasing food production to keep pace with growing population require more land which is not available due to degraded arable land area (Onyerika., 2016). In recent years, several modern approaches to control land degradation (soil erosion) for enhanced agricultural production and development have failed due to lack of knowledge and perception of farmers who are into various agricultural production. Farming is the main occupation of the people in the study area, thus issues related to land degradation cannot be over emphasized. These farmers have little or no information on the extent to which land degradation can affect their productivity and output level which constitutes a gap in knowledge hence the need to carry out this study on the assessment of the perceived effects of land degradation on cereal crop production in rural areas of Niger State, Nigeria. In view of the above, the study attempt to identify the forms of land degradation cases experienced by the respondents; assess the perceived effects of land degradation on cereal crop production output and examine the adaptation strategies to mitigate the effects of land degradation

METHODOLOGY

The study was carried out in Niger State which is located within Latitude 10°00′N and Longitude 6°00′E with annual rainfall varying from 1300mm in the North to 1600mm in the south. The State covers a total land area of 76,363 square km with a population of 3,950,249 according to 2006 Population Census.

Three stage sampling techniques were employed to select 227 respondents for the study. The first stage involved the random selection of Bida, Shiroro and Wushishi Local Government Area from each of the three agricultural zones of Niger State. Second stage involved the selection of three villages each from the selected LGAs which are; efu ndatwaki, efu madami, edzwayagi, gwada, kafa, kuta, lokogoma, wushishi, bankogi. Primary data were elicited from respondent with the aid of a semi-structured questionnaire complemented with interview schedule. Data collected were analyzed using descriptive statistics (mean, frequency distribution count, percentages and Likert type rating scale).

RESULTS AND DISCUSSION

The result in Table 1 depicts that majority (84.1%) of cereal crop farmers in the study areas had experienced one forms of soil degradation or other. The study area is an agrarian society with over 400,000 farming households according to Niger State Ministry of agriculture (2012), thus activities of man and natural occurrences which constitute menace to land degradation over the years had enormously affected the productivity of the farmers. As result of the state contribution to food sustenance in Nigeria, efforts were put in place by several Governmental and Non-Government Organization such as Nigeria Institute of Soil Scientist to help conserve soil for improved productivity.

The study revealed that runoff (89.8%), waterlogging (78.9%) and soil structure destruction (75.3%) were the physical land degradation experienced by cereal crop farmers while low nutrient availability (96.5%) and increase soil acidity were the (72.1%) were the major chemical land degradation experienced by cereal crop farmers in the study area. This is similar to the findings of Onyerika, (2016) who opined that runoff and soil acidification were the major type of land degradation in the study area. Excess water that exceeds the amount that the soil can absorb usually results in runoff, which can wash away rich topsoil. Activities of man, like a poor irrigation and drainage system, as well as natural occurrences like floods, usually contribute to the runoff. Meanwhile waterlogging reduces aeration in the soil, thereby **lowering oxygen levels in the root zone, which reduces plant growth.**

Table 1: Types of land degradation (Physical and Chemical degradation)

|  |  |  |
| --- | --- | --- |
| Variables | Frequency | Percentage |
| Experience any land degradation in your farm | 191 | 84.14 |
| Physical |  |  |
| Soil structure destruction | 171 | 75.33 |
| Dispersion of soil | 59 | 25.99 |
| Sealing of pore spaces | 44 | 19.38 |
| Low infiltration | 62 | 27.31 |
| Reduce root generation | 51 | 22.4 |
| Waterlogged | 179 | 78.85 |
| Runoff | 204 | 89.87 |
| Accelerated erosion | 35 | 15.42 |
| Compression, and increase density | 5 | 2.20 |
| Chemical |  |  |
| Low nutrient availability | 219 | 96.48 |
| Low nutrient uptake | 95 | 41.85 |
| High mobility of element | 39 | 17.18 |
| Presence of toxic substances | 12 | 5.29 |
| Increased soil acidity | 163 | 72.12 |
| Salinity and sodicity | 14 | 6.17 |
| High level of alkalinity | 43 | 18.94 |

**Source: Field survey, 2022**

Effects of land degradation on cereal crop production output

The result in Table 2 shows that soil nutrients loss (=4.5) was ranked first among the effects of land degradation on cereals crop output, this was followed by occurrence of soil erosion and reduction of crop yield (=4.3). Others include increased labour supply (=3.9), low output of farm produce (=3.9) and reduced labour productivity (=3.8). In addition, reduction of income (=3.7) and previous cultivated field abandon due to poor nutrient (=3.7) were perceived by cereals crop farmers as the effects of land degradation on their output.

Table 2: Effects of land degradation on cereal crop production output

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Effects | Weight sum | Weigh mean | Rank | Decision |
| Occurrence of soil erosion which reduce soil nutrient | 981 | 4.3 | 2nd | Agreed |
| Changes cropping system over the year | 745 | 3.3 | 12th | Agreed |
| Recommended hybrid seeds are used during cultivation | 834 | 3.7 | 8th | Agreed |
| Shifting cultivation has become less common | 806 | 3.6 | 11th | Agreed |
| Previous cultivated field are abandon due to poor soil fertility | 830 | 3.7 | 8th | Agreed |
| Farmers spend resources on how to improve their land | 930 | 4.1 | 4th | Agreed |
| Low output of farm produce | 886 | 3.9 | 5th | Agreed |
| Reduce farmers income | 841 | 3.7 | 8th | Agreed |
| Reduce crop yield | 971 | 4.3 | 2nd | Agreed |
| Increase labour supply | 880 | 3.9 | 5th | Agreed |
| Reduce land productivity | 859 | 3.8 | 7th | Agreed |
| Soil nutrient loss | 1031 | 4.5 | 1st | Agreed |

**Source: Field survey, 2022**

Adaptive strategies

The results in Table 3 revealed the adaptive strategies adopted by crops farmers to reduce the effects of land degradation on their output. The Table revealed that majority (87.2%) of the cereal crop farmers adopted terracing to reduce the menace of land degradation. Terracing is the practice of curving several, flat levelled areas in to hills steps which are bordered by a mud wall to prevent run off and holds the soil nutrients in the beds. The major advantage of terracing is that it reduces the water movement and its velocity thereby reducing soil erosion and permits more intensive cropping than would otherwise be possible. The other adaptive strategies adopted by cereal crop farmers in the study areas include mixed farming (68.7%), organic manure (63.9%), inorganic fertilizer application and afforestation (55.5%).

Table 3: Distribution of respondent according to adaptive strategies

|  |  |  |
| --- | --- | --- |
| Adaptive strategies | Frequency | Percentage (%) |
| Crop rotation | 89 | 39.2 |
| Mixed cropping | 99 | 43.6 |
| Mixed farming | 156 | 68.7 |
| Terracing | 198 | 87.2 |
| Zero tillage | 67 | 29.5 |
| Fallowing | 51 | 22.5 |
| Organic manure | 145 | 63.9 |
| Inorganic manure | 126 | 55.5 |
| Intercropping | 62 | 27.3 |
| Combination of organic and inorganic | 90 | 39.7 |
| Afforestation | 126 | 55.5 |
| Planting of grass | 26 | 11.5 |
| Stone line | 48 | 22.2 |

**Source: Field survey, 2022**

CONCLUSION AND RECOMMENDATION

Based on the study, it can be concluded that land degradation constitutes menace to cereal crop production in the study area. Runoff, waterlogging and soil structure destruction were the physical land degradation experienced by cereal crop farmers while low nutrient availability and increase soil acidity were the chemical degradation associated with the study area. Furthermore, soil nutrients loss, occurrence of soil erosion and reduction of crop yield were the topmost effects of land degradation on cereal crop output. Terracing, mixed farming and the use of organic and inorganic manure were the adaptive strategies adopted by cereal crop farmers to mitigate against the effects of land degradation. The study recommended that cereal crop farmers should be sensitized by relevant stakeholders on the effects of their activities on the land which deplete soil nutrients and train on the best coping strategies for natural occurrences like flood.

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## EFFECTS OF INSURGENCY ON CROP FARMING ACTIVITIES OF RURAL WOMEN IN ADAMAWA STATE, NIGERIA

Joshua, G. G., Umar, I. S., Ajayi, O. J., Abdullahi, B. and Bamero, B. K.

Department of Agricultural Extension and Rural Development, Federal University of Technology, Minna, Nigeria

\*Corresponding author E-mail and Phone number: [garnvwagloria07@gmail.com](mailto:garnvwagloria07@gmail.com) +2349020107483

ABSTRACT

*The study analyzed the effect of insurgency on agricultural activities of rural women in Adamawa State, Nigeria. Multi-stage sampling technique was used to select 232 rural women involved in agricultural production in which semi -structured questionnaire complemented with interview schedule was employed to collect primary data. Data collected were analyzed using descriptive statistics (such as means, percentages, frequency counts and attitudinal measuring scale such as Likert type rating scale) and inferential statistics (such as, OLS and Gini Coefficient) the outcome of the accessibility of production inputs after insurgency showed that, cutlass (=2.43), hoe (=2.25), herbicides ( = 2.13), fertilizers ( = 2.03) and improved seeds ( = 2.03) were highly accessible by respondent. The result of the calculated Gini-coefficient was 0.53 which is close to one; this implies that there is inequality in income distribution among rural women in the study area. Regression analysis results revealed that farm size (0.2081), education (0.2081) and years of farming experience (0.6093) to be positive and significant while insurgency activities, loss of farmlands, lost of assets, lost of animals, relocation and frequency of attack were found to be negative and significant. This study recommended that, adequate sensitization of the rural women who are the most vulnerable victims of insurgency and the need for Adamawa State Ministry of Agriculture to establish a rehabilitation and training centre (skills acquisition programme) for victims of insurgency*

**Key Words:** Insurgency; women; farming; rural; input

**INTRODUCTION**

Agriculture plays significant roles in Nigeria economy in terms of rural employment, self-sufficiency in food, fiber, and export earnings before the discovery of oil (Towobola *et al*., 2014). In Nigeria, studies on women roles in agriculture have shown that women play a vital role in different aspects of income generation activities such as farming and non-farming operations. Women perform larger percentage of households’ social, economic and cultural activities, they contributed to national and economic growth, even though not well documented statistically (Food and Agriculture Organization (FAO), 2011). Rural women play significant role as producers of food for the maintenance of the family. However, the incidence of insurgency has destabilized agricultural and socio-economic activities of the nation (Adebayo, 2014). The instability generated by the insurgency has caused substantial decrease in agricultural production (Ojo et al., 2018). The effects of Boko Haram insurgency agricultural production are numerous and cut across all aspects of life especially in the North Eastern part of Nigeria (Beatrice, 2015). The states that are epicenter of Boko Haram insurgency include Borno, Yobe and Adamawa States. Their activities make those affected areas unsafe for human habitation, pushing hundreds of thousands of farmers out of their lands. It should be noted that most of the farmers in Northern Nigeria are rural dwellers and rural areas happened to be more seriously hit areas by the Boko Haram insurgency. From the inception of insurgency in the Northern part of the country in 2009 and its first attack in Adamawa State in 2011, few studies (Babagana *et al.,* 2018; Ojo *et al.,* 2018) have revealed serious negative effect on crop production activities. However, there is dearth of empirical evidence on the impact of insurgency on the outputs of women crop farmers in Adamawa State. This has constituted a gap in knowledge that needed to be filled. It is against this backdrop that this research was conceived to assess the effects of insurgency on crop farming activities of rural women in Adamawa State, Nigeria. The specific objectives of the study are to: assess the level of rural women access to production inputs in the study area; determine the pattern of income distribution among the rural women and determine the effects of insurgency on crop output of rural women.

METHODOLOGY

The study was conducted in Adamawa State, Nigeria. Adamawa State is one of the States that was formed on the 27th of August 1991. It is located between Latitude 7º11' North of the equator and Longitude 11º14' East of the Greenwich meridian. The State has human population of about 3,168,101 according to 2006 population census(NPC, 2006). The population was projected to be 4,283,270 in 2017 at 3.2% annual growth rate (National Bureau of Statistics (NBS), 2015).

Three- stage sampling technique was employed to select 232 rural women in the study area using Taro Yammane model as used by Sunday *et al.* (2015). Primary data were elicited from the respondents using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive statistics such as means, percentages, frequency counts and attitudinal measuring scale such as Likertrating scale and inferential statistics(such as, OLS and Gini Coefficient and attitudinal measuring scale such as scale).

RESULTS AND DISCUSSION

Level of accessibility of inputs by women farmers

The respondents’ level of access to agricultural production inputs in the study area are presented in Table 1. The result revealed that the respondents had high access to cutlass (=2.43) which ranked 1st among the production inputs. This was followed by hoe (=2.25) and ranked 2nd. This implies that the rural women farmers had high access to cutlasses and hoes. This is expected because cutlasses and hoes are among the oldest farming inputs commonly found with farmers especially in Nigeria and other developing nations. High accessibility to herbicides ( = 2.13), fertilizers ( = 2.03) and improved seeds ( = 2.03) ranked 3rd, 4th.and 5th respectively. This implies that access to agricultural inputs by women farmers was not highly affected by the insurgency in the study area this is in line with Umar *et al*. (2019) who reported similar findings.

Table 1: Levels of accessibility to production inputs by respondents

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Level of Accessibility** | **HA** | **A** | **NA** | **WS** | **WM** | **Rank** | **Remarks** |
| Cutlass | 142 | 47 | 43 | 563 | 2.43 | 1st | Accessible |
| Hoe | 121 | 49 | 62 | 523 | 2.25 | 2nd | Accessible |
| Herbicides | 54 | 154 | 24 | 494 | 2.13 | 3rd | Accessible |
| Improved seeds | 50 | 138 | 44 | 470 | 2.03 | 4th | Accessible |
| Fertilizer | 33 | 172 | 27 | 470 | 2.03 | 4th | Accessible |
| Pesticides | 75 | 59 | 98 | 441 | 1.90 | 6th | Poorly Accessible |
| Plough | 24 | 51 | 157 | 331 | 1.43 | 7th | Poorly Accessible |
| Knapsack sprayer | 17 | 45 | 170 | 311 | 1.34 | 8th | Poorly Accessible |
| Pumping machines | 18 | 41 | 173 | 309 | 1.33 | 9th | Poorly Accessible |
| Ridger | 16 | 39 | 177 | 303 | 1.31 | 10th | Poorly Accessible |

**Source: Field Survey, 2019. Note:** HA = Highly Accessible (3), A = Accessible (2), NA = Not Accessible (1), WS = Weighted Sum, WM = Weighted Mean

Income Distribution among the Respondents

The pattern of income distribution among the respondents in the study area was achieved using Gini-coefficients. As revealed in Table 2, the calculated Gini-coefficient was 0.53 which is close to one. This implies that there was inequality in the distribution of income among the rural women in the study area. This could be associated with insurgency in the area as most of the rural women are displaced from their various homes depriving them access to farmland to carry out their agricultural activities. Low yield is associated with low income generation except those that have other sources of income from non-farming activities which could actually lead to income variation among the rural women farmers. This finding is in corroboration with Ayinde *et al.* (2012) who obtained a Gini-coefficient of 0.59 and 0.67 for agricultural and non-agricultural incomes respectively.

Effects of Insurgency on Crop Production

Regression analysis result presented in Table 3, reveals t the coefficient of determination (R2) valuew as 0.7563 implying that about 76% variation in the crop output of the rural women farmers was explained by the independent variables included in the model, the remaining 24% unaccounted for could be due to type error or other variables not captured in the model.

Table 2: Distribution of respondents based on their income generation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Income (₦)** | **Frequency** | **Proportionof respondents (X)** | **Cumm. Proportion of incomes** (**Y)** | **XY** |
| < 200,001 | 29 | 0.13 | 0.04 | 0.00 |
| 200,001 - 400,000 | 29 | 0.13 | 0.10 | 0.01 |
| 400,001 - 600,000 | 46 | 0.20 | 0.25 | 0.05 |
| 600,001 - 800,000 | 36 | 0.16 | 0.42 | 0.06 |
| 800,001 - 1,000,000 | 46 | 0.20 | 0.69 | 0.14 |
| > 1,000,000 | 46 | 0.20 | 1.00 | 0.20 |
| **Total** | **232** | **1.00** |  | **0.47** |
| **GI** |  |  |  | **0.53** |

**Source: Field Survey, 2019**

The coefficient of farm land lost (-0.3001) was negative and significant at the 0.01 probability level; implying that a unit increase in lost of farm land will lead to 0.30 decrease in crop output of the respondents. This has the expected *a prior this is be*cause land is one of the important factors of agricultural production thus any activity that decreases land availability will invariably affect the total output. The reason for this result could be attributed to the fact that land meant for farming is used as the hideout of the insurgent thereby rendering the land unutilized.

The coefficient of animals lost (-0.2447) was negative and significant at the 0.01 probability level; implying that a unit increase in lost of animals will leads to 0.2447 decrease in crop output of the respondents. Animals such as donkeys, horse, ox and cattle as well as poultry dungs aid crop production. Apart from providing the needed cash after sales to procure inputs, they play one role or the other especially in supplying organic manure. Majority of the farmers lost their animals due to activities of insurgency which had negative effects on crop production in the study area.

The coefficient of assets lost (-0.5605) was negative and significant at the 0.01 probability level; implying that a unit increase in lost of assets especially production assets will leads to 0.5605 decrease in crop output of the farmers. Production assets like plough, ridger and other equipment are very key to crop production. In most cases, farmers were deprived of using them due to activities of insurgency which will in turn have negative effects on crop production of the rural women farmers.

The coefficient of relocation (-0.1449) was negative and significant at the 0.05 probability level; suggesting that a unit increase in relocation of farmers in the study area decreases their crop outputs. The activities of insurgency had forced many farmers to abandon farmlands and relocate to safer places. This act of relocation had negatively affected crop production activities and outputs of the rural women farmers in the study area.

The coefficient of frequency of attack (-0.7582) was negative and significant at the 0.01 probability level; implying that a unit increase in frequency of attack from insurgents decreases crop output of the respondents. The more the attacks from the insurgents, the more farmers abandon their farmlands use for cultivation and consequently affecting their production activities and output negatively in the study area.

The coefficient of people displaced (-0.1661) was negative and significant at 0.05 probability level; implying that a unit increase in people displaced will leads to 0.7582 decrease in crop output of the respondents. This meet the *a priori expectation.* Many of the respondents take refuge at IDP camps for safety, abandoning their original homes and farm lands which invariably leads to decrease in their crop outputs.

The coefficient of exposure to bomb (-0.2548) was negative and significant at 0.10 probability level; implying that a unit increase in exposure to bombs will lead to 0.2548 decrease in crop outputs of the respondents. This outcome is expected because, the more farmers are exposed to bombs, the more they abandon that location for safety.

Table 3: Regression estimate on effects of insurgency on crop production

|  |  |  |
| --- | --- | --- |
| Variables | Coefficients | T-value |
| Loss of farm land | -.3001 | -2.89\*\*\* |
| Loss of crops | .1096 | 1.39 |
| Loss of animals | -.2447 | -3.73\*\*\* |
| Loss of asset | -.5605 | -5.76\*\*\* |
| Loss of lives | -.0596 | -0.47 |
| Relocation | -.1449 | -2.25\*\* |
| Frequency of attack | -.7582 | -6.23\*\*\* |
| People displaced | -.1661 | -2.42\*\* |
| Death of several farmers | -.0084 | -0.09 |
| Exposure to bombs | -.2548 | -1.98\* |
| Fear of being killed | .1502 | 0.90 |
| Fear of abduction | .0501 | 0.40 |
| Fear of attack | -.1268 | -0.96 |
| Constant | 10.6271 | 13.15\*\*\* |
| R-squared | 0.7563 |  |
| Adjusted R-squared | 0.7239 |  |
| F-ratio | 14.07\*\*\* |  |

**Source: Field Survey, 2019**

**Note:** \*\*\* implies significant at 0.01, \*\* significant at 0.05%, \* significant at 0.10%.

CONCLUSION AND RECOMMENDATION

Based on the study it can be concluded that cutlass, hoe, herbicides, fertilizers and improved seeds were highly accessible by the respondent. More so, there is inequality in income distribution among rural women in the study area. In addition, farm size, education and years of farming experience had direct relationship with crop production while insurgency activities, loss of farmlands, lost of assets, lost of animals, relocation and frequency of attack had inverse relationship with crop production by rural women. The study recommended that, adequate sensitization of the rural women who are the most vulnerable victims of insurgency and the need for Adamawa State Ministry of Agriculture to establish a rehabilitation and training centre (skills acquisition programme) for victims of insurgency

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## INDIGENOUS KNOWLEDGE AND COPING CAPACITY OF FARMERS FOR CLIMATE CHANGE ADAPTATION: A CASE STUDY OF AGAIE LOCAL GOVERNMENT AREA, NIGER STATE. NIGERIA

M. Salihu1\*, I. U. Gbogan1, A. A. Oke2

1Ministry of Agriculture and Rural Development, Minna, Niger State, Nigeria.

2Dept of Quantity Surveying, Federal University of Technology Minna, Niger State, Nigeria

\*Author’s E-mail:[babayadi84@gmail.com](mailto:babayadi84@gmail.com); GSM**:** 07039614626

ABSTRACT

*Globally, climate change is one of the most severe environmental threats facing humans. Climate change has adversely affected agricultural productivity in Nigeria. This paper is part of a study that examined how indigenous knowledge system (IKS) of climate change plays a role in adjusting to the changing climate in Agaie LGA of Niger State, Nigeria. Structured questionnaire was administered to 314 farmers selected amongst the communities in the study area. The study concluded that prolonged dry periods and unusually early rains cause uncertainties in onset of farming season. These consequences of climate change are linked to ‘reduced yields and income’, which are being fueled by ‘burning of wood fuel’, ‘bush burning’ and ‘use of fertilizers. Therefore, this study has shown that local communities have a good understanding of climate variability and change; there is a need to incorporate this understanding into climate interpretation, so as to increase the application of indigenous knowledge for climate change adaptation.*

**Keywords:** Climate change, coping strategies, Indigenous Knowledge, Adaptation

INTRODUCTION

Climatic change is attributable to natural climate cycle and human activities (Ziervogel *et al.,* 2006); as the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent. It is projected that crop yield in Africa may decline by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003). This is because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. Wisner *et al.* (2004) reports that the vulnerability of agriculture is determined by both the nature and magnitude of environmental stress like climate change and the societal capacity to cope with and/or recover from environmental change. This study is an attempt to collate sustainable indigenous knowledge on climate change adaptation practices in Agaie LGA of Niger State.

Review of Related Literature

Adaptation to global warming is a response to climate change that seeks to reduce the vulnerability of social and biological systems to climate change effects (Head, 2010). The capacity and potential for humans to adapt (called adaptive capacity) is unevenly distributed across different regions and populations, and adaptive capacity is closely linked to social and economic development (Adger *et al.*, 2005). Adaptation can be categorized into two: building adaptive capacity (by increasing the abilities of groups, individuals or organizations to adapt to changes), and implementing adaptation decisions (by transforming that capacity into action).

Over the years, local people have used their knowledge and practices to adjust to changing economic, ecological, and social circumstances (Anik and Khan, 2012), thus helping communities to minimize disaster risks and formulate cost-effective and participatory adaptation measures (Nakashima *et al.,* 2012).

METHODOLOGY

This study was conducted in Agaie town, which is the headquarter of Agaie Local Government Area of Niger State. It lies between latitude90 00′ 3060 N and longitude 6019′ 556 E. Agaie is located in a low basin within the valley of River Gbakogi. The mean annual rainfall of the study area is 1227 mm3 and mean monthly temperature of 27°C - 35°C. The predominant tribe is Nupe; the indigenous habitants are mostly Muslims, farmers, and fishermen. The socio-economic status and literacy level is low. Infrastructural facilities present in the town include a government owned general hospital, and erratic electricity and pipe-borne water supply.

The study employed field observation through focus group discussions and semi - structured questionnaire administered to 314 farmers selected amongst the wards of the study area to collect primary data. The perception of local communities is important to have a better understanding of the scientific basis of their indigenous knowledge. The data collected was analyzed through the use of percentages and Mean Item Score (MIS); the results were presented in bar charts.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The majority (86%) of the respondents were male, while 14% were female. About three quarters of the sample (74%) were between the economically active age range of 30 – 59 years; within the study area, farming does not appear to have been left to the very old. Majority of the respondents (56%) had primary education, 30% had secondary education, and 14% had tertiary education. Crop farming is the principal activity of 71% of the respondents.

Climate change impact on agriculture

Results in Figure 1 revealed that majority (97%) of the respondents agreed that heavy winds, drought and decrease in soil moisture have been increasingly experienced in the study area. As shown in Figure 1, Mean Item Scores of more than 3.49 indicate agreement by the respondents.

Based on the magnitude of the Mean Item Scores, it was observed that the respondents ranked ‘reduced yield’ 1st in terms of climate change impact on agriculture; ‘reduced income’ was ranked 2nd while ‘streams/rivers drying up’ was ranked 3rd. This is line with Otitoju (2013). Mark *et al.* (2008) observed that features of climate change could impact agro-climatic conditions, altering growing seasons, planting, and harvesting calendars, water availability, pest, weed and disease populations.

Activities of farmers that contribute to climate change

The respondents ranked ‘burning of wood fuel’ 1st in terms of contributing to climate change. ‘Bush burning’ was ranked 2nd while ‘use of fertilizers’ was ranked 3rd. The high cost of alternative energy such as cooking gas and kerosene and the poverty level of farmers in the study area makes burning of wood fuel as cooking energy a major practice (Mohammed, 2018). Bush burning as the 2nd ranked activity is as a result of the traditional practice of clearing farmland for farming activity, which increases the concentration of greenhouse gases in the atmosphere. Also, majority of the farmers (91%) had reported decrease in soil fertility with consequent increase in fertilizer application).

CONCLUSION AND RECOMMENDATIONS

The study concluded that local communities have a deep understanding of climate variability and change, hinged on increase in temperature, and erratic and delayed rainfall. Prolonged dry periods and unusually early rains cause uncertainties in onset of farming season. These consequences of climate change are linked to ‘reduced yields and income’, which are being fuelled by ‘burning of wood fuel’, ‘bush burning’ and ‘use of fertilizers.

This study recommended that since farmers in Agaie have some perception of the effects of their activities on climate change, the following actions can be taken:

1. Programmes that educate and enlighten farmers in Agaie LGA on climate change coping strategies should be frequently organized so that activities of farmers that contribute to the impact of climate change can be avoided.
2. Indigenous coping strategies and best practices from other communities both within and outside Nigeria should be incorporated for better results.

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## ADOPTION OF BIO-FORTIFIED FOOD CROP IN NIGERIA: A REVIEW

1Lawal, A.T., 1Pelemo, J. J., 2Abdullahi, B., 1Obamero, B.K., 1Shuaibu, S. O., and

1Usman, F. R.,

1Department of Agricultural Technology, Kogi State Polytechnic, Lokoja (Itakpe campus), Kogi State, Nigeria.

2Department of Agricultural Extension and Rural Development, Federal University of Technology Minna, Niger State, Nigeria

\*Correspondent Author’s E-mail and Phone number: [lawalahmed242@gmail.com](mailto:lawalahmed242@gmail.com) +2348164881149

ABSTRACT

Micronutrient deficiency is a form of malnutrition which occurs as a result of low micronutrient in our diet, most of the traditional staple foods consumed in Nigeria are low in micronutrients. Micronutrient deficiency has also been attributed to poor processing and handling of food resulting in nutrient loss, lack of consumption of fruits and vegetables and high cost of nutritious foods. The introduction of micronutrients in our staple food through crop breeding resulting in food crop rich in micronutrients has proven to be cost effective and a long term solution to remedying micronutrient deficiency. Previous studies have revealed a relationship between socio-economic factors such as age, household size, education, extension, awareness and farmer associations. However, there is need for further study on the adoption of various bio-fortified food crops as most of existing are studies centered on the adoption of bio-fortified cassava. This studies would take into cognizance socioeconomic determinant affecting the adoption of bio-fortified food crops especially crop specific determinants.

**Keywords:** Adoption,Biofortified, Micronutrient, Deficiency, Malnutrition, Food,

INTRODUCTION

The world is faced with various health challenges affecting people across developed and developing countries, malnutrition and hunger has been identified as one these challenges. there are 11 million people undernourished in developed countries and almost all the hungry people, 791 million, live in developing countries, representing 13.5 percent, or one in eight, of the population of developing counties (FAO 2015). In Nigeria, Global Hunger Index (GHI) 2022 reported an index scores of 27.3 implying hunger is a serious problem in the country with 12.7% of the population undernourished (Global Hunger Index 2022). One of the forms of malnutrition occurs as a result of deficiency of micronutrients called micronutrient deficiency or hidden hunger. This results in poor immune system function, stunting, wasting, limited cognitive development and iron deficiency anemia (Onuegbu *et al.,* 2022). Micronutrient deficiency is a result of suboptimal diets, consumption of staples food with low micronutrient, poor processing and handling of food resulting in nutrient loss lack of consumption of fruits and vegetables, high cost of nutritious foods.

Micronutrient deficiencies contribute significantly to child mortality worldwide, and annual vitamin A and zinc deficiencies are estimated 600,000 and 400,000 deaths respectively (Annim, *et al.,* 2022). It has been estimated that 25% of children under six years of age in Nigeria suffer from vitamin A deficiency. This may result in poor growth, impaired vision, and impaired epithelial integrity (Nguema, 2010). Statistical facts available shows a huge gap exist in meeting the nutritional requirement in Nigeria. Despite the progress recorded in controlling micronutrient deficiencies through supplementation and food fortification, new approaches are required, especially to reach the rural poor a better approach to control vitamin A, iron, and zinc deficiencies of staple food crops in poor countries known as bio-fortification.

Bio-fortification is the process of breeding food crops that are rich in micronutrients, such as vitamin A, zinc, and iron. It refers to technologies for enhancing, through biological processes such as breeding and transgenic techniques, the micronutrient content of staple foods.

Adoption of bio fortified food crops by farmers.

Although there have been several attempts by government in amending the issue of malnutrition, some of these programmes are expensive with short term benefits. Bio-fortification of staple food crop has been identified as less expensive and long term solution to remedying malnutrition. Since the introduction of bio-fortified food crops to farmers, there is a need to understand the adoption rate and factors affecting the adoption of bio-fortified food crop among farmers. by so doing, socioeconomic attributes aiding or inhibiting the adoption of bio-fortified food crops are identified, some of the factors affecting the adoption of bio-fortified foods and recurrent in previous studies are elaborated below.

Table 1. Determinants of Adoption of Bio-fortified Food Crop

|  |  |  |
| --- | --- | --- |
| Determinants | Number of paper mentions | |
| Positive relationship (+) | Negative relationship(-) |
| Household size | 2 | 1 |
| Age | - | 4 |
| Education | 4 | 2 |
| Extension | 7 | - |
| Farmers Association | 5 | - |
| Awareness | 4 | - |

Source: Author’s categerization

Household size: the size of household affects farming decisions such as farm size, labour use, and crop to be cultivated; studies have revealed a significant relationship between household size and adoption bio-fortified food crops. Studies of Abdoulaye *et al.,* (2015) and Uwandu *et al.,* (2019) have revealed positive relationship between household size and adoption of bio-fortified food crop. However, Oyeneke *et al.* (2020) in their study discovered a negative relative relationship between household size and Bio-fortified food crop.

Age: the years of existence of a farmer has had significant relationship with adoption of modern technology or innovation, most times age plays a complementary role with experience as it is assumed older age comes with more experience of farming. Adoption of innovation is lesser among farmers of older ages. Previous studies have shown a negative relationship between age and adoption of bio-fortified food crops ( Abdoulaye *et al.,* 2015; Ayodele *et al.,* 2020 Kolapo *et al.,* 2020).

Education: educational attainment is vital in dissemination of new farming technologies as it helps the farmer in understanding intricacies and complexities that comes with adoption. Uwandu *et al.,*(2019) in their study revealed a positive relationship between education between education attainment and adoption of bio-fortified food crops. This was affirmed by findings of Oyeneke *et al.,*(2020) and Abdoulaye *et al.,* (2015). However, Kolapo *et al.,* (2020) reported a negative relationship between education and adoption of bio-fortified food crop.

Extension: at the heart of disseminating new technology is an Agricultural extension service bridging the gap between manufacturers or inventors of new technology and farmers. Ayodele *et al.,* (2020) in a study aimed at examining the determinants of adoption of bio-fortified cassava among farmers in South West Nigeria affirmed a positive relationship between extension delivery and adoption of bio-fortified food. This was further affirmed by findings of Uwandu *et al.,* (2019) and Ayinde *et al.,* (2017).

Farmers association: groups of farmer sharing mutual interest in the form of farmers’ association or cooperative societies are often a point of entry for inventors or manufacturers of modern agricultural technologies who wish to target farmers directly. In a study by Onyegbulam *et al.,* (2019) awareness had a positive relationship with adoption of bio-fortified cassava in Abia state Nigeria. This was consistent with findings of Ayodele *et* *al.,* (2020) and Oyeneke *et* *al.,* (2020)

Awareness: farmers being informed of a new technology is usually the first step of disseminating, increasing awareness through the use of various forms of media, increase the probability of adoption. This was affirmed by the findings of Kolapo *et al.,* (2020) Oyeneke *et al.,* (2020). This implies awareness has been effective in dissemination of Bio-fortified food crops

CONCLUSION

Previous studies on adoption of bio-fortified food crop by farmers reveals there exist a relationship between socioeconomic characteristics of the farmers and adoption. Also, agricultural extension services, and awareness had a strong relationship with adoption of bio-fortified food crops. However, there is need for further study on the adoption of bio-fortified various food crops as most of previous findings are on cassava, focus on the adoption of other bio-fortified food crops such as maize and potatoes would reveal certain determinants peculiar to a particular crop. Through a gender tailored approach, understanding the gender differentials in adoption of bio-fortified food crops would reveal factors affecting adoption of bio-fortified food crops some of which may be gender specific.

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## DETERMINANTS OF THE ADOPTION OF IMPROVED BEE HIVE TECHNOLOGIES IN BENUE STATE, NIGERIA

1Lawal , A. T., 2Abdullahi, B., 1David, M. J., 1Usman, F. R., and 1Shuaibu, S. O.

1Department of Agricultural Technology, Kogi State Polytechnic, Lokoja (Itakpe campus), Kogi State

2Department of Agricultural Extension and Rural Development, Federal University of Technology Minna, Niger State, Nigeria

\*Correspondent Author’s E-mail and Phone number: [lawalahmed242@gmail.com](mailto:lawalahmed242@gmail.com) +2348164881149

ABSTRACT

*This study was carried out to assess the determinant of adoption of improved beekeeping technologies in Benue State. Three-stage sampling procedure was used to select 212 beekeepers; primary data were elicited from the respondents with the aid of a semi-structured questionnaire. Data were analyzed using descriptive statistics and logit regression model. The findings indicated beekeeping experience, household size, extension contact and membership of cooperative were the major determinant of improved keeping adoption in the study area while indiscriminate bush burning(97.5%), theft(91.5%), lack of beekeeping skills(76.9%), Lack of credit facilities(75.0%), where the major constraint faced by the beekeepers in the study area. The study recommends that effort should be geared toward providing extension services to beekeepers. Membership of cooperative society should be encouraged among beekeepers. Also, beekeepers should fire trace round their farm during at the onset of dry season to avoid adverse effects of bush burning on beekeeping.*

**Key words:** Adoption, determinant, Bush burning, and Beekeeping

INTRODUCTION

Honey Bees are one of the most important organisms on earth, they belong to the family *Apoidae* and order *Hymenoptera* which includes honey bees, bumble bees, stingless bees, and carpenter bees. Although there are over 20,000 species of wild bees, the species usually managed by beekeepers is the western honey bee (*Apsimellifera adasonti*) and Nigeria in particular (Eforuoku and Thomas 2015). Bee keeping is the art and science of raising honeybees for man to benefit economically. The practice of beekeeping also referred to as apiculture dates back many years. There is evidence of people collecting honey from wild bees as far back as 15,000 years ago (Tew 2016).

Beekeeping is an industry that provides the ability for economically marginalised groups, such as landless poor and rural people, to access income without exacerbating environmental and land tenure problems (Schouten and Lloyd, 2019). Honey bees have great potential to be developed as a smallholder niche industry with low input costs and the ability to scale-up quickly. Bee products can be marketed through existing networks and bees in many cases improve productivity of crop-farming systems through improved pollination.

Beekeeping has evolved to be a very lucrative agricultural practice for local people in developing countries of the world. As an agricultural activity that may generate income all year round under suitable climate conditions of which Nigeria is one of the best country due to its vegetation and weather condition, apiculture provides more advantages for producers when compared with other agricultural activities. In spite of the importance of honey and its by-products from beekeeping, their contributions to rural income, Gross Domestic Product (GDP) and the economic development of nations including Nigeria, Beekeepers in Nigeria have relied on traditional beekeeping practice (Eforuoku and Thomas 2015). The practices of hunters and destructive bee keeping techniques which among them include the use of traditional equipment and harvesting technique which entail killing the bees in addition to low quality products are some of the disadvantages of traditional beekeeping practices (Ubeh *et al.,* 2021). This has led to decline in bee population and honey production below optimum output and quality. Hence this study investigates the determinants of the adoption of improved bee hive technologies in Benue State, Nigeria. Specifically, it aims to:

1. determine factors influence adoption of beehives technology
2. identify challenges associated with beekeeping in the study areas.

METHODOLOGY

The study was carried out in Benue State. The State is one of the six states constituting the North Central region of Nigeria with its headquarters in Makurdi. Benue State is located between Latitudes 6030'N and 8010'N and Longitudes 6033'E and 100E. Three-stage sampling technique was used in selecting bee farmers in the study area, the first stage was random selection of one local government form each of the three (3) agricultural zone in the state namely Buruku, Markudi and Otukpo. Second stage involved the random selection of three communities from each of the selected local government, proportionate sampling used in selecting farmers in the third stage of the sampling A total of 212 bee farmers were selected for the study. Primary data elicited from the respondents with the aid of a semi-structured questionnaire were used for the study; descriptive statistics was used to identify the constraints in beekeeping and binary logistic regression model was used to determine the factors affecting the adoption of improved beekeeping technologies.

Implicitly, the model is stated as

Explicitly it is expressed as:

β1MS + β2GD + β3ED + β4BE + β5HS + β6AC + β7EC + β8MC + β9BW + β10NH + β11CI + β12SI + β13AD + β14TH + β15BM + β16AV + β17AG + µ--------------------14

Where:

Y = (Adoption of at least one modern beehive technology 1 if otherwise 0)

β = estimated coefficient

β1 –β12 = Coefficient of explanatory variables

MS =Marital status (Married 1, if otherwise 0), GD = Gender (male 1, female 0),

ED = Education (Years), BE = Beekeeping experience (Years), HS = Household size (Numbers), EC =Extension contact (Number of visit), MC = Membership of cooperative (Yes 1, 0 no), BW = Bee workshop (Yes 1, 0 no), AD =Area devoted foe beekeeping (ha)

TH = Types of hives (Number), BM = Baiting material (Number), AV = Apiary visit (Yes 1, 0 no), AG = Age (years) = error term

RESULTS AND DISCUSSION

**Factors influencing adoption of improved beekeeping technologies**

The findings in Table 1 shows that the pseudo R-squared was 0.2526 which shows a relatively good fit for the binary logit model while the chi-square results shows that the likelihood ratio statistics was statistically significant.

**Table 1: Determinant of beehives adoption**

|  |  |  |
| --- | --- | --- |
| Variables | Coefficient | Z-values |
| Marital status | 1.6204 | 0.02 |
| Level of education | 1.033 | 0.79 |
| Beekeeping experience | -.8666\*\*\* | -5.33 |
| Household size | -. 7903\* | -1.99 |
| Level of involvement | 2.6495 | 1.58 |
| Extension contact | -.5082\*\* | -2.39 |
| Membership of cooperative | 3.5163\*\*\*\* | 2.92 |
| Beekeeping workshop | .7666 | -1.26 |
| Types of baiting | 1.1145 | 0.80 |
| Types of bee hives | 1.0397 | 0.52 |
| Area devoted beekeeping | .7428 | -1.28 |
| Age | -.0163\*\*\* | -2.88 |
| Pseudo R squared | 0.2526 |  |
| Log Likelihood | -150.40 |  |
| LR Chi squared | 101.65\*\*\* |  |

**Source: Field survey, 2022**

The coefficient for beekeeping experience (0.866) was negative and statistically significant at 0.01 probability level implying that a unit increase in beekeeping experience may likely leads to 0.866 decreases in adoption of beehives. This is against the *a priori* expectation, because increase in beekeeping experiences is expected to enhance adoption of innovation. This contradicts findings of Muya's (2014) findings, which suggested that experienced farmers were more willing to try new and difficult agricultural technologies. Furthermore, more experienced farmers may find it difficult switching to the use of modern beehive technologies due to years of using certain technology and bee farming methods.

Household size (0.7903) had a negative relationship with adoption and statistically significant at 0.10 probability level implying that a unit increase in household size may likely leads to 0.7903 decreases in adoption of beehives. This disagrees with the studies of Workneh (2011) and Bunde and Kibet (2015) who opined that family size has positive influence on adoption of modern technologies. The reason for this result could be attributed to the fact meeting physiological and other needs of the family may likely reduce the amount resources available to adopt the technology.

The coefficient for extension contact (0.5082) was negative and statistically significant at 0.05 probability level implying that a unit increase in extension contact may likely leads to 0.5082 decreases in adoption of beehives. This is against the *a priori* expectation, because extension agent is expected to create awareness about new innovations which is expected to enhance adoption of such innovation. This contradicts the study of Amanuel (2018) who concluded that farmers who have access to extension services are more likely to embrace improved agricultural technologies. The reason for this result could be attributed to poor extension contact and inadequate subject matter specialist on bee farming in the study areas.

Membership of cooperative (3.5163) had positive relationship with adoption and statistically significant at 0.01 probability level implying that a unit increase in membership of cooperative may likely leads to increases in adoption of beehives. This is the *a priori* expectationand it is similar to the study of Ogunbameru *et al.* (2008) who argued that participation in cooperative have the potential of creating confidence between farmers and financial institutions thus allowing farmers to have access to farm credit from such institutions using their collective grains in a community warehouse as collateral. The reason for this finding could be attributed to high level of beekeeping cooperative in the study areas and the prevalent of social media which pave ways for easy communication among keepers.

Challenges of beekeeping

The results in Table 2 shows the challenges faced by beekeepers in the study areas. From the Table, Indiscriminate bush burning (97.2%), theft (91.5%), Lack of beekeeping skills (76.9%), lack of credit facilities (75.0%) major constraints faced by beekeepers in the study area. However, drought (16.5%) Low quality beekeeping materials (28.3%) Pest and diseases (33.0%) Lack of beekeeping materials (33.5%) were identified as the least constraints faced by beekeepers in the study area. The major constraints identified implies the presence of externalities in the form of indiscriminate bush burning and theft which results in loss of bees in the farm. Furthermore, the least constraints identified implies the presence of a conducive environment for beekeeping and availability of capital inputs needed for beekeeping.

**Table 2: Distribution of respondent according to challenges of beekeeping**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable | Frequency | Percentage | Rank |
| Fear of sting | 133 | 62.7 | 7th |
| Pest and diseases | 70 | 33.0 | 12th |
| Lack of beekeeping materials | 71 | 33.5 | 11th |
| High cost beekeeping materials | 153 | 72.2 | 5th |
| Lack of credit facilities | 159 | 75.0 | 4th |
| Lack of beekeeping skills | 163 | 76.9 | 3rd |
| Absconding of bees | 139 | 65.6 | 6th |
| Indiscriminate application of agro-chemicals | 123 | 58.0 | 8th |
| Labour shortage | 87 | 41.0 | 9th |
| Low quality beekeeping materials | 61 | 28.8 | 13th |
| Theft | 194 | 91.5 | 2nd |
| Lack of storage facilities | 84 | 39.6 | 10th |
| Bush burning | 206 | 97.2 | 1st |
| Drought | 35 | 16.5 | 14th |

**Source: Field survey, 2022**

CONCLUSION AND RECOMMENDATION

Based on the study it can be concluded that beekeeping experience, household, extension contact and membership of cooperative were the determinant of adoption of improved beekeeping in the study areas while indiscriminate bush burning, theft, lack of beekeeping skills, high cost beekeeping materials, absconding of bees, fear of sting and indiscriminate application of agro-chemicals were the major constraint facing beekeepers while drought, Low quality beekeeping materials, Pest and diseases, Lack of beekeeping materials, were the least constraints faced by beekeepers in the study area. From the findings of the study the following recommendation were made.

1. Effort should be geared toward providing extension services to beekeepers.
2. Membership of cooperative society should be encouraged among beekeepers as farmer groups ease entry in dissemination of modern technology hence, a target of technology dissemination.
3. Beekeepers should fire trace round their farm during at the onset of dry season to avoid adverse effects of bush burning.
4. Modern beekeeping equipment should be provided for beekeepers at subsidized rate or in form of credit with option of payment in installments.

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## RISK ANALYSIS OF CEREAL/LEGUME FARMERS IN NIGER STATE, NIGERIA

Abubakar, U. K.1, Mohammed, U. S.2, Tanko, L.2 and Adebayo, C. O2.

1Department of Horticultural Technology, Federal Polytechnic, Bida, Niger State, Nigeria

2Department of Agricultural Economics and Farm Management, Federal University of Technology, Minna, Niger State, Nigeria

Corresponding Author’s e-mail: [abubakarusmankpange@yahoo.com](mailto:abubakarusmankpange@yahoo.com)

Phone No.: 08063297627

ABSTRACT

*This study describes the socio-economic characteristics of the cereal/legume farmers in Niger State, Nigeria, identify risk associated with cereal/legume enterprise; determine the risk attitude of the farmers and identify the management strategies employed in minimizing risk associated with cereal/legume enterprise in the study area. Multistage sampling technique was used for the selection of two Local Government Areas (LGAs) from each of the three agricultural zones I, II, and III, respectively. Farming communities were randomly selected from each of the sampled LGAs from which respondents were proportionately selected to make a total of 296 respondents for this study. Primary data was collected with the aid of structured questionnaire and interview schedule. The data collected were analysed using descriptive statistics, Safety-first and factor analysis. The result showed that the mean age of the farmers was 41 years and about 86.4% of them were members of cooperative society. About 59% of the cereal/legume farmers was risk averse and only about 5.4 per cent of them was risk preferring. Production risk claimed about 90.5% of all risks associated with cereal/legume enterprise in the study area. Spreading sale* (selling at different period), *family member working off-farm and early planting of crops were employed for managing risk in the study area. It is recommended that Government in conjunction with the donor agencies should make provision for interest free credit facilities to the farmers at the appropriate time to enable them take as much risk as possible to increase their Cereal/Legume production.*

**Keywords:** Risk, Analysis, Cereal, Legume, Farmers

INTRODUCTION

Agricultural production is subject to risk and the attitudes of producers toward risk influence input choices as long as it affects production (Picazo-Tadeo *et al.,* 2011). Un-like other economic activities, agricultural enterprises are faced with so many risks and uncertainties such as input supply and prices, post-harvest losses and product prices, extreme weather conditions as well as pests and diseases (Nmadu *et al.*, 2010). Other natural hazards such as floods and fire outbreaks are equally important with regards to their impact on the success or failure of an agricultural enterprise (Aina *et al.,* 2012). Furthermore, risk and uncertainty are basic to any decision- making framework due to the fact that, risk is an imperfect knowledge where the probabilities of the possible outcomes are ascertained.

Lack of clear understanding of farmers’ attitudes towards risks remains an important factor inhibiting increased agricultural productivity. Increasing crop production to take advantage of ban on crop importation largely depends on the risk attitude and risk management strategy of the farmers. Therefore this research described the socio-economic characteristics of the cereal/legume farmers in Niger State; identify risk associated with cereal/legume enterprise; determine the risk attitudes of the farmers and, identify the management strategies employed in minimizing risk associated with the enterprise in the area.

METHODOLOGY

Study Area

Niger State has its headquarters in Minna, comprising of 25 Local Government Areas. These are further divided into three agricultural zones namely; zones I, II and III. The State is located in the North-Central zone of Nigeria between Latitudes 8o Nˊ and 11o 20Nˊ and Longitudes 4o 301ˊE and 7o 401 E. It shares common boundaries with Zamfara State to the North-West, Kaduna State to the North-East, and Federal Capital Territory to the South-East. The main occupation of the people of the State is farming which is the back bone of her economy, employing over 80 per cent of the total population in the State. It is endowed with 8.3 million hectares of land which allows for the production of staple food crops, vegetation for grazing, production of fishery and forestry. The State experiences mean annual rainfall of between 1,100mm and 1,600mm per annum and temperatures of not more than 94F between March and June and not less than that, between December and January (Niger State GIS, 2020).

Sampling Techniques and Method of Data Collection

The study employs multistage sampling technique for data collection. The first stage involves the random selection of two Local Government Areas (LGAs) from each of the three agricultural zones. In the second stage, farming communities were randomly selected from each of the sampled LGAs and the third stage involved the random selection of respondents from each of the sampled communities proportionate to their frames following (Tanko and Kpange, 2014), as in equation (1) to give a total of 296 respondents for this study. Primary data were collected with the aid of structured questionnaire complemented with interview schedule and administered by the researchers and trained enumerators to elicit relevant information from the respondents.

 1

Where: nh = sample size to be determined, n = targeted number of respondents, Nh = sample frame (total number of farm households in each community), N = finite population (total number of farm households in the study area).

Table 1: Sampling frame and sample size of cereal/legume producers in Niger State

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sampled State** | **Agricultural Zone** | **Selected LGAs** | **Sampling frame** | **Sampling size** |
| Niger | I | Mokwa | 29,240 | 85 |
|  |  | Katcha | 23,891 | 69 |
|  | II | Paikoro | 9,450 | 27 |
|  |  | Gurara | 8,281 | 24 |
|  | III | Wushishi | 9,525 | 28 |
|  |  | Kontagora | 21,238 | 62 |
| **Total** |  |  | **101,625** | **296** |

Source: Niger State GIS (2007)

Method of Data Analysis

The data were analysed with the use of descriptive statistics such as frequency distribution and percentages to describe the socio-economic characteristic of the farmers, Safety-first approach for determining the risk attitude of the farmers while factor analysis was used in the determination of risk management strategies employed by the farmers.

Specification of factor analysis model

The safety-first behavioural approach was used to generate risk aversion parameter (Ks) for each respondents following Sadiq *et al.* (2018) as expressed below:

 2

Where; Ls is the risk index of kth farmer, θ is variance parameter; Rk is the unit price of the chosen most influential input for Kth farmer; Nk is quantity of the chosen most influential input of the Kth farmer; Rz is the unit price of the output of Kth farmer; Bk is the elasticity coefficient of output with respect to the chosen input; and, μz is the mean of the output. Following Sadiq *et al.* (2018), the risk aversion parameter Ls was used to classify farmers into three distinct categories as expressed below;

*0<*L𝑠*<0.4 =* Low risk aversion/Risk preference

*0.4<*L𝑠*<1.2 =* Intermediate/moderate risk aversion/Risk neutral

*1.2<*L𝑠*<2.0 =* High risk aversion/Risk aversion

Factor analysis was used to determine the risk management strategies for the cereal/legume based farmers. It conceived that standard parametric statistical measures are suitable for ordinal variables in the form of Likert-type scale (1 not important, 2 less important, and 3 very important) (Jirgi, 2013). It reduces attribute space from a larger number of variables to a smaller number of factors which makes a “non-dependent” procedure (that is, it does not assume that a dependent variable is specified). The data was screened to check for outliers that might attenuate the result following Jirgi (2013).

**Specification of factor analysis model**

**** 3

 4

 5

 6

Where: Y1,Y2, Y3,…,Yn = observed variables (management strategies),

Β1, β2, β3, …,βn correlation co-efficient,

X1, X2, X3,…,Xn = unobserved underlying factors of risk management strategies

RESULTS AND DISCUSSION

The result shows that the mean age of the sampled cereal/legume farmers in Niger State was 41 years. This showed that the household heads were mostly youths. This implied that they had a great advantage of practicing new production techniques of the enterprise for a better output. All the sampled farmers for this study were masculine. The result also revealed that 46.8% of the farmers adopted the cropping practice for the past nine years. This implied, that the enterprise worth practicing in the study area. The result further showed that all the farmers were married with a minimum of one dependent.

The vast majority (86.4 per cent) of the cereal/legume farmers in study area were members of at least a cooperative society. This can give them the opportunity of harnessing agricultural input incentives if well managed. In addition, 41.4% had access to credit which was used to finance their cultivation of the cereal/legume enterprise. This implied that less half of the sampled farmers access to credit facility in the study area. The result shows that more than half (59%) of the cereal/legume farmers in the study area had one form of formal education. This implied that there is tendency of comprehending new technologies to improve their productivity.

The risk attitudes of the cereal/legume farmers in Niger State

The result in Table 2 showed that about 59.0% of the cereal/legume farmers were risk averse with negative attitude towards risk. These could be as result of their poor financial status. Thus, they engaged in cultivation primarily to meet their basic needs with little surplus to sell in the market. This corroborates the findings of Sanusi, *et al.* (2021) that 61.1% of the rice farmers in North-central Nigeria operated at poor capital base and lack the mindset of entrepreneurship to commercial production. The Table 2 further showed that 35.6% of the farmers operated at risk neutral status while about 5.4% of the farmers were found to be risk preferring with that took a higher entrepreneurial risk to produce for the market. This could possibly be that they realized the importance of bearing a higher risk and had the financial back-up to behave as risk preferring cereal/legume farmers in the study area.

Table 2: Risk attitude of the cereal/legume farmers in Niger State

|  |  |  |
| --- | --- | --- |
| **Risk attitude** | **Frequency** | **Percentage** |
| risk averse (< 0) | 174 | 59.0 |
| neutral (0 to <1) | 105 | 35.6 |
| preference (> =1) | 16 | 5.4 |
| **Total** | **295** | **100.0** |

Source: Field Survey, 2020

Risks associated with Cereal/Legume enterprises in Niger State

The identified sources of risk challenging the cereal/legume enterprise is presented in table 3. The result shows that about 90.5 per cent of the sampled cereal/legume farmers in Niger State were faced with production risk. The study also finds out that 7.5 per cent of them suffered financial risk. This could be as result of their in ability to fulfil the credit terms. Meaning the respondents were not accessing adequate loan facility to finance their farming activities. Marketing risk constituted 1.4 per cent of total risks associated with the cereal/legume enterprise in the study area.

Table 3: Risk associated with cereal/legume enterprise in Niger State

|  |  |  |
| --- | --- | --- |
| **Type of risk** | **Frequency** | **Percentage** |
| Production | 267 | 90.5 |
| Market | 4 | 1.4 |
| Financial | 22 | 7.5 |
| Human | 2 | .7 |
| **Total** | **295** | **100.0** |

Source: Field Survey, 2020

Analysis of risk management strategies of cereal/legume farmers in Niger State

The result in Table 4 showed that spreading sales (0.7410), cooperative society (0.7397), borrowing cash or grain (0.7308), storage programme (0.7169), adashe contribution, (0.7100), training and education (0.6879), gathering market information (0.6781), price support (0.6368), selling before harvest (0.6242) and reduced consumption (0.4975) were the risk management strategies employed by the farmers. This finding is in line with that of Agboola (2015) who reported that selling before harvesting, cooperative society and engagement in off-farm activities were used for aversion of risk among farming households in FCT, Abuja, Nigeria. Family members working off-farm (0.8022), investing off farm (0.6013) and faith in God (0.391) were also used. This implied that involvement in off-farm activities will reduce risk faced by farmers. This corroborates the work of Batool (2017) who stated that diversification into non-farm income served as means of shielding farmers from risk and the uncertainties of agricultural production.

Early planting (0.5034), planting drought tolerant varieties (0.4957), planting early maturing varieties (0.4792) and spraying for disease and pest (0.4303) were the environmental factors adopted for managing risk in the study area. This corroborates Aminu *et al.* (2019) that application of fertilizer, pesticide and insecticide are major ways of reducing risk among farming households in Ogun State of Nigeria.

Table 4: Analysis of risk management strategies of cereal/legume farmers in Niger State

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Niger State** | | |
| **Variables** | **Economics/Institutional factor** | **Off-farm/ spiritual factor** | **Environmental factors** |
| Selling before harvest | 0.6242 |  |  |
| Spreading sale | 0.7410 |  |  |
| Training and education | 0.6879 |  |  |
| Adashe contribution | 0.7100 |  |  |
| Cooperative society | 0.7397 |  |  |
| Storage programme | 0.7169 |  |  |
| Gathering market information | 0.6781 |  |  |
| Price support | 0.6368 |  |  |
| Borrowing cash or grain | 0.7308 |  |  |
| Reduce consumption | 0.4975 |  |  |
| Family members working off farm |  | 0.8022 |  |
| Household working off farm |  | 0.6710 |  |
| Investing of off farm |  | 0.6013 |  |
| Faith in God |  | 0.5391 |  |
| Fertilizer provision by self |  |  | 0.7954 |
| Intercropping |  |  | 0.6582 |
| Spraying for disease and pest |  |  | 0.4303 |
| Planting drought tolerant varieties |  |  | 0.4957 |
| Planting early maturing varieties |  |  | 0.4792 |
| Early planting |  |  | 0.5034 |
| Chi2 (χ2) | 3571.91 | 3.62375 | 2.10208 |
| Eigen-value | 6.09841 |  |  |
| % of variance | 16.9 | 31.5 | 45.5 |
| Kaiser-Meyer-Olkin Test | 0.784 |  |  |
| Bartlett’s Test of Sphericity (χ2 | 3559.482 |  |  |

Sources: Field Survey, 2020

CONCLUSION

Risk is an essential factor in investment decision making to reduce fundamental problems and encourage agricultural entrepreneurship. Lack of clear understanding of farmers’ attitudes towards risks remains an important factor inhibiting increased agricultural productivity. Very few of the cereal/legume farmers were risk preferring in behaviour to invest into cereal/legume production at commercial quantity. Spreading sales of farm produce, cooperative membership, borrowing cash/grain, working off-farm, early planting and planting of draught tolerant crops were measures of managing risk associated with the cereal/legume farmers in the study area. The extension agents should put more effort in convincing the farmers that were not members of any cooperative society to do so, to enable them take advantage of the farm input incentives, loans and grants enjoyed by the members of the various cooperative societies.

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## GENDER ANALYSIS OF FARMING HOUSEHOLDS’ ACCESS TO LIVELIHOOD RESOURCES IN SELECTED LOCAL GOVERNMENT AREAS OF NIGER STATE, NIGERIA

\*Muhammad, H. U., Salihu, I.T., Muhammed, Y., Abdullahi, A. and Jibrin, S.

Department of Agricultural Extension and Rural Development, Federal University of Technology, Minna, Niger State, Nigeria

\*Correspondent e-mail and Phone No: [haruna.usman@futminna.edu.ng](mailto:haruna.usman@futminna.edu.ng) 07039699896, 08058435793

ABSTRACT

*The study analyzed rural farming households’ access to livelihood resources along gender line in Bosso, Chanchaga and Wushishi Local Government Areas of Niger state, Nigeria. The specific objectives of the study were to: describe the socio-economic characteristics of the rural farming household along the gender line; examine their access to livelihood resources; determine the factors influencing access to livelihood resources along the gender line and examine the constraints associated with accessing livelihood resources. Three-stage sampling procedure was used to select 130 rural farming household heads (67 male and 63 female). Semi-structured questionnaire complemented with an interview schedule was used to obtain primary data which was analyzed using descriptive statistics and Probit regression model. The results revealed that majority (71.7%) of the male were between 41-50 years of age with a mean of 46 years, while 47.6% of the female were in the age range of 41-50 years with a mean of 44 years. More so, 71.6% and 63.5% of the male and female farming households respectively, had household size of 1-5 people with mean of 6 persons. Majority (82.1%) of the male farming households had access to farmlands, while most (68.7%) of the female had no access to farmlands. Also, more than half (56.7%) of the male had access to communication facilities while 55.6% of the female had no access. Probit regression analysis revealed age of the male (0.0466; P<0.05), cooperative membership (1.6684; P<0.01) and annual income (-2.83e-06; P<0.10) to be positive and significant. In the same vein, age of the female (0.1429; P<0.01), cooperative membership (1.8387; P<0.05) and annual income (5.55e-06; P<0.10) were positive and significant, while marital status (-0.4836; P<0.05) was negative and significant. Poor credit and unfavorable government policy were the most serious constraints faced by the rural farming households along gender line in the study area. The study recommended that government and other relevant stakeholders should provide the rural households with credit at subsidized rate to enable them enhance their livelihood. Also, favorable government policy should be put in place that can improve livelihood of the rural households in the study area.*

**Keywords:** Gender, rural household, livelihood, resources, access

INTRODUCTION

Agriculture plays a pivotal role in the provision of employment opportunities and income to most rural inhabitants in developing nations, Nigeria inclusive. However, many of the rural farming communities continue to produce at subsistence level using crude implements which result in low output, thus, making farming less productive, less profitable and unattractive endeavour. This might not be unconnected to their inability to access livelihood resources. Livelihood could be described as the way people combine and use their assets, capabilities and undertake activities to secure a means of living (Micheal *et al.,* 2021). The various activities undertaken by people in order to earn income help to reduce Vulnerability and increase their overall living standard within the subsiding social, economic, political and environmental influence on livelihood strategies (Eneyew and Bekele, 2012).

Nwandu *et al.* (2016) averred that, the choice of livelihood activities depend largely on access to and control over five major livelihood assets/capitals which include; human, Physical, social, financial and natural capitals. However, poor households face livelihood problems such as exposure to risks, malnutrition, shorter life expectancy and inadequate access to social and economic services as well as limited opportunities for income. It is a fact that, both men and Women do not have the same access to livelihood resources, despite the equal roles they play in agricultural production activities. FAO (2009) posits that rural women do not have equal access and control over assets as men, particularly land and fund, reducing their socioeconomic well-being. Oyesola and Ademola (2012) stressed that rural women lack access to social assets such as networks and associations which mar their ability in political decision making. Furthermore, female face inequalities in accessing education, skill development and training opportunities, particularly in the northern part of the country attributable to religious and cultural beliefs and this impede their capabilities. These therefore call for strategies that can help in reducing gender inequalities in accessing livelihood resources as this will not only improve nutrition, health and education outcomes, but it will help in the realization of both immediate and long-time economic and social benefits for families, communities and the nation as a whole (Aliyu *et al.,* 2021). The study was therefore conceived, to extend the frontier of knowledge of farming households’ access to livelihood resources along gender line as well as factors influencing their access to such resources in the study area.

METHODOLOGY

The study was carried out in Bosso, Chanchaga and Wushishi Local Government Areas of Niger State, Nigeria. Niger State lies between Latitude 8°20ꞌ and 11°30' North, and Longitude 3°30' and 7°40ꞌ East of the equator. The state covers an estimated land area of 74, 244 KM² with a human population of 3,954,772 people (NPC, 2006). However, the population was projected in 2019 using 3.2% growth rate of National Burenau of Statistics (NBS) to be 5,960,112 people. The state experiences two distinct seasons namely; wet and dry, with annual rainfall varying from 1100mm-1600mm. The temperature ranges from 23°C-37°C (Niger state Agricultural and Mechanization Authority (NAMDA, 2018). The major occupation of the people is farming (Crop and livestock). Three-stage sampling procedure was used. First stage involved purposive selection of three Local Government areas (LGAs) due to their predominant livelihood activities along gender line. Second stage was random selection of two villages from each of the selected LGAs which produced six villages. The third stage involved random selection of 130 respondents (67male and 63 female). Primary data were collected using semi-structured questionnaire complemented with interview schedule. Data were analyzed using descriptive (frequency counts, percentage and mean) and inferential (probit regression model) statistics.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

The socioeconomic characteristics of the rural farming household, described along gender line are presented in Table 1. Majority (71.6%) of the male headed households were in age bracket of 41-50 years with a mean of 46 people while 47.6% were female headed who aged between 41-50 years with a mean of 44-years. This implies that most of the household heads in the study area were in their active productive age, capable of undertaking livelihood activities. This finding disagree with that of Obi-Egbodi *et al.* (2021) who in their study area (Ogun State) found female household heads to be above their active productive age. This may have negative implication on their access to livelihood resources. Tables1 also shows most of the household heads to be married with household size of 6 persons on the average. More so, about 35.8% of the men and 47.6% of the women had no education. Although, a greater proportion of the male possess one form of education or the other. This was expected to be an advantage for the male over the female in accessing livelihood resources.

Gender Access to Livelihood Recourses

The results in Table 2 revealed that Majority (82.17%) of the male had access to farmland as against 31.3% of the female who had access to farmland. This implies that greater proportion of men had access to farmland in the study area. This finding substantiates that of Adebola *et al.* (2015) who noted that historically, in most cultures, female access to land involved right of use, but not ownership and that when common land is converted into state ownership and then to private land, women often lose their traditional right and are not always considered when new laws are enacted. Results further revealed that (Table 2) greater proportion of both male (64.2%) and female (57.1%) had no access to improved technology. This implies that rural farming households in the study area had poor access to improved technology and this was likely to impact negatively on their well-being. Also more than half (56.7%) of the male had access to communication facilities as against 44.4% of the female rural farming households. This may be attributed to better literacy attainment by the male. Literacy level assist individual to understand the benefit and how to use communication facilities. Group membership was high for both gender, about 79.1% of the male and 88.9 % of the female were members of social group. This implies that rural greater proportion of the rural farming households in the study area were members of one group or to order. This might be attributed to their understanding of benefit derivable in group membership, as most the government or international donor assistance to rural farming households are targeted at group rather than individuals.

Also, majority (62.7%) of the male were involved in decision making as against 49.2% of the female. This implies that, in decision making male have better opportunity to partake in decision making than female, this scenario can be attributed a typical aspect of gender inequality. This finding concurs with that of Adebola *et al.* (2015) who reported that, low participation in decision making by female to be a typical aspect of gender inequality. The result further indicated gender, (male 61.8% and female 57.1%) respectively had poor access to financial resources. Also in terms of government support fund like giants just a few of both gender (male 25.4% and female 30.2%) had access to such livelihood resources. This implies that majority of the rural farming households were poorly assisted and this was likely to impact negatively on their well-being. More so, more than half (53.7%) of the male had access to quality education as against 47.6% of the female, implying that greater proportion of the male had better access to quality education. Table 2 showed both gender (male 83. 6% and female 66. 7%) had access to rural labour as against just a few women (17.5%) that had access to labour. This implies that just a small proportion of the female can access rural labour, this may be due to their limited financial resources and marginalization by the male. Similarly, most(56.7%) of the male had access to skill acquisition while about 44.4% of the female had access, implying that the female rarely have equal opportunities with male in participating in skill acquisition which can enhance their livelihood activities.

Factors influencing Rural Household Access to Livelihood Resources

Table 3 revealed the result of probit model used in analyzing the factors influencing rural farming households’ access to livelihood resources. Age is positive and significantly influence male access to livelihood resource (P<0.05), age of the female is positive (0.145299) and significant (p<0.01). This implies that as the respondents along gender line in the study area advances in age they were more likely to access livelihood resources. The marital status of the female is negative (-0. 4835588) and significantly influenced access to livelihood (p<0.01), implying female that were unmarried have less chances to access livelihood resources. Coop. membership of the male was positive (1.668409) and significantly influenced their access to livelihood resources (p<0.001) also female coop. membership had positive coefficient (1.838672) and significantly influenced their access to livelihood resources (p<0.10). This result revealed male that were members of coop. societies were more likely to access livelihood resources more than the female. This might be due to disparity in recognition female always experience in the society.

The result further indicated that, total annual income of male had positive coefficient (2.83E-06) and significantly influenced their access to livelihood resources (P<0.10). Also, the coefficient of total annual income of the female had positive coefficient (5.55-06) and significantly influenced their access to livelihood resources (P<0.05). This implies that, the more total annual income of the respondents, the more likelihood to access livelihood resources as it is believed that individuals with good Socio economic disposition were more likely to pay for whatever assistance they have received in form of loan. More so, number of cooperative membership had positive coefficient (0.538755) and significantly influenced female access to livelihood resources (P<0.10). This implies that, the number cooperate societies female belong the more likely to access livelihood resources.

Constraints faced by Rural farming households in Accessing Livelihood Resources

Table 4 revealed some major constraints faced lay the male to include poor credit facilities (ẋ=2.30), unfavorable government policy (ẋ=2.26), lack of basic infrastructure (ẋ=2.24), poor transportation and inadequate farmland (ẋ=2.22), and high level of illiteracy. Similarly, some of the constraints considered by the females as very serious are; poor credit (ẋ=2.95), unfavorable government policy (ẋ=2.56), lack of basic infrastructure (ẋ=2.52), poor transportation (ẋ=2.38) and poor storage facilities (ẋ=2.22).

CONCLUSION AND RECOMMENDATIONS

The study concluded that most of the rural farming households along the gender line in the study area faced problem of poor access to credit facilities as well as unfavorable government policies on livelihood resources. It was therefore recommended that, government and well to do individuals should assist rural farming households in the study area with subsidized credit facilities to enable them increase production. Also government should always formulate policies that favour rural farming households in their bid to access livelihood resources.

Table 1: Socio-economic characteristics of the respondents

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | Male (n = 63) | | Female (n = 63) | |
|  | **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** |
| Age (Years) |  |  |  |  |
| 30-40 | 10 | 14.9 | 18 | 28.6 |
| 41-50 | 48 | 71.6 | 30 | 47.6 |
| 51-60 | 4 | 6.0 | 14 | 22.2 |
| Above 60 | 5 | 7.5 | 1 | 1.6 |
| Mean | **46** |  | **44** |  |
| Marital status |  |  |  |  |
| Married | 48 | 71.6 | 40 | 63.5 |
| Divorce | 6 | 9.0 | 7 | 11.1 |
| Widow | 9 | 13.4 | 10 | 15.9 |
| Single | 4 | 6.0 | 6 | 9.5 |
| Household size (No) |  |  |  |  |
| 1-5 | 42 | 62.7 | 45 | 71.4 |
| 6-10 | 18 | 26.9 | 15 | 23.8 |
| Above 10 | 7 | 10.4 | 3 | 4.8 |
| Mean | **6** |  | **6** |  |
| Level of education |  |  |  |  |
| Non formal | 24 | 35.8 | 30 | 47.6 |
| Primary | 20 | 29.9 | 21 | 33.4 |
| Secondary | 14 | 20.9 | 8 | 12.7 |
| Tertiary | 9 | 13.4 | 4 | 6.3 |

**Source: Field Survey, 2021**

Table 2: Rural households’ access to various resources

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Livelihood | Male (n=63) | | Female (n = 63) | |
|  | **Frequency** | **Percentage (%)** | **Frequency** | **Percentage (%)** |
| Physical resources -bold |  |  |  |  |
| Access to farmland | 55 | 82.1 | 20 | 31.3 |
| Access to important technology | 24 | 35.8 | 27 | 42.9 |
| Access to communication faculties | 38 | 56.7 | 28 | 44.4 |
| Group membership | 53 | 79.1 | 56 | 88.9 |
| Participation in decision making | 25 | 62.7 | 31 | 49.2 |
| Financial resources-sold |  |  |  |  |
| Access to credit facilities | 26 | 38.8 | 27 | 42.9 |
| Access to government support fumd (grants) | 17 | 25.4 | 19 | 30.2 |
| Human resources-bold |  |  |  |  |
| Access to quality education | 36 | 53.7 | 30 | 47.6 |
| Access to good health service | 56 | 83.6 | 42 | 66.7 |
| Access to rural labour | 48 | 71.6 | 52 | 17.5 |
| Access to skills acquisition | 38 | 56.7 | 35 | 44.4 |

**Source: Field Survey, 2021**

Table 3: Factors influencing rural household’s access to livelihood resources

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Male (n = 63)** | | **Female (n = 63)** | |
|  | **Coefficient** | **t-value** | **Coefficient** | **t-value** |
| Age | 0.0465909 | 1.91\*\* | 0.145299 | 2.45\*\*\* |
| Marital status | 0.0766397 | 1.29 | -0.4835588 | -3.14\*\*\* |
| Household size | -0.0246522 | -0.27 | 0.0116074 | 0.04 |
| Education level | 1.867527 | 1.56 | 1.096088 | 0.39 |
| Occupation | -0.4770486 | -1.14 | 0.6114843 | -0.73 |
| Extension contact | -0.4770486 | -0.04 | 0.4257184 | 0.73 |
| Cooperative membership | 1.668409 | 3.53\*\*\* | 1.838672 | 1.66\* |
| Access to credit | -0.6108885 | -1.27 | -0.3582717 | -0.78 |
| Annual income | 2.83E-06 | 1.79\* | 5.55E-66 | 2.40\*\* |
| Income savings | 0.090145 | 0.21 | 0.2878936 | 0.65 |
| Number of cooperatives | -0.0483143 | 0.54 | 0.538755 | 1.81\* |
| Constant | -4.929692 | -2.84\*\*\* | -6.439628 | -1.69\* |
| **Chi-Squared** |  | **24.26** |  | **32.27** |
| **Pro>chi2** |  | **0.0143\*\*\*** |  | **0.00134\*\*\*** |
| **Psendo R2** |  | **0.2612** |  | **0.3778** |

**Source: Field Survey, 2021**

**Note: \*\*\*, \*\* and \* implies significant at 1%, 5% and 10% level of probability**

**Table 4: Constraints faced by rural household access to livelihood resources**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Constraints** | **VS (%)** | **S (%)** | **NS (%)** | **WM (ẋ)** | **Decision** |
| **Male** |  |  |  |  |  |
| Poor credit facilities | 27 (40.3) | 33(49.3) | 7(10.4) | 2.30 | Serious |
| Unfavorable Government policy | 26 (38.8) | 32(47.8) | 99(13.4) | 2.25 | Serious |
| Lack of infrastructure | 24 (35.8) | 35(52.2) | 8(11.9) | 2.25 | Serious |
| Poor transportation system | 29 (43.3) | 32(35.8) | 14(20.9) | 2.22 | Serious |
| Inadequate farm land | 25 (37) | 32(47.8) | 10(14.9) | 2.22 | Serious |
| Community culture, value and norms | 16 (23.9) | 33(46.3) | 18(26) | 1.97 | Not Serious |
| High level of illiteracy | 22 (32.8) | 31(46.3) | 14(20.9) | 2.12 | Serious |
| Poor storage facilities | 6 (9.0) | 25(37.3) | 36(53.7) | 1.55 | Not Serious |
| **Female** |  |  |  |  |  |
| Poor credit facilities | 30 (47.6) | 23(36.5) | 10(15.9) | 2.95 | Serious |
| Unfavorable Government policy | 41 (65.1) | 16(25.4) | 6(9.5) | 2.56 | Serious |
| Lack of infrastructure | 37 (58.7) | 22(34.9) | 4(6.4) | 2.52 | Serious |
| Poor transportation system | 31 (49.2) | 25(39.7) | 7(19) | 2.38 | Serious |
| Inadequate farm land | 23 (36.5) | 20(31.7) | 13(20.6) | 2.16 | Serious |
| Community culture, value and norms | 19 (30.2) | 20(31.7) | 24(38.1) | 1.92 | Not Serious |
| High level of illiteracy | 10 (15.9) | 35(55.6) | 18(28.6) | 1.87 | Not Serious |
| Poor storage facilities | 21 (33.3) | 35(55.6) | 7(11.1) | 2.22 | Serious |

**Source: Field Survey, 2021**

**Note: VS = Very Serious, S = Serious, NS = Not Serious and WM = Weighted Mean**

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## FARMERS’ PERCEPTION OF EFFECTIVENESS OF EXTENSION AGENTS IN OSUN STATE, NIGERIA

Sulaimon, O.I.1, Omotoso, A.B.1, Adeniyi, B.A.1, Popoola O.M.1

1Oyo State College of Agriculture and Technology, Igboora

\*Corresponding email address: omotosoabeebtunde@yahoo.com

ABSTRACT

*The study assessed the farmers’ perception of the extension agents’ effectiveness in Osun State, Nigeria. Multistage sampling procedure was used to elicit information from 240 farmers. Data were analysed using descriptive statistic such as frequency counts, mean and percentage. The result reveals that 57.25 percent of the respondents were male with their mean age and household size estimated at 47 years and 7persons respectively. This showed that majority of the respondents were still in their economic productive age with mean income from farming estimated at ₦49,500.50. Distribution of respondents based on perceived assessment of extension agents’ (EAs) knowledge/mastery of subject matter revealed that 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived EAs as low in term of benefits from the messages, moderate in term of integrate theories with practical and high in term of topics presentation, respectively. The distributions of the respondents based on their perception about EAs mastery of subject matters relating to agricultural practices, showed that 67.50 percent of them were in the opinion that EAs are knowledgeable in technological application in crop production. In addition, 51.67 percent of the EAs are knowledgeable in processing/storage technology, 37.50 percent were into input distribution, 32.50 percent in income generating strategies and 41.67 percent in marketing strategies. The research therefore recommends training and revalidating should be organized to extension agent to boost their knowledge on subject matter.*

**Keywords*:***Extension agents, Subject matter, Marketing, Respondents, Technology dissemination

INTRODUCTION

Over the years, agricultural extension has been at the forefront in delivery of adequate information for farmers for increased production (Ezeh, 2013). The role of extension today goes beyond technology transfer but includes assisting farmer to form groups, dealing with marketing issues, addressing public interest issues in rural areas such as resource conservation, agricultural production, food safety, nutrition, family education, and youth development (Ijeoma and Adesope, 2015). Various agricultural extension approaches have been employed to deliver extension services to farmers in the world (Ibitoye, 2013). Such extension approaches include general ministry-based extension services; integrated extension; university-based extension; commodity-based extension; input supply extension; participatory extension; and farming systems research and extension (Ibitoye, 2013). Some extension approaches were successful than others, but none of them were exceptionally good in reaching and involving the majority of poor farmers. Ezeh (2013) observed that agricultural extension depends largely on information exchange between farmers and broad range of other actors that directly link agricultural knowledge and information. Ijeoma and Adesope (2015) opined that the mission of the extension service is to provide research-based information, educational programs, and technology transfer and needs of the people, enabling them to make informed decisions about their economic, social and cultural well-being.

Problem Statement

Traditional farming is the most predominant practice adopted by many farmers in Nigeria, which usually resulted in declining in agricultural production yearly (Codjoe *et al.,* 2013). The blame on the observed decline in agricultural production was due to dependency of farmers on traditional agricultural technologies and inadequate innovation (Agbamu, 2007). Based on this, a wide range of policies, strategies, and approaches were formulated by the Nigeria government to reverse the worsening food and agricultural trends towards sustaining agricultural growth. These included, introducing a range of agricultural initiatives and the Agricultural Development Project (ADP). Despite all these efforts, farmers seem to have not benefited from agricultural sector initiatives especially food crop farmers in Osun state in particular have failed to benefit from services delivered by agricultural extension agents under the introduced initiatives (Apantaku and Oyegunle, 2016). According to Gwary *et al. (*2013), food crop farmers in rural areas have been experiencing low yields, which were attributed to lack of extension services and poor technical knowledge. As a result, the general extension approaches was seen as being ineffective in enhancing farmers’ adoption of innovations. Therefore, the interaction between the extension agents and the farmers and the extent to which farmers perceived extension agents as useful to them is vital to bringing change in agricultural output and could explain the dynamics embedded in advices adopted by farmers in a given locale (Ibitoye, 2013). For example, the frequency of contact by extension agents is crucial because it is through this that important and useful information about improved and recommended agricultural practices are disseminated to farmers (Iwena, 2008). The amount or type of useful information disseminated to farmers will be useful to determine the effectiveness of extension agents in transferring knowledge needed by farmers to improve production. This study therefore, gathered information about the extent to which farmers viewed their extension agents as being effective in transferring the required information and knowledge necessary to enable them achieve optimal production in farming. Hence, the study assessed the perception of farmers’ on effectiveness of extension agents in Osun State. The specific objectives are to ascertain the frequency of contact between farmers and extension agents as well as determine the respondents’ perception of extension agents’ knowledge/mastering of subject matters related to agricultural production.

METHODOLOGY

The study was conducted in Osun State, South Western Nigeria. It is an inland state in Nigeria, with its capital at Osogbo. It is bounded in the north by Kwara state, in the east by Ekiti State and partly by Ondo State, in the south by Ogun State and in the west by Oyo State. It has a tropical climate with rainforest vegetation on its southern part and a derived savannah on its northern end. It has an estimated land area of 9,251 square kilometers. The estimated human population is 3,416,959 (2006 population census) and it is characterized commercially by a dual economic focus, the bourgeoning industrial sector and a dominant agricultural sector.

Sampling Techniques

Multistage sampling technique was used to select 240 food crop farmers from 18 communities in two agricultural zones of Osun State (Ife and Iwo). First stage involved the selection of two Zones, which are Ife and Iwo randomly. Second stage involved simple random selection of three (3) blocks from each of the two ADP zones respectively making six blocks. Stage three, involved random selection of four (4) cells from each of the six blocks making 24 cells. While the last stage involved random selection of ten (10) rural households from each of the 24 cells making 240 rural households. Primary data were collected using structured interview guide. Data were analysed using frequency count, percentage and mean.

RESULTS AND DISCUSSION

Socioeconomic characteristics of the respondents in the study area

Table 1 revealed the socioeconomic characteristics such as age, marital status, education, farm size, religion and household size of the respondents in the study area. The study showed that 57.50 percent of the respondents were male with mean age of the respondent estimated at 45 years. This was in line with Ibitoye (2013) who also showed the mean age of the rural households to be 48 years. In terms of marital status, 56.67 percent of the respondents were married, 24.17 percent were single while 11.67 percent were divorced. On the educational level, 25.00 percent of the respondents had primary education, 40.00 percent of the respondents had secondary education, and those with tertiary education were 10.00 percent, while 10.83 percent of the respondent had no formal education.

**Table 1: Distribution of Socioeconomic characteristics of the respondents**

|  |  |  |  |
| --- | --- | --- | --- |
| CHARACTERISTICS | FREQUENCY | Percentage (%) | MEAN |
| Age |  |  |  |
| Less than 30 | 66 | 27.50 |  |
| 30 – 40 | 38 | 15.83 |  |
| 41 – 50 | 46 | 19.17 | 47 |
| 51 - 60 | 22 | 9.17 |  |
| Above 60 | 68 | 28.33 |  |
| Marital Status |  |  |  |
| Single | 58 | 24.17 |  |
| Married | 136 | 56.67 |  |
| Widowed | 28 | 11.67 |  |
| Divorced | 18 | 7.50 |  |
| Gender |  |  |  |
| Male | 138 | 57.50 |  |
| Female | 102 | 42.50 |  |
| Occupation |  |  |  |
| Farming | 52 | 21.85 |  |
| Trading/Civil servant | 138 | 57.50 |  |
| Artisan | 50 | 20.65 |  |
| Household size |  |  |  |
| Less than 4 | 88 | 36.97 |  |
| 4 – 8 | 86 | 36.13 | 7 |
| 9 - 12 | 52 | 21.85 |  |
| Above 12 | 12 | 5.04 |  |
| Education level |  |  |  |
| Primary Education | 60 | 25.00 |  |
| Secondary Education | 96 | 40.00 |  |
| Tertiary Education | 24 | 10.00 |  |
| No formal Education | 60 | 25.00 |  |
| Religion |  |  |  |
| Christian | 78 | 32.50 |  |
| Islam | 128 | 53.33 |  |
| Traditional | 28 | 14.13 |  |
| Income (₦) |  |  |  |
| Less than 50,000 | 156 | 65.00 | 49,500.50 |
| 50,000 - 100,000 | 60 | 25.00 |  |
| Above 100,000 | 24 | 10.00 |  |
| Total | 240 | 100.00 |  |

Perceived Assessment of Extension agent knowledge/Mastery of Subject matter

Table 2 revealed the perceived assessment of extension agent knowledge/mastery of subject matter by the respondents in the study area. Based on good knowledge of subject matter, 35.83 percent perceived them low, 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived the extension agent as low in term of beneficial of the messages, medium in term of integrate theories with practical and high in term of topics presentation respectively. About 52.50 percent of the respondents perceived extension agent as high in term of explanatory of subject matter.

Table 2: Perceived Assessment of Extension agent knowledge/Mastery of Subject matter

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No | Assessment questions | Low  Freq (%) | Medium  Freq (%) | High  Freq (%) |
| 1 | Have good knowledge of subject matter | 84 (35.83) | 34 (14.17) | 120 (50.00) |
| 2 | Have a lot of new technologies | 94 (39.17) | 64 (30.83) | 72 (30.00) |
| 3 | Messages are beneficial | 78 (32.50) | 44 (18.33) | 116 (49.16) |
| 4 | Integrate theories and practical | 118 (49.17) | 52 (21.67) | 70 (29.17) |
| 5 | Presentation of topics is good | 86 (35.83) | 22 (9.17) | 132 (55.00) |
| 6 | Listen to your problem | 82 (34.17) | 56 (23.33) | 102 (42.50) |
| 7 | Act as if they know all | 78 (32.50) | 96 (40.00) | 66 (27.50) |
| 8 | Impose their ideas | 98 (40.83) | 100 (41.67) | 42 (17.50) |
| 9 | Extension agent is very explanatory | 84 (35.00) | 30 (12.50) | 126 (52.50) |

Percentages are in parentheses

Perceived areas covered by Extension agents

The result of respondents' perceived areas in agricultural practices covered by extension agents in the study area showed that majority (67.50 percent) of the respondents perceived that the extension agents covered areas on production technologies as against 32.50 percent that perceived they did not cover areas on commodity crop production. About 51.67 percent, 37.50 percent, 32.50 percent and 41.67 percent perceived that the extension agents covered areas on processing/storage technology, input distribution, income generating strategies and marketing respectively. Furthermore, 58.33 percent, 21.6 percent and 25.0 percent of the respondents perceived that the extension agents did not cover areas that have to do with micro-credit, environmental and health issues.

**Table 3: Perceived areas covered by Extension agents**

|  |  |  |  |
| --- | --- | --- | --- |
| S/No | Coverage areas | Yes  Freq (%) | No  Freq (%) |
| 1 | Commodity crop production technologies | 78 (32.50) | 162 (67.50) |
| 2 | Processing and Storage technologies | 116 (48.33) | 124 (51.67) |
| 3 | Input distribution | 150 (62.50) | 90 (37.50) |
| 4 | Income generating strategies | 162 (67.50) | 78 (32.50) |
| 5 | Marketing | 140 (58.33) | 100 (41.67) |
| 6 | Micro-Credit | 140 (58.33) | 100 (41.67) |
| 7 | Environmental issue | 52 (21.67) | 188 (78.33) |
| 8 | Health issue | 60 (25.00) | 180 (75.00) |
| 9 | Information and Communication technology | 116 (48.33) | 124 (51.67) |

Percentages are in parentheses

Relevance of Extension agents’ message to respondents’ technological need

Table 4 revealed the distribution of respondents on their perceived relevance of extension agents’ message to their technological needs. In term of message on improved varieties, 38.33 percent, 34.17 percent and 27.50 percent perceived the message as highly relevance, low relevance and not relevance respectively. In addition, in terms of messages/information on processing technology, fertilizer application and storage technology, 31.67 percent, 63.33 percent and 24.37 percent of the respondents perceived EAs message as highly relevant, low relevant and not relevant respectively.

**Table 4: Relevance of Extension agents’ message to respondents Needs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S/No | Relevance of EAs message | Highly relevant  Freq (%) | Low relevant  Freq (%) | Not relevant  Freq (%) |
| 1 | Improved varieties | 92 (38.33) | 82 (34.17) | 66 (27.50) |
| 2 | Processing | 76 (31.67) | 70 (29.17) | 94 (39.17) |
| 3 | Fertilizer application | 72 (30.00) | 16 (6.67) | 152 (63.33) |
| 4 | Harvesting technique | 70 (29.17) | 50 (20.83) | 120 (50.00) |
| 5 | Storage need/problem | 72 (30.25) | 58 (24.37) | 108 (45.38) |
| 6 | Application of herbicides and Pesticides | 72 (30.00) | 10 (4.17) | 158 (65.83) |

Percentages are in parentheses

CONCLUSIONS AND RECOMMENDATION

The study assessed farmers’ perception of effectiveness of extension agents in Osun state, Nigeria. The study revealed that male (57.52 percent) dominate farming activities in the study area. Majority (56.67 percent) of the respondents are married with mean age and household size estimated at 47 years and 7 persons respectively. Perceived assessment of EAs knowledge/mastery of subject matter by the respondents showed that 32.50 percent, 21.67 percent and 55.0 percent of the respondents perceived the EAs as low in term of beneficial of the messages, medium in term of integrate theories with practical and high in term of topics presentation respectively. Also perceived distribution of the respondents based on relevance of EAs message to their technological needs or problems revealed 51.67 percent, 37.50 percent and 41.67 percent perceived that the extension agents covered areas on processing/storage technology, input distribution, income generating strategies and marketing respectively highly relevant, low relevant and not relevant respectively. The study recommends training program for extension agents in Osun state to boost their knowledge on varieties of subject matter relating agricultural production. Also, proper monitoring of extension agents from time to time and provision of incentives for them, which will serve as motivation.

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## SOCIOECONOMIC FACTORS INFLUENCING THE KNOWLEDGE AND ATTITUDE OF MAIZE FARMERS ON THE SAFE USE OF AGROCHEMICAL IN AGAIE AND BIDA, NIGER STATE, NIGERIA

Jibrin, S., Abdullahi, A., Ahmed, I. I., Mohammed, I. and Nwankwo, O. R

Department of Agricultural Extension and Rural Development, FUT Minna, Niger State, Nigeria.

Corresponding Author’s Email [safil4real@gmail.com](mailto:safil4real@gmail.com) 07030648457

ABSTRACT

*The study accessed the Socioeconomic factors influencing the knowledge and attitude of Maize farmers on the safe use of agrochemical in Zone I, Niger State, Nigeria. To achieve the study objectives, 4-stage sampling technique was used to randomly select 110 maize farmers for the study. Data were collected using questionnaire, complimented with interview schedules, and analyzed using descriptive statistics and Probit regression model. Based on the findings of the research, it was discovered that the mean age of the respondents were 42 years, 85% of the maize farmers were male, 89% were married, mean number of dependents of the maize farmers was 8. The mean of total years spent in school was 10 years, about 95% had no training on agrochemical handing while 92% had no extension contact. About 24% of the maize farmers use agrochemical to increase yield, with fertilizer as one of the major agrochemicals used. More so, 24% of the respondents used safety face mask, 29% claimed that Personal Protective Equipment use slows one down, while on knowledge and attitude, knowledge that agrochemical use improves crop yield had mean score of 2.05 and knowledge of agrochemical hazards had mean score of 2.01. Sex, marital status, level of education and farm size were positively significant while maize farming experience, source of capital and amount of credit where negatively significant at different probability levels. The study recommends that trainings on safe agrochemical use should be organized for farmers by extension agencies, since experience does not increase awareness.*

**Keywords**: Maize farmers, Knowledge and Attitude, Agrochemical and Safe use

INTRODUCTION

Agrochemicals are chemicals (pesticides and fertilizers) that are used to boost agricultural production. They are used as soil conditioners, acidifiers, nutrients and they are also used to manage diseases caused by fungi, bacteria, pests and viruses, thereby improving agricultural productivity. Agrochemical use has led to increased food production (Omari, 2014).. Nevertheless, exposures to other organisms during the periods of application, including human beings, is poorly controlled (Apeh, 2018). Maize (*Zea mays*) has become a very important staple food that is being consumed by millions of Nigerians. Researches in the production and marketing of maize in various parts of the nation have shown the increasing importance of this crop. However, the continued cultivation of maize as a staple food is threatened by certain problems, such as those of pest and diseases. The use of agrochemical is not without safety or precautionary routines and practices contained on the labels and also supported by relevant national and international agencies in every country (e.g. WHO, Federal Environmental Protection Agency (FEPA), National Environmental Standards and Regulations Enforcement Agency (NESREA) etc, in Nigeria) that are expected to keep farmers from ill health related problems (Mc Arthur and Mc Cord, 2014). Hence this study tends to find outthe Socio-economic factors influencing the knowledge and attitude of maize farmers on the safe use of agrochemical in Zone I, Niger State, Nigeria**.** The specific objectives are describe the socio-economic characteristics of maize farmers in the study area, to identify the various uses of agrochemical, type of agrochemical and personal protective equipment (PPE) used by the respondents in the study area; determine the knowledge and attitude level of respondents on the safe use of agrochemical in the study area; determine the socio-economic factors influencing the knowledge and attitude of the respondents.

**Table 1: Distribution of maize farmers in Niger State**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ZONE | Local Government Area (LGA) | Name of Communities/Villages | Sample Frame | Sample Size (20%) |
| I | Bida | Bida  Dabarako | 205  110 | 41  22 |
|  | Agaie | Nami  Jipo 1 | 122  115 | 24  23 |
|  | Total |  | 552 | 110 |

Source: Niger State Agricultural Mechanization and Development Agency, 2018.

**Analytical Tools**

Descriptive statistics was used to achieve objective one (i) and two (ii) while Probit regression model was used to achieve objective three (iii).

RESULTS AND DISCUSSION

The result revealed that the mean age of the respondents was 42 years,85% of the maize farmers were male, 89% were married, mean number of dependents of the maize farmers was 8. The mean of total years spent in school was 10 years, about 95% had no training on agrochemical handing while 92% had no extension contact. The study is in line with the findings of Tijjani *et al*., (2018) who reported that respondents in the in Jere Local Government Area of Borno Statewhere male, with mean household size of 8 and mean age of 39. Findings from this study also reveals that 24.02% of the respondents used agrochemical to increase yield, 22.70% used agrochemical to improve quality of crop. Ladapo *et al*., (2020) reported that agrochemical increase yield.

**Table 2: Distribution of respondents according to reasons for agrochemical use**

|  |  |  |
| --- | --- | --- |
| **Reason** | **Frequency** | **Percentage** |
| Increase yield | 110 | 24.02 |
| Improve quality of crop produce | 104 | 22.70 |
| Control pest and diseases | 104 | 22.70 |
| Improve appearance of farm produce | 59 | 12.88 |
| As advised by extension agent | 81 | 17.69 |

**Note Multiple responses recorded Source: Field survey, 2021.**

About 31% of the respondents used fertilizer, 30% used herbicide and 27% used insecticide, while only 8% used fungicide. This implies that the respondents use more of fertilizers than any other agrochemical. This finding does not correspond with the findings of Mengistie *et al*., (2017), who reported that in vegetable farming, insecticides (58 %) are the mostly used agrochemicals due to serious insect pests in vegetable production.

**Table 3: Distribution of respondents according to types of agrochemical used**

|  |  |  |
| --- | --- | --- |
| Agrochemical | Frequency\* | Percentage (%) |
| Fertilizer | 110 | 31.70 |
| Herbicide | 106 | 30.55 |
| Fungicide | 31 | 8.93 |
| Insecticide | 96 | 27.67 |
| Nematicide | 2 | 0.57 |
| Rodenticide | 2 | 0.57 |

**Note; \* Multiple responses recorded Source: Field survey, 2021**

Furthermore, findings reveal that about 24% of the respondents used safety face mask, 16.4% used safety boots, 15.2% used safety overall, 15.2% used safety hand gloves, 12.6% used safety nose mask, 9.1% used safety goggles, while 7.6% used safety hat. This implies that the respondents make use of safety face mask more than any other protective equipment, this is probably due to the Covid 19 protocol that was compulsorily put in place to avoid its spread, and this also helped to inform many about the ability of one to contact health problems from the air. Therefore, they may now also have dread for chemicals that are applied in the air (whether in powdery or liquid form). Fadlullah, *et al*. (2015) reported in their study that farmers do not wear protective clothing,

**Table 4: Distribution of respondents according to use of Personal protective equipment/clothing (PPE)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Safety PPE** | **Frequency** | **Percentage (%)** |  |
| Safety overall | 40 | 15.2 |  |
| Safety boot | 43 | 16.4 |  |
| Safety goggle | 24 | 9.1 |  |
| Safety hat | 20 | 7.6 |  |
| Safety nose mask | 33 | 12.6 |  |
| Safety hand gloves | 40 | 15.2 |  |
| Safety face mask | 63 | 23.9 |  |

**Note Multiple responses recorded Source: Field survey, 2021.**

On the reasons why farmers do not use PPE, 29% of the respondents claimed that PPE use slows one down, 22% claimed it is not comfortable, .17% claimed they don’t see need for one, 16% claimed it is not available and 14% claimed is too expensive. This could be due to the nature the PPE, which could be quite burdensome, the claims of seeing no need shows complete ignorance. Khalid *et al.* (2013) who reported that87% of the farmers apply fertilizer to their crop.

**Table 5: Distribution of respondents according to reasons why respondents do not use PPE**

|  |  |  |
| --- | --- | --- |
| **Reason** | **Frequency** | **Percentage (%)** |
| Too expensive to afford | 29 | 14.0 |
| Not available | 34 | 16.4 |
| Not comfortable | 46 | 22.2 |
| Slows one down | 61 | 29.5 |
| Don’t see need for one | 37 | 17.9 |

**Source: Field survey, 2021.**

Further analysis reveals the response of the farmers as regards their knowledge and attitude; knowledge that agrochemical use improves crop yield (mean=2.05), knowledge of agrochemical hazards (mean=2.01), trained on PPE use and handling (mean=1.88), Knowledge of the name of the agrochemical used (mean=1.85), knowledge that not all agrochemical have the same adverse effects (mean=1.78) while trained on handling and use of agrochemical (mean=1.6).

**Table 6: Distribution of respondents’ knowledge and attitude level**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Knowledge and attitude** | **NK(1)** | **K(2)** | **VK(3)** | **WS** | **Mean** | **Rank** | **Decision** |
| Agrochemical use improves crop yield | 26(26) | 52(104) | 32(96) | 226 | 2.05 | 1st | Knowledgeable |
| Knowledge of agrochemical hazards | 24(24) | 61(122) | 25(75) | 221 | 2.01 | 2nd | Knowledgeable |
| Trained on PPE use | 37(37) | 37(74) | 32(96) | 207 | 1.88 | 3rd | Not knowledgeable |
| Knowledge of the name of agrochemical used | 25(25) | 55(110) | 23(69) | 204 | 1.85 | 4th | Not knowledgeable |
| Not all agrochemical have the same adverse health effects | 37(37) | 60(120) | 13(39) | 196 | 1.78 | 5th | Not knowledgeable |
| Consequences of mishandling agrochemical | 44(44) | 56(112) | 9(27) | 183 | 1.66 | 6th | Not knowledgeable |
| Trained on handling and use of agrochemical | 57(57) | 40(80) | 13(39) | 176 | 1.6 | 7th | Not knowledgeable |
| knowledge of alternative forms of pest control | 56(56) | 43(86) | 11(33) | 175 | 1.59 | 8th | Not knowledgeable |

**Note: NK; Not knowledgeable, K; Knowledgeable, VK; Very knowledgeable Source: Field survey, 2021.**

**Socio economic factors influencing the knowledge and attitude of respondents**

**T**he Probit model revealed that sex was significant at 5% implying that the more males are involved in farming the more awareness is created about agrochemical use Ndaghu *et al.* (2017); Abayomi, (2018) reported that most farmers in the study areas where married and tends to comply with agrochemical safety practices. Marital status was significant at 10% implying that the more married farmers are involved, the higher the knowledge level, this could be due to the fact that there is a sense of responsibility attached to married people. Hence, they need to take care of themselves not just for their sakes, but also their spouse and family at large. Level of education was significant at 10% implying that the more educated the farmers are the more their knowledge level increases. Maize farming experience was significant but negatively at 10% which implies that increase in farming experience does not necessarily increase knowledge level. Because farmers can have experience even in ignorance and can continue in a wrong direction for a long time. Farm size was positively significant at 1% implying that the more hectares a farmer has the more his knowledge level is increased. This is because, as expansion takes place the chances of meeting more extension agents, other farmers increase thereby causing a positive change to take place. Source of capital and amount of credit were significant but negatively at 5% which implies that the amount did not influence the knowledge level of farmers. This could be because many farmers tend to receive loans or grants and channel it to family affairs/problems and not just for farm operations, this in turn affects their productivity in the farm.

**Table 7: Probit model estimates of Socio economic factors influencing the knowledge and attitude of respondents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables** | **Coefficient** | **t-value** | **P-value** |
| Age | -0.0005 | -0.01 | 0.990 |
| Sex | 1.1772 | 2.12 | 0.034\*\* |
| Marital status | 0.4642 | 1.67 | 0.096\* |
| Number of children | -0.0956 | -1.23 | 0.220 |
| Level of education | 0.1554 | 1.67 | 0.096\* |
| Maize farming experience | -0.0517 | -1.75 | 0.081\* |
| Farm size | 2.2119 | 2.72 | 0.007\*\*\* |
| Source of capital | -0.5767 | -2.03 | 0.043\*\* |
| Amount of credit | -0.00002 | -2.27 | 0.023\*\* |
| Amount spent on pesticide/herbicide | 0.00003 | 0.63 | 0.528 |
| Amount spent on fertilizer | 5.15e-06 | 0.22 | 0.823 |
| Constant | -0.9574 | -0.64 |  |
| Source of labour | -0.3898 | -1.25 | 0.211 |
| Extension agent visit | 0.3201 | 1.53 | 0.127 |
| LR Chi2 (13) |  |  |  |
| Prob > Chi2 = 0.0000 |  |  |  |
| Pseudo R2 = 0.3391 |  |  |  |
| Log likelihood = 43.83297 |  |  |  |

**Source: Field survey, 2021. \*\*\* Significant at 1%, \*\* Significant at 5% and \*Significant at 10%**

RECOMMENDATIONS

1. Extension programs strictly based on the peoples dialect and traditions should be held to help the uneducated farmers understand and catch up with others.
2. Extension agents should sensitize farmers on need to use personal protective equipment (PPE) and training on safe agrochemical use should be organized for farmers, since experience does not increase awareness
3. Agencies producing personal protective equipment and clothing, should manufacture new and moderate or more flexible design/style for PPE products to enable farmers be more comfortable wearing them on.

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## A REVIEW ONEFFECTS OF BIOFORTIFIED PRO-VITAMIN A MAIZEADOPTION ONFARMER’S LIVELIHOOD STATUS IN NIGER STATE, NIGERIA

**T. L. Yusuf, U. S. Isah, and J.O. Ajayi**

Department of Agricultural Extension and Rural Development, Federal University of Technology Minna, Niger State, Nigeria

\*Correspondent Author E-mail and Phone number: [y.lakpene@futminna.edu.ng](mailto:y.lakpene@futminna.edu.ng)08030412627

ABSTRACT

*Food and nutrition insecurities are the primary chal­lenges in most developing countries especially in Sub-Saharan Africa (SSA). Increasing maize productivity has been identified as one of the strategies to curb food in­security in SSA.The study reviewed the Bio-fortified pro-vitamin A maize adoption on farmer’s livelihood status. Systematic review was adopted and all the relevant documents (research articles and book chapters) were sorted according to laid-down eligibility criteria. Fifty (50) articles and book chapters containing relevant and useful information were included in this review.From the review of related literature, it can be concluded that pro-vitamin A-biofortified maize (PVABM) was accepted by consumers regardless of its orange color and farmers are willing to cultivate pro-vitamin-a maize variety in Kwara State, Nigeria****.*** *Also, the level of adoption of Vitamin A bio-fortified Maize variety was low. Age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations were the major factors influencing the adoption of bio-fortified pro-vitamin A maize. The study therefore recommended that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to sensitizing farmers on the relative advantage of bio-fortified pro-vitamin A maize and the price should be subsidized for ease of adoption.*

**Keywords**: Biofortified; pro-vitamin; livelihood; adoption; maize

INTRODUCTION

Maize is the global leading cereal in terms of production, with 1,016 million metric tons (mmt) produced on 184 million hectares (m/ha) globally (FAOSTAT, 2013). Maize is produced globally across temperate and tropical zones and spanning all continents. Maize is one of the three leading global cereals that feed the world (Shiferaw *et al.*, 2011). Maize, together with rice and wheat, dominate human diets (Ignaciuk and Mason-D'Croz, 2014) and provide at least 30% of the food calories of more than 4.5 billion people in 94 developing countries. Maize alone contributes over 20% of total calories in human diets in 21 low-income countries, and over 30% in 12 countries that are home to more than 310 million people. Out of the 22 countries in the world where maize forms the highest percentage of calorie intake in the national diet, 16 are in Africa (Nuss and Tanumihardjo, 2011). Nigeria is the second largest maize producer in Africa, after South Africa, with an estimated 10.79 million metric ton produced in 2014 (FAOSTAT, 2014). Despite its high production volumes, Nigeria’s average maize yield of 1.8 million metric ton/ hectare is one of the lowest among the top 10 maize producers in Africa. It lags behind countries such as Egypt and South Africa where the yields are 7.7 million metric ton / hectare and 5.3 million metric ton/ hectare respectively (FAOSTAT, 2014).

Food and nutrition insecurities are the primary chal­lenges in most developing countries especially in Sub-Saharan Africa (SSA). Increasing maize productivity has been identified as one of the strategies to curb food in­security in SSA. This is because maize is widely pro­duced and consumed in this region, has higher yield potential and more responsive to management than other cereal crops like sorghum and millet grown in SSA (Badu-Apraku *et al.,* 2011).

Bio-fortification is a new public health intervention that seeks to improve the micronutrient content of staple foods consumed by the majority of poor people using conventional plant-breeding techniques in order to make a measurable impact on the magnitude of micronutrient malnutrition (Meenakshi *et al.*, 2012). According to Pérez (2019), bio-fortified crops can be classified into two main groups. Those with a visible or observable nutritional trait (crops like cassava and sweet potato that change colour from white/cream to yellow/orange when enriched with vitamin A), and those with invisible or nonvisible traits (that cannot be observed in plain sight).Since the introduction of Pro Vitamin –A maize in the country, few studies have been conducted to assess its impact on the income of the farmers particularly in the study area and with great variation in the scope of coverage. This has constituted a gap in terms of knowledge on the significance of the Pro VitaminA maize on the livelihood of the farmers. Therefore this study reviewed some related literature on Bio-fortified pro-vitamin A maize adoption on farmer’s livelihood status and specifically reviewing some related literature on the perception of the farmers on Bio-fortified Pro-Vitamin-A Maize, adoption level of Biofortified Pro-Vitamin A maize and factors influencing adoption of biofortified maize.

METHODOLOGY

Systematic review was adopted for this review. Information on Bio-fortified Pro-Vitamin-A Maize were retrieved from electronic database which include Google Scholar, Research Gate, and Semantic Scholar, using search terms of “perception of farmers on Bio-fortified Pro-Vitamin-A Maize”, adoption level of Biofortified Pro-Vitamin A maize”, and livelihood status of the farmer. A database was created for the articles, books, and conference papers published from 199 to 2020 obtained. Based on the eligibility criteria as regards their relevance (unavailability of full text or not published in English), fifty (50) articles and book chapters containing relevant and useful information were included in this review. The study was carried out in three phases. The first phase describes the perception of the farmers on Bio-fortified Pro-Vitamin-A Maize, the second phase described the adoption level of Biofortified Pro-Vitamin A maize while the third phase involved studies on factors influencing adoption of biofortified maize.

Perception of the farmers on Bio-fortified Pro-Vitamin-A Maize

A number of studies have been conducted looking at farmers’ perceptions, consumer acceptance, breeding and the potential impact of provitamin A-biofortified maize (PVABM) in combating micro nutritional malnutrition. These studies have primarily been conducted in the sub-Saharan region, as per the HarvestPlus programmed studies conducted on PVABM have shown that there is the potential for this maize to be accepted by rural communities (Egesel *et al*., 2003). Thus, along with all the previously noted benefits of PVABM, researchers should not overlook the current smallholder farming systems in rural communities, where farmers utilize the local maize landraces in their marginal agricultural land. Farmers will need to be convinced to introduce PVABM into their farming systems. Farmers usually do not adopt improved maize hybrids (Mills *et al.,* 2017).

The main cause for this could be the lack of consideration of farmers’ preference in the development of these hybrids. Farmers have different preferences and select maize for different traits and the most preferred trait for selection is yield. Farmers should be considered in the production of new hybrids, as their willingness to adopt and incorporate the product is important (Mbata *et al.*, 2009). Stevens and Winter–Nelson (2008) assessed the acceptance of provitamin A-biofortified maize (PVABM) through taste and trading. Their findings showed that PVABM was accepted by consumers regardless of its orange color. However, these findings may vary between countries and regions. A study by Olayinka *et al.*(2020) reported in their work farmers’ willingness to cultivate pro-vitamin-a cassava variety in Kwara State, Nigeria**.** The study showed that about half of the respondents had high knowledge about the improved cassava variety and a vast majority expressed willingness to cultivate it. Sex and knowledge level had significant association with willingness to cultivate pro vitamin A maize with female farmers found to be about 3 times more likely willing to cultivate than male.

Adoption level of Biofortified Pro-Vitamin A maize

Many factors were identified as possible determinants of the adoption or acceptance of the pro-vitamin A biofortified crop in Nigeria. According to De Steur *et al.* (2012) who reported that Nutritional information and visible trait (yellow colour) is one known property of vitamin A biofortified crops that consumer were well aware that this crop differs from their local variety acceptance/adoption was now based on how well informed they are of its nutritional advantage against the high incidence of the vitamin A micronutrient deficiency in their communities (De Steur *et al.,*2010*;* Onyeneke *et al.,*2019)*.* This nutritional information proved a significant factor in consumer preference and willingness to pay for yellow coloured pro-vitamin A biofortified maize crop in Nigeria (especially in Imo State of the South-East) (Oparinde *et al.*, 2016; Birol *et al.,* 2015). The information of the nutrition and health benefits content and length of nutritional campaigns remains an important factor, just as Bouis *et al.(*2017) show the integration of biofortified food to children’s diet, thus increasing adoption.

Asfir (2016) in their work on determinants of adoption of Vitamin A bio-fortified Cassava variety among farmers in Oyo State, Nigeria revealed that the level of adoption of Vitamin A bio-fortified Maize variety was low as access to media, contact with extension agents, among others are the determinants of adoption of vitamin A bio-fortified maize variety in their study area.

Accordingly, De Groote *et al*. (2016) found that adopters ranked agronomic performance as more important than nutritional benefits for adoption. Thus, farmers who are aware of the variety but lack knowledge of its nutritional attributes may not adopt bio-fortified crops. However, the extent to which knowledge of the nutritional benefits and awareness of varieties affects the adoption of bio-fortified varieties has not been quantified. While this gap has been acknowledged in previous research on the adoption of bio-fortified crops, it has hardly been addressed in any empirical study. This study evaluates the effect of variety awareness and nutrition knowledge the on adoption of bio-fortified crop varieties in the Kisii and Nyamira counties of Kenya.

Hao *et al.* (2015) in their study on extension and adoption of bio-fortified crops: Quality protein maize in Africa revealed that the farmers in project communities participated in extension activities in all countries except Kenya. In these communities, familiarity with QPM was high again except for Kenya, but understanding of their nutritional benefits was much lower. In all countries, farmers evaluated quality protein maize (QPM) varieties to be good or better than conventional varieties (CV) for post-harvest characteristics. For agronomic characteristics, however, QPM varieties scored better than CV in Uganda, about the same in Tanzania, but less in Ethiopia. Adoption patterns differed widely between the countries: in the project areas it varied from 70% in Uganda, 30% in Tanzania to none in Kenya. In the control areas, adoption was only observed in Uganda. Factors that significantly influenced adoption were farmers’ participation in extension activities, farmers’ agronomic and post-harvest evaluation of quality protein maize (QPM) versus conventional maize (CM) and their understanding of the nutritional benefits of QPM. Evaluation for agronomic performance was found to be more important than knowledge of nutritional benefits, thus favoring the first approach. A reliable seed supply was, however, found to be a basic condition for adoption. More also, De Groote *et al*. (2016) find that Quality protein maize (QPM) farmers showed high familiarity with the varieties, but low understanding of their nutritional attributes and benefits – an indication of failure to disseminate information on the nutritional benefits.

Factors Influencing Adoption of Biofortified Maize

In general, factors that will influence a farmer’s ability and willingness to adopt agricultural technologies involve both farm-specific aspects (i.e., the characteristics of the farmers and the resources at their disposal), and circumstances related to the biophysical and socio-economic context of the farming operation. Technologies may at times be rejected not because of their intrinsic qualities, but rather because they are not compatible with these factorsInternational Maize and Wheat Improvement Center (Remidius 2020). Information regarding the existence of new agricultural technology is of course a prerequisite for technology adoption. Such information can be obtained from various external sources, such as extension agents, fellow farmers or different media such as television or radio. Importantly, farmers will also require the necessary information to assess the suitability of the technology for their farming system and to understand the potential risks associated with the use of the technology. For instance, farmers may be uncertain about the profitability of the new technology or differences in economic returns between new and old technologies. Such uncertainties may arise due to insufficient knowledge about yields of new technologies, the types and costs of needed inputs, or expected market prices and demand for the produce (Abadi and Pannell, 1999).

Weather conditions and climatic shocks also increase uncertainty and risk, in particular among subsistence farmers who are dependent on rainfall (Abadi and Pannell, 1999). Another influencing factor in technology adoption is the farmers attitude to risk. In this context, the farmers attitude to risk i.e., whether they are risk avert, risk neutral or risk preferring is an important determinant for their willingness to adopt new technologies (Marra *et al.,* 2003).

Chete,(2021) reveal that adoption of improved maize seed varieties among the households was positively influenced by age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations. However, the study concluded that improving farmers’ education, expanding coverage and depth of extension services and strengthening farmer associations are useful policy actions for promoting adoption of improved maize varieties. It is also important to address availability, accessibility and affordability issues constraining adoption, enhance credit access and mitigate risk perceptions.

According to Olusegun *et al.* (2016) in their studies onfactors influencing adoption decisions of maize farmers in Nigeria revealed that farmers across the entire agro-ecological regions of country share some negative sentiments regarding adoption of improved maize variety (IMV). Renewed emphasis on interventions that would enable farmers gain more access to farmland, and promote formal education and extension service are advocated. An attempt to incorporate variables that capture farmers’ perception/experience on agro-climatic/ ecologically related concerns in adoption study could aid better understand of what drives farmers’ adoption decisions across the country especially in the light of the emerging climate change issues and its implication on food production.

Olatade *et al.* (2016) in their work on how does farmers’ characteristics affect their willingness to adopt agricultural innovation the case of bio-fortified cassava in Oyo state, Nigeria revealed that farmers’ willingness to adopt bio-fortified cassava in the study area were influenced mainly by gender, source of inputs, marital status, access to extension officer and membership of farmer organization.

CONCLUSION AND RECOMMENDATIONS

From the review of related literature, it can be concludedpro-vitamin A-biofortified maize (PVABM) was accepted by consumers regardless of its orange color and farmers are willingness to cultivate pro-vitamin-a maize variety in Kwara State, Nigeria**.** Also the level of adoption of Vitamin A bio-fortified Maize variety was low and age, household size, level of education, farming experience, labour availability, contacts with extension agents, farm size, off-farm income and membership of associations were the major factors influencing the adoption of bio-fortified pro-vitamin A maize. The study therefore recommends that relevant stakeholders (State government, Non-governmental organization and community based organization) should intensify efforts to sensitizing farmers on the relative advantage of bio-fortified pro-vitamin A maizeand the price should be subside for ease of adoption.

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# ANIMAL SCIENCE/PRODUCTION

## EFFECT OF DIFFERENT PROCESSING METHODS ON NUTRIENTS AND ANTI-NUTRIENT COMPOSITION OF LEUCAENA (*Leucaena leucocephala*) SEEDS

M. Adeyanju, O.J. Alabi, S.S.A. Egena and E.Z. Jiya

Department of Animal Production, Federal University of Technology Minna, Niger State, Nigeria.

Email:mercyadeyanju.4@gmail.com

ABSTRACT

*Effect of different processing methods on proximate and anti-nutrient composition of Leucaena leucocephala seeds was carried out. Three different processing methods (boiling, sprouting and roasting) were carried out. All the processed seeds were milled, labelled and taken to the laboratory for proximate and phyto-chemical analysis. Results of the study revealed that processing significantly influenced (P<0.05) all the proximate and anti-nutritional contents determined. Raw Leucaena leucocephala seeds contain 94.12 % dry matter, 4.46 % ash, 39.74 % crude protein, very low in crude fibre (6.89 %), 12.73 % ether extract, 30.31 % and nitrogen free extract. Boiling, 8.48 %, roasting, 8.32 % and sprouting, 8.25 %, significantly increased the fibre content of the seeds. Anti-nutritional factors were significantly (P<0.05) influenced by the processing methods. Raw seeds were found to contain high anti-nutritional factors (Phytate, 6.30 mg/ 100g and saponin, 8.56 mg/ 100g). Raw and roasted seeds had similar high content of tannin (raw, 4.25 mg/ 100g and roasted, 3.87 mg/ 100g). The roasted seeds were high in oxalate contents (11.34 mg/ 100 g). It was concluded that Leucaena leucocephala seeds should be improved by processing before being used as livestock feed.*

**Key words**: Proximate and anti- nutritional factors, processing methods, raw, toasted and boiled *Leucaena leucocephala* seeds.

INTRODUCTION

Nigeria possesses a great deal of vegetation that is adequate to produce animal feed. However, there is serious inadequacy of animal protein production in Nigeria, this is because of high cost of feed occasioned by the use of conventional feed stuff. Over a period of time, commercial poultry farmers have increased universally; however, the demand for animal protein is still far higher than the supply, hence, animal protein is expensive especially in developing countries. The high cost of animal protein has made it unaffordable for the average Nigerian man (Ani and Adiegwu, 2005). Feed and feeding represents 70 to 80 % of the total variable cost of monogastric feed. This is due to the usage of conventional feed stuffs (maize, groundnut cake and soya beans) which are in demand by man for food and industries. This has led to prolonged competition for feed ingredients between the poultry industry and the human population. Therefore, to reduce this problem, several researchers have recommended the use of nonconventional feedstuffs in poultry nutrition. There are many nonconventional feeds or agricultural by-products with substantial nutritional value and are inexpensively available in large quantities. Presently, only a small number are in use either due to lack of adequate nutritional information, for other purposes, or presence of some deleterious constituents like alkaloids, toxic amino acids, phenolic compounds, tannins, trypsin inhibitors, carcinogens and glucosinolates. Various sources of agricultural by products and their nutritional characteristics have been reviewed, this is because of high cost of feed occasioned by use of conventional feed stuff (Nuha *et al.,* 2010). However, there are limited information on the effect of different processing methods on proximate and ant-nutritional contents of *Leucaena leucocephala*. Therefore, this study is aimed at determining the effect of different processing methods on proximate and ant-nutritional contents of *Leucaena leucocephala.*

MATERIALS AND METHODS

Experimental site

The research work was conducted at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology, Bosso Campus, Minna, Niger State, Nigeria. Minna lies between latitude 90 28ʹ to 90 37ʹ N and longitude 60 23ʹ to 60 33ʹ E with annual rainfall of 1000 – 1500 mm and a temperature range of 280 – 30 0CThe mean annual rain fall varies from 1102.6 to 1361.7 mm (FUTMIN, 2018).

Sample collection and methods of processing

*Leucaena* *leucocephala* pods were harvested along the road side in Minna, Niger State. The pods were opened and the seeds were gathered and sorted to remove dirts and stones. The seeds were divided into batches and processed through the following methods: Roasting, Boiling and Sprouting:

Sprouting

The method of processing by Echendu *et al.* (2009) was used. Five kg of *Leucaena leucocephala* seeds was soaked for 24 hours and covered in a moist jute bag. They were moistened daily until they shot out. The sprouted seeds were packed and sun-dried to a moisture level of about 10 – 15 % .The sun-dried seeds were milled and labelled Sprouted Leucaena seed meal (SLSM). They were stored in a plastic air-tight container or leather to prevent it from getting spoilt from air and moisture until when required. The method of processing raw and sprouted seeds by Madubuike *et al*. (2003) could also be used. Five kg of legume seeds were cleaned by picking of dirt and washing with water then sun-dried to a moisture level of about 10 – 15 % the sun-dried seeds were milled and labeled Raw Leucaena seed meal (R-LSM).

Toasting

Five kg of Leucaena seed was roasted at 1000 C for 30 minutes using stove with iron pot mixed with sand as described by Sola-ojo *et al*. (2013). During toasting, the seeds were stirred continuously to ensure uniform toasting and to prevent burning until they turned brown. The toasted seeds were then spread out to cool after which they were milled using a hammer mill with sieve size of 3 mm and labelled Toasted Leucaena seed meal (TLSM).

Boiling

Another five kg of Leucaena seed was subjected to boiling at 1000 C for 15- 30 minutes as described by Ahamefule *et al*. (2008) after which water was drained off by means of a 10 mm sieve and the boiled seeds were sun -dried. The seeds were then milled using hammer mill and then sieved with a 3mm sieve size and labeled Boiled Leucaena seed meal (BLSM).

All the samples were stored in a plastic air-tight container to prevent them from getting spoilt from air and moisture until when required.

All the processed samples were subjected to laboratory analysis in triplicate to determine the proximate, energy and anti-nutrient contents according to the method of AOAC (2006), at the Animal Science Laboratory, Federal University of Technology, Minna, Niger State, Nigeria.

Data Analysis

Data generated were subjected to Analysis of variance (ANOVA) using the general linear model of statistical analysis system, Version 9.3 (SAS). Significance was accepted at P <0.05.

RESULTS AND DISCUSSION

The proximate and energy values result of differently processed *Leucaena leucocephala* seeds meal is presented in Table 1. All the parameters measured were influenced (P<0.05). Raw *Leucaena leucocephala* seeds meal had higher (P<0.05) dry matter, ash, crude protein, ether extract and energy. The toasted seed meal had higher (P<0.05) dry matter, ash, crude fibre, ether extract and energy when compared with the other treatment. Sprouted *Leucaena* seed meal treatment had lower (P<0.05) dry matter, ether extract and energy among all the treatment and control. Raw legumes are reported to have higher nutritional contents when compared to most treated ones Seena *et al.* (2005) in wild legume; Adekojo *et al.* (2014) in *Leucaena* leaves meal. This is because treatments alter some of the nutrients in the legumes. The dry matter value of 92.44 % observed in this study was lower than 93.50 % dry matter as reported by Michael *et al.,* (2019) in their study on *Jatropha curcas* seed meals. They were, however, significantly different (P<0.05). The crude protein contents ranged between 30.62 – 39.74 %, the crude protein value of 35.23 % boiled seeds in this study was higher than 34.82 % as reported by Wafar *et al*. (2018) in boiled *Kapok* seed meals, while the crude protein value of 39.74 % in raw seeds observed in this study was higher than 37.69 % as reported by Ogbemudia *et al.* (2017) on mineral and proximate composition of soya bean seeds. The crude protein value of 30.62 % in toasted seeds observed in this study was similar 30.46 % as reported by Michael *et al.* (2019) in toasted *Jatropha curcas* seed meals. The ether extract value of 6.89 % in toasted seeds observed in this study was similar to 6.75 % as reported by Michael *et al.* (2019) in toasted *Jatropha* seed meals. They were, however, all significantly different (P<0.05) from one another.

Results on the effects of processing on the anti- nutritional factors of *Leucaena leucocephala* seeds are presented on Table 2. The results revealed that all the parameters measured were influenced (P<0.05) by processing. Phytate, tannin and saponin contents were highest (P<0.05) in the raw *Leucaena leucocephala* seeds. While boiled treatment led to higher (P<0.005) reduction of phytate (32.06 %), tannin (62.97 %) and saponin when compared with the raw. The sprouted treated method was next to the boiled processing method. Toasting had the least reduction method. Oxalate contents were highest (P<0.05) in the toasted seeds, with a higher (P<0.005) in sprouted seeds. There was no (P>0.05) difference in the tannin contents of the toasted *Leucaena leucocephala* seed meal when compared to the raw. However, the higher percentage reduction of all parameters observed in boiling in this study confirms with the reports of Saulawa *et al*. (2014) and McEwan *et al*. (2014) who reported that boiling method was very effective in reducing anti-nutrients in baobab (*Adansonia digitata)* and Amadumbe (*colocasia esculenta*), respectively when compared to other processing methods. The apparent decrease in the content of phytates during boiling may be partly due to heat hydrolysis or leaching into the boiling medium or by the formation of insoluble complexes between phytates and other components such as phytate-proteins and phytate-protein-mineral complexes has reported by Mohammed *et al*. (2011). Reduction of phytate is expected to enhance the bioavailability of proteins and dietary minerals of the seeds. All the anti- nutrient parameters observed in this study for raw seeds differ from what was reported by Poonam and Pushpa (2009) who observed that low tannin content of 1.2 %. The variations could be due to reasons reported by Ann and Neema (1982) that species may vary not only in composition of nutrient but in type and amount of toxins based on location.

CONCLUSION

Results from this study revealed that the proximate and phytochemical compositions of raw and differently processed *Leucaena leucocephala* seeds differ significantly (P<0.05). The processed seeds were found to contain higher contents of crude fibre (boiled). The anti-nutrients were significantly reduced with processing, raw *leucaena* had higher anti-nutritional content. Among the treated, the boiling method had the highest anti-nutrition reduction.

Table 1: Proximate composition of *Leucaena leucocephala*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Analysis | RLSM | BLSM | SLSM | TLSM | SEM | P-Value |
| Dry matter | 94.12a | 86.19c | 79.32d | 88.44b | 2.004 | 0.001 |
| Ash | 4.46a | 3.49d | 3.61c | 4.11b | 0.147 | 0.001 |
| Crude Protein | 39.74a | 35.23b | 31.52c | 30.62d | 1.36 | 0.001 |
| Crude Fibre | 6.89c | 8.48a | 8.25b | 8.32b | 0.241 | 0.001 |
| Ether Extract | 12.73a | 10.61c | 8.91d | 12.44b | 0.581 | 0.001 |
| Nitro. Free Extract | 30.31b | 28.38c | 27.02d | 32.96a | 0.844 | 0.001 |
| Energy | 3.95a | 3.50c | 3.14d | 3.66b | 10.99 | 0.001 |

\*All values are means of triplicate determinations expressed in dry weight basis, a,b,c,d=means with different superscripts on the same row are significantly different (P<0.05), RLSM – Raw Leucaena seed meal, BLSM – Boiled Leucaena seed meal, SLSM- Sprouted Leucaena seed meal, TLSM- Toasted Leucaena seed meal. SEM=Standard error mean, P=Probability value.

Table 2. Antinutritional composition of *Leucaena leucocephala*

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Treatment | RLS | BLSM | SLSM | TLSM | SEM | P-Value |
|  | Phytate | 6.30a | 2.39d | 3.91c | 5.62b | 0.58 | 0.001 |
|  | Saponin | 8.56a | 3.17d | 4.18c | 7.31b | 0.83 | 0.001 |
|  | Tannin | 4.25a | 1.24c | 2.54b | 3.87a | 0.45 | 0.001 |
|  | Oxalate | 8.45c | 9.65b | 7.84d | 11.34a | 0.51 | 0.001 |

\*All values are means of triplicate determinations expressed in dry weight basis, a,b,c,d=means with different superscripts on the same row are significantly different (P<0.05), RLSM – Raw Leucaena seed meal, BLSM – Boiled Leucaena seed meal, SLSM- Sprouted Leucaena seed meal, TLSM- Toasted Leucaena seed meal. SEM=Standard error mean, P=Probability value.

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## PERFORMANCE OF ARBOR ACRE BROILER CHICKENS FED DIET ENRICHED WITH VARYING LEVELS OF NANO ZINC SUPPLEMENTATION AT FINISHER PHASE

Sa’aci, Z. A. 1, Alabi, O. J. 1, Jiya, E. Z. 1 and Ijaiya, A. T. 1

1Department of Animal Production, Federal University of Technology, Minna, Nigeria.

[mohammedsaaciz@gmail.com](mailto:mohammedsaaciz@gmail.com) 09133016602

ABSTRACT

*Three weeks feeding trial was conducted to determine the effect of nano zinc supplementation on growth performance and nutrients digestibility of broiler chickens aged four weeks. Three hundred and twenty Arbor Acre broiler chicks were randomly distributed into sixteen treatments with four replicates consisting of five birds per replicates in a completely randomized design on 4×4 factorial combinations. Birds were reared on deep litter and fed basal diets supplemented with varying levels of nano zinc for 21 days. Data obtained were analyzed using Statistical Package for Social Science (SPSS version 16.0). Results showed that total feed intake and daily feed intake were significantly (P<0.05) influenced amongst the growth parameters and CP, CF and Ash digestibility were improved. Based on growth and nutrient digestibility performance;dietary supplementation of nano zinc at 30 mg/kg NZn supplemented diet improved feed efficiency and nutrients digestibility of broiler chickens without negative effect on their growth performance and therefore, recommending that farmers can use nano zinc as a source of feed additive to boost birds’ growth performance.*

**Keywords:** Nano Zinc, Supplementation, Growth, Nutrient digestibility and Broiler chickens

INTRODUCTION

Micro minerals are very essential in poultry nutrition for optimal productive performance (Haiam *et al*., 2020). Zinc (Zn) is required for the normal functioning of the animal body, it plays crucial role as cofactor of more than 300 enzymes, structural and regulatory functions in antioxidant and immune system, nucleic acid synthesis, cell proliferation, protein synthesis, protein and carbohydrate metabolism, and enzymatic activities in the living system (Fayiz *et al*., 2021). National Research Council (1994) recommended 30 mg of Zn/kg for broiler chickens; this might not be adequate to support maximum performance as reported by Du *et al*. (2007). Recently, the indiscriminate used of zinc in the diets for optimal productivity, causing public concern due to environmental pollution exerted by minerals excretion. With the emergence of nanotechnology, nano zinc can be incorporated in a nano form as a feed supplement to improve the efficiency of trace minerals in broiler chickens (Geetha *et al*., 2020).

The nano-sized particles have higher potential than the conventional with very high surface area to volume ratio enables nanoparticles to be effective in very small amounts and absorbable more quickly than inorganic and organic minerals (Sawosz *et al*., 2009). The aim of this experiment was to evaluate the influence of dietary nano zinc oxide supplementation on growth performance and nutrients digestibility of finished Arbor Acre broiler chickens.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria.

Source of materials

The feed ingredients maize and soybean were purchased from Gidan Matasa and step by step Agro store, Western bypass, Minna. Zinc nitrate Zn(NO3)2, Sodium hydroxide (NaOH), were bought from Pan lac laboratory equipment and chemicals store, Keteren gwari, Minna. The Africa scent leave (*Ocimun gratissimum*) was sourced from olericulture garden FUT, Minna. All other reagents and equipment used were obtained from the Step ‘B’ Drug and Vaccine Discovery Laboratory, Bosso Campus, Federal University of Technology, Minna. The green synthesis of nano zinc wascarried out at the abovelaboratory in line with the method described by Jay and Shafkat (2018). Experimental diet was formulated in line with nutrients requirement recommended for finisher broiler chickens (NRC, 1994), as shown in Table 1 below.

Experimental animals, management and design

Broiler chicks were sourced from Yammfy Farm hatchery, Ilemona, Kwara state. Three hundred and twenty (320), day old broiler chicks of Arbor Acre strain were randomly assigned to (4 x 4) factorial arrangements in a completely randomized design having 16 treatments with five birds per replicate. Birds were reared on deep litter and all management’s practices suggested for broiler production were strictly observed.

Data collection and statistical analysis

Data collected on growth performance and nutrients digestibility were subjected to 4×4 factorial design using General Linear Model (GLM) procedure of the Statistical Package for Social Science (SPSS version 16.0). Significant means variations were separated using Duncan multiple range test of the same package

Table 1: Ingredients composition of the experimental diets (as fed)

|  |  |
| --- | --- |
| Ingredients % | Finisher phase |
| Maize | 55.00 |
| Soybean cake | 26.00 |
| Fish meal | 3.00 |
| Wheat offal | 11.00 |
| Palm oil | 1.00 |
| Limestone powder | 1.00 |
| Bone meal | 2.00 |
| Salt | 0.25 |
| Lysine | 0.25 |
| Methionine | 0.25 |
| Premix | 0.25 |
| Total weight (kg) | 100.00 |
| Calculated analysis |  |
| Crude protein (%) | 20.00 |
| Crude fibre (%) | 5.53 |
| Ether extract (%) | 5.55 |
| Ca (%) | 1.11 |
| Avail P (%) | 0.58 |
| ME (kcal/kg) | 3000.00 |

Premix supplied per Kg of diet: Vit. A, 2.5iu;Vit D3, 0.5iu; Vit E, 0.0057mg; Vit. K, 0.0005mg; Vit, B1, 0.00045mg; Vit B2, 0,0013mg; pantothenic acid, 0.0018mg; Vit. B12, 0.000005mg; Folic acid, 0.00018mg; Biotin, 0.000015mg; Choline chloride, 0.075mg; Cobalt, 0.00005mg; Copper, 0.00075mg; Iodine, 0.00025mg; Iron, 0.0025mg; Manganese, 0.01mg; Selenium, 0.00005mg; Zinc, 0.0075mg; Antioxidant, 0.00031mg

RESULTS AND DISCUSSION

Table 2 revealed that all parameters measured were not significantly (P>0.05) affected by the test ingredient except total feed consumed and daily feed consumed. Results indicated that birds fed 20 mg/kg NZn supplemented diet had higher total and daily feed intake than their counterparts. This might be due to variation in the dietary levels of nano zinc supplementation. The present study agreed with the observation of Zhao *et al*. (2014) reported improvement in the feed intake of broiler chickens fed diets supplemented with zinc oxide nanoparticles. Table 3 Showed that crude protein, crude fibre and ash digestibility contents were significantly (P<0.05) influenced by nano zinc supplementation. Generally, ZN aids digestive enzymes that catalyzed the breaking down of protein in the digestive tract. Results indicated that CP and CF in birds on 30 mg/kg NZn supplemented diet had higher (P<0.05) values than those from 20 mg/kg NZn supplemented diet. This might mean 30 mg/kg impact higher protein digestibility. This could be the reason Kumar *et al*. (2021) observed low level of the CP in the faecal output of birds fed NZn when compared to other treatments.

Table 2: Effect of dietary nano zinc oxide supplementation on growth performance of arbor acre broiler chickens (28 - 49 d)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Levels of nano zinc  (mg/kg) | Initial body weight (g/b) | Final body weight (g/b) | Total weight gain (g/b) | Daily body weight gain (g/b) | Total feed consumed (g/b) | Daily feed consumed  (g/b) | FCR |
| 20 | 970.93 | 2199.62 | 1228.72 | 58.50 | 2621.84a | 124.85a | 2.18 |
| 30 | 968.86 | 2208.18 | 1239.21 | 59.01 | 2460.91d | 117.19d | 2.01 |
| 40 | 969.56 | 2172.65 | 1203.19 | 57.28 | 2507.32c | 119.39c | 2.13 |
| 50 | 980.76 | 2188.60 | 1207.83 | 57.51 | 2518.46b | 119.92b | 2.11 |
| SEM | 11.49 | 54.42 | 55.32 | 1.86 | 5.21 | 0.17 | 0.06 |
| P-value | 0.70 | 0.92 | 0.90 | 0.90 | 0.01 | 0.01 | 0.59 |

abcd = means in the same column with vary superscript differs significantly (P<0.05).

Table 3: Effect of dietary nano zinc oxide supplementation on nutrients digestibility of arbor acre broiler chickens (28 - 49 d)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Levels of nano zinc  (mg/kg) | CP  (%) | DM  (%) | CF  (%) | EE  (%) | ASH  (%) | NFE  (%) |
| 20 | 80.06b | 86.84 | 76.98b | 81.66 | 78.92ab | 79.68 |
| 30 | 86.23a | 85.50 | 83.79a | 83.06 | 81.20ab | 84.94 |
| 40 | 83.87ab | 89.70 | 80.68ab | 84.41 | 77.14b | 82.99 |
| 50 | 84.81ab | 88.77 | 81.34ab | 83.09 | 81.84a | 85.11 |
| SEM | 1.56 | 1.70 | 1.62 | 1.95 | 1.38 | 1.86 |
| P-value | 0.03 | 0.31 | 0.04 | 0.80 | 0.04 | 0.16 |

ab = means in the same column with vary superscript differs significantly (P<0.05).

DM = dry matter, CF = crude fibre, CP = crude protein, EE = ether extract and NFE = Nitrogen Free Extract.

SEM = standard error of mean

P –value = probability levels

mg = milligram and Kg = kilogram % = percentage

The current study concord with Saleh *et al*. (2012) indicated improvement in crude fibre and crude protein digestibility of broiler chickens fed diets supplemented with zinc (0, 20, 40, 60 and 90 mg/kg). Ash demonstrated that birds on 50 mg/kg NZn supplemented diet had higher (P<0.05) ash digestibility values than those from 40 mg/kg NZn supplemented diet. This agreed with the observation of Saleh *et al*. (2012) who reported enhanced ash utilization in broiler chickens from dietary supplementation of zinc oxide.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results obtained from the present study, it was evidenced that dietary supplementation of NZn to Arbor acre broiler chickens influenced total and daily feed intake. Crude protein and fibre digestibility were also affected by the dietary treatments. For improve performance and digestibility 30 mg/kg of NZn is recommended for Arbor acre broiler chickens.

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## ASSESSMENT OF MATING PROFILE OF RED SOKOTO BUCKS ADMINISTERED VARYING DOSAGE OF ETHANOLIC EXTRACT OF TIGER NUT (*Cyperus esculentus*)

Sakpe. Y. Y1, Adama. J. Y.2, Kudu. Y.S2, Usman. A.2

National Agricultural Extension Research and Liason Services/ A.B.U Zaria1

Federal University of Technology, Minna2

ABSTRACT

*Tiger nut (Cyperus esculentus) is consumed by humans and livestock. It also has many medicinal uses such as aphrodisiac properties. There is an incidence of sexual incompetence, erectile dysfunction, premature ejaculation and reduced libido on the rise. . Hence, this study seeks to asses or evaluates the effect of ethanolic extract of tiger nut on mating traits or profiles of red Sokoto bucks. Consequently, the effect of ethanolic extract of tiger nut on mating profiles to determine the sexual performance efficiency in male Red Sokoto bucks were investigated. Nine (9) healthy red Sokoto bucks were divided in to three treatments of three bucks per treatment in a complete randomized design. The bucks were treated with ethanolic extract of tiger nut (EETN) at 0ml, 5ml and 10ml respectively for a period of 90 days (12wks). After which the bucks were allowed to mate with the does for the observation of sexual traits by introducing number of equivalents does (n=18). The mating parameters either decreased or increased in a EETN dose dependent manner; without traces of weaknesses or reduced penile reflexes and a higher significance function (p<0.05) was observed in group C. In conclusion EETN has a strong lasting potential on mating profile in male goats (buck) can be used as a fertility booster*

**Keywords**: *Cyperus* esculentus, Bucks, Aphrodisiac, libido, Erectile dysfunction.

INTRODUCTION

Herbal therapy remains a very vital aspect in the day-to-day treatment or management of sexual disorder and as such plants with aphrodisiac properties are being utilized in the management of this sexual scourge and to improve sex lives in traditional folklore (Prakash *et* *al*., 2015). Male sexual behavior consists of a complex pattern of genital responses, which when initiated, is maintained, and directed by signals and within and outside the body (Abedi *et* *al*., 2014). The complex patterns include mating and premating behavour that allows the male to trace and mate, and asses her potential mating choice thereby stimulating a receptive reaction (Abedi *e* t *al.,* 2014). Mating abnormality is characterized by a range of sexual problems, which pose a serious health challenge being that a significant number of men are affected with the estimated value cutting across the globe (Prakash *et* *al*., 2015). Problems of sexual dysfunction and poor libido are on increase due to environmental pollution, lifestyle and nature of works Anderson (2018). In a mature buck, response to sexuality begins with a very hot sexual desire to erection, sniffing, bleating, then to orgasm and ejaculation (Prakash *et* *al.,* 2015). Thus, the ability to formulate a safe herbal therapy to combat this rising menace, which usually causes erectile dysfunction, will help in alleviating the plight of the victims. Tiger nut have been used over time to treat different ailments relating to infertility, low sperm count and poor libido in man and animals (Prakash *et* *al*., 2015, Adama *et* *al*., 2020). Thus, we attempt to research on something that can be used faster and with less financial implications compared to the orthodox medicine. Mating profile differs across species ranges from lower animals to the very large mammals. Series of parameters are investigated in the build–up to assessing mating behavioural changes in animals and man. Mount latency, mount frequency, intromission frequency, ejaculatory latency, post-ejaculatory interval, ejaculation frequency , intromission latency , inter –intromission interval and sometimes intromission ration have been reported (Obiandu *et* *al*., 2018). *Cyperus* *esculentus*, have been reported to stimulate male and female sexual performances. Cyperus esculentus ( family Cyperecae) known as( “aya” in Hausa; “efa” Nupe;” “ofio” in Yoruba and Tiger nut in English and is cultivated in the hot and dry climatic regions of Africa as a potentials food sources( Sharma *et* *al*., 2010).

MATERIALS AND METHOD

The study was carried out at National Agricultural Extension Research and liaison Services, North central Zonal office, Baddegi, Niger state from April to June 2021. The state falls within the northern guinea savanna zone of Nigeria and is about 430m above the sea level. It is located between latitude 90 31’ and 90 42’ North and longitudes 60 29’and 60 41’ East of equator. Niger state has two distinct climates, the dry season from (November to March). And the rainy season from (April – October) with mean annual rain fall between 1,000mm to 1,500 mm, with an average highest temperature in the month of March and lowest temperature in the month of August. The mean annual temperature is between, 21 to 36.50c. The relative humidity observed in the state varied from 15-65% - 26.39% (NASDP, 2020).

**Collection** **of** **plant** **materials**: Fresh tiger nut (*Cyperus esculentus*) were purchased from Kure Ultra –modern market, Minna, Niger state, Nigeria. The fresh tiger nut were screened and washed to remove sand and debris , sun dried and pulverized in to fine powder using pestle and mortar in line with ( Ekalou *et* *al*.,2015). The tiger nut powder was soaked in 85% ethanol solution for 48 hours, mixed every 6 hours and then filtered using the muslin cloth. The filtrate was evaporated using rotatory evaporator. This was also to remove excess alcohol from the extract before finally kept in refrigerator for use throughout the experiment.

Source and Management of Experimental Animals:

Nine (9) red Sokoto bucks within the age range of 5-6 months were used for this study. The does were purchased from within Niger state principallyfrom goat market at Izom. The goats were allowed to acclimatize for a period of two (2) weeks.. During acclimatization, the goats were administered with Ivomectin®; a broad spectrum anti-parasitic drug, to remove both ecto and endo parasites.  Broad spectrum anti-biotic (20 % Oxyteracycline manufactured by Heibei huarun pharmacy co Ltd, china), Penstrep (manufactured by Kepro, Holland), and some other drugs were administered when necessary to keep the animals in good health. Feed and water were provided ad libitum.

Experimental Design and Procedure

The nine (9) bucks were randomly divided in to four treatments in a completely randomized design. The animals were allowed to acclimatize for the period of two weeks before the commencement of the research. The bucks in control and treatment groups were treated with 0ml, 5ml and 10ml of tiger nut extract per kilogram body weight thrice (3) in a week respectively through oral gavage throughout the experiment. .After 4week ( 30 days) of experiment , mount latency, mount frequency , intromission frequency, ejaculatory latency , post –ejaculatory interval, ejaculation frequency , intromission latency, inter-intromission interval were keenly observed after introducing (does). Adienbo *et* *al*., (2013) method for determining sexual characteristics in animals were adopted for mating profile in this present study.

**Data analysis.**

Data collected were subjected to the analysis of Variance (ANOVA) Using SAS statistical package (SAS, 2006). Duncan Multiple Range Test was employed to separate the treatment means.

RESULTS

Results of Mating Profile of Red Sokoto Bucks Administered Varying Dosage of Ethanolic Extract of Tiger Nut (*Cyperus* *esculentus*) is here presented in Table 1. Administration of ethanolic extract of tiger nut (EETN) for a periods of 90days had a significant effects (p<0.05) in ML, IL, PEI, EL, EF, MF and III compared to the control

Table 1: Mating profiles in bucks administered varying dosage of ethanolic extract of tiger nut for 90 days

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| PROFILE | CONTROL | 5mg | 10mg | SEM |
| Mount latency (ML) sec.  Mount frequency (MF)  Intromission latency (IL) sec.  Intromission frequency (IF)  Ejaculation latency (EL) sec.  Ejaculatory frequency (EF)  Post – ejaculatory interval (PEI) sec.  Inter – intromission interval (III) sec.  Intromission ratio (I/R) | 183.16 ± 0.2c  2.32 ± 0.9c  114.55 ± 4.1a  11.06 ± 0.5c  345.37 ± 3.1bc  1.75 ± 0.4c  295.62 ± 2.3c  34.58 ± 0.2bc  2.70 ± 0.3c | 406.15 ± 0.2b  3.71 ± 0.3b  224.80 ± 2.7b  31.93 ± 0.6b  434.90 ± 3.7ab  2.75 ± 0.4b  385.50 ± 1.1ab  43.19 ± 0.6ab  3.79 ± 0.5b | 791.27 ± 0.3a  5.89 ± 0.3a  322.23 ± 1.1a  42.02 ± 0.4a  541.22 ± 2.1a  3.05 ± 0.9a  485.12 ± 1.3a  54.11 ± 2.2a  4.05 ± 0.1a | 0.34  0.23  0.25  0.26  0.42  0.31  1.23  0.32  0.27 |

abc means within a row having with different superscripts differed significantly (p<0.05).

DISCUSSION

In this study, we defined each parameter for a mating profile to enable the understanding of the terms that constitutes sexual traits in bucks (Atoigwe *et* *al*. 2015). The mount latency (ML) is the interval from the introduction of does to the first mount. Mount frequency (MF) showed the number of mounts prior to an ejaculation while inter-intromission interval (III) is the average intromission between succeeding intromissions. These observations were significantly demonstrated by the ethanolic extract of tiger nut especially on the 30 day of administration as compared to the control (1-3). This proofs that ethanolic extract of tiger nut has aphrodisiacs potentials (Ekaluo, *et* *al*., 2015), which emphasized the need for reduced time of ML, IL, PEI, and III as an indication of power, potency , improved sex drive and vigour in sexuality. These findings support the claim in which reduced ML, IL, PEI, and III were observed to be a reflection of sexual inspiration in animals (Fourche *et* *al*., 2015).

This also support the findings of Atoigwe *et* *al*., (2015) who opined that Garcina kola seed caused a highly significant( p< 0.01) increase in MF, EL, IF, and IR and that a rise indicates that Garcina kola is capable of causing improved sexuality in treated bucks.. This finding is further buttressed by the report of Fouche *et* *al*. (2015) who stated that MF is an important measure of both libido and potency and as such an elevated value is indicative of a sustained increase in sexual stimulus or activities and aphrodisiac property in a plant. While there is an affirmation that elevated MF is believed to be an important index of sexual stimulus ,efficacy of erection and coordination(Prakash *et* *al* ., 2015) while intromission frequency (IF) observed as the number of vaginal penetration until there is a discharge, which differs from intromission latency (IL) that relates to the recorded time from when a does is introduced in to the investigation pen to the first vaginal penetration (Atoigwe *et* *al* .,2019).

A delayed penetration is an indication of poor sexual performance, viability and reduced libido. This findings revealed a dosages dependent in intromission frequency (IF) from the ethanolic extract and a reduction in IL in a similar manner as reported by Atoigwe *et* *al*. (2015). This research agrees with an earlier report by Atoigwe *et* *al*. (2015) who opined that medicinal crops with possible potentials to improve sexual arousal, sexual stimulus ought to result in a significant increase in IF and decrease IL, which are both indicative of aphrodisiac activities. This agrees with Sharma et al., (2010) who reported that a significant rise in the sum of intromission frequency (IF) is an indication of erectile efficiencies ,penile positioning and the perfect manner at which ejaculatory reflexes are coordinated after activation. The improvement observed in sex drive, sexual ability, vigour, strength and erectile viability was further corroborated by increase intromission ration (I/R) across all the treatment groups compared to control. This supported the findings of Allouh *et* *al*., (2015) who defined the intromission ration as the extent of successful vaginal penetration, which is calculated as intromission frequency (IF)/ (mount frequency +intromission frequency). However, the degree of efficiency or improvement is best shown in treatment two (2) and three (3) as compared to treatment 1(control).

The intensity of sexual libido increases along line of doses which agrees with Adama *et* *al*., (2020) who lamented that this increasement in sexual urge appetite was as a result of administered extract. Other parameters like ejaculatory frequency (EF), which is the number of discharges observed from the period of mount to a specified time frame (40 minutes). Ejaculatory latency (EL) being the time between the first intromission and the first discharge. Post ejaculatory interval (PEI) as the time between a discharge following the vaginal penetration. Anderson (2011) argued that the ability to engage in the act of sexual performance depend on the erectile function thus it can be observed that erectile dysfunction, affect the entire sex life even when there is a very strong sexual urge. The above research reveals adequate penile erection and penetration was more pronounced in bucks in treatment two and three but significantly higher (p<0.05) in treatment three which agrees with Adama *et* *al*. (2020 ); in which erection was observed in all the treated rabbits (2020) in a doses dependent manners.

CONCLUSION

In conclusion, this study shows that ethanolic extract of tiger nut (EETN) has a potential for the reactivation of sexual dysfunction in a dosage dependent manners. EETN can be used as a fertility booster and in attenuating sperm

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## APPARENT NUTRIENT DIGESTIBILITY AND PERFORMANCE OF GROWER PIGS FED ENERGY AGRO BY-PRODUCTS

Iwegbu, A; Moseri, H; Onwumelu, I. J and Irikefe-Ekeke, E.P

\*Department of Animal Production, Dennis Osadebay University, Asaba, Delta State, Nigeria.

\* Department of Agricultural Education, University of Delta, Agbor, Delta State, Nigeria.

Correspondent author:Iwegbu, A.; Department of Animal Production, Dennis Osadebay University, Asaba, Delta State (iwegbuabraham89@gmail.com) 08034996299.

ABSTRACT

*A six-week feeding trial was conducted to determine the visible nutrient digestibility and performance of grower pigs fed energy agro by-products. The dietary energy agro by-products used were; maize as control, palm kernel meal (PKM), brewer’s dried grain (BDG) and wheat offal (WO) at 44% levels of replacement respectively. Thirty-two (32) cross bred grower pigs (Large white x Landrace) were randomly allocated to four (4) treatments diets (1, 2, 3 and 4) in a complete randomized design (CRD). Each treatment group contained four grower pigs of two (2) males and females grower pigs replicate twice making a total of eight pigs per treatment. Feed and water were supplied as ad libitum. Nutrient digestibility was significantly (p˂0.05) affected, while performance characteristics such as weekly weight gain and average weight gain per pig were also significantly (P<0.05) influenced by the treatments with pkm (5kg) having highest mean value compared to 4.4kg, 4.1kg and 4.4kg for treatments 1, 3 and 4 respectively. Feed intake (FI) and feed conversion ratio were not significantly (P>0.05) influenced by dietary treatments, with mean values ranged between 24.4kg in the brewer’s dried grain diet to 30.2kg in palm kernel meal diet. In conclusion, the results above revealed that the experimental animals fed palm kernel meal treatment diet comparatively perform better than other dietary treatments is therefore recommended as an agro energy by-product in grower pigs diet.*

**Keywords:** Grower pigs, digestibility, performance, feed

INTRODUCTION

Livestock production constitutes an important component of the agricultural economy in developing countries and it is an instrument of socio-economic change, increase income and improve quality of rural life (Igene et al., 2013). Igene (2022) noted that among the multiple role of livestock industry, food production and gainful employment are the most important. He further observed that in over 12 million in West Africa, of whom over 2 million are in Nigeria, depend on livestock and livestock related enterprises for their livelihood. The role of monogastric food animals; swine and poultry in particular, has increased animal potential in Sub-Sahara Africa cannot be overemphasized (Amaefule et al., 2009). Philip (2012) observed that animal proteins from pig and poultry have become major source of protein and are consumed by over 70% globally. The growth and development of the industry has tremendously evolved from backyard business to commercially based industry (Igene and Oboh, 2006). Globally, the piggery and poultry industry are characterized by relative faster growth in consumption and trade volume than many other agricultural livestock subsectors (Esonu et al., 2001). In African countries to be precise Nigeria, nutrition is one of the major bottlenecks to the survival and satisfactory productivity of man. Igene (2022) stated that nutrition supply for any type of external and internal use which involves the ingestion, digestion, transportation, absorption and assimilation of various nutrients and their movements to all body cells and removal of unusable materials and waste products of metabolism. To address the problems associated with feeding and compilation, the use of conventional feed must be de-emphasized (Kim et al., 2011). One of the ways of tackling this issue is by adopting the use of agro by-products in feeding approaches. Very many agricultural by-products exist around the globe particularly in Nigeria which can be well harnessed in pig feeding (production). The focus of this research is utilization of these non-conventional agro by-products of brewer’s dried grain (BDG), palm kernel meal (PKM), and wheat offal (WO) as alternative to conventional maize in grower pigs’ diets.

MATERIALS AND METHODS

Experimental Site, Ingredients and Duration

The experiment was conducted at the Piggery Unit of the Teaching and Research Farm of the Faculty of Agriculture, Ambrose Alli University, Ekpoma in Esan West Local Government Area of Edo State, Nigeria. The farm is located in the tropical savanna rainforest vegetation belt, with Longitude 6.44oC North and 6.08oC East with mean ambient temperature of about 29oC and relative humidity of about 76%. All the feed (experimental) ingredients were purchased at Animal Feed Shops in Benin City, Edo State. The experiment lasted for a period of six weeks.

Management of Experimental Animals and Design

Thirty-two (32) grower pigs crossbred Large white, and Landrace mixed with (males and females), an average weight of 20.8kg were used for the experiment. They were divided into four (4) groups based on their average initial weight, were allocated to four treatment diets (1,2,3 and 4), each treatment group had eight (8) grower pigs of two (2) males and females replicated four (4) in a complete randomized design (CRD). Sanitary hygienic conditions were kept throughout the experimental period and the grower pigs were allowed for five days acclimatization period before the commencement of the feeding trial. Animals were fed twice daily (morning and evening) while water was supplied as required throughout the experimental period. Routine vaccination, medication and other management practices were observed.

Diet Formulation

The experimental diets were formulated with maize (control), were palm kernel meal (PKM), brewer’s dried grain (BDG) and wheat offal (WO) replaced maize. Diet 1, served as the control contained maize while diets 2, 3 and 4 had palm kernel meal, brewer’s dried grain and wheat offal to replace maize at 44% across the treatments as source of energy on weight equalization basis as shown in Table 1.

Data Collection and Analysis

The initial weights of the experimental animals (grower pigs) were taken at the beginning of the experiment and subsequently at weekly intervals throughout the duration of the feeding trial. Parameters that were assessed included initial weight (kg), average weekly feed intake (kg), average weekly weight gain (kg) and feed conversion ratio. Data were subjected to a one-way analysis of variance (ANOVA) and means were compared using Duncan’s Multiple Range Test (1955) as described by Steel and Torrie (1990).

Table 1: Composition of experimental diets

|  |
| --- |
| **Ingredients % Diet 1 Diet 2 Diet 3 Diet 4**  Maize PKM BDG WO |
| Maize (control) 44.0 0 0 0  Palm Kernel Meal (PKM) 0 44.0 0 0  Brewer’ Dried Grain (BDG) 0 0 44.0 0  Wheat Offal (WO) 0 0 0 44.0  Cassava 30.6 30.6 30.6 30.6  Groundnut Cake (GNC) 20.0 20.0 20.0 20.0  Blood Meal 3.5 3.5 3.5 3.5  Bone Meal 2.0 2.0 2.0 2.0  Vit/Min Premix 0.25 0.25 0.25 0.25  Lysine 0.15 0.15 0.15 0.15  Methionine 0.15 0.15 0.15 0.15  Salt 0.25 0.25 0.25 0.25 |
| **Total 100 100 100 100**  **Calculated:**  **Crude Protein (%) 21.69 22.97 22.39 21.55**  **Energy (Kcal/kg) 3002.24 2852.24 2878.07 2789.59** |

RESULTS AND DISCUSSION

Table 2: Performance of Grower Pigs Fed Agro By-Products

|  |
| --- |
| **Parameters Dietary Treatments**  **1 2 3 4**  **Maize (Control) PKM BDG WO SEM** |
| Ave. initial weight (kg) 20.0 21.4 20.6 20.4  Ave. final wt/pig (kg) 47.4b 51.6a 45.0b 47.2b  1.56  Ave. weekly feed intake (kg) 14.03 14.30 14.03 13.01 0.59  Ave. total wt gain/pig (kg) 26.6ab  30.0a  24.4b  26.8ab  0.75  Ave. weekly wt gain/pig (kg) 4.4ab  5.0a 4.1b  4.4ab  0.78  Ave. feeds conversion ratio (kg) 3.30 2.90 3.40 3.20 0.28  Mortality % 0.00 0.00 0.00 0.00 |
| abc: means in the same row with different superscripts are significantly (P<0.05) different.  The results shown on Table 2, revealed that the final weight gain was significantly (P<0.05) higher in palm kernel meal diet compared to other diets. This could be as a result of the presence of oil in the by-products which have enhanced the amount of calories in the PKM as supported by Olomu (1995) and De Lange (et al., 2010). The total weight gain was also highest in the PKM compared to the maize controlled diet. There were comparable values for average total weight of the experimental animals in treatments 1 and 4 while treatment 3 was least with a value of 24.4 kg. This result is agreement with the findings of Igene and Oboh (2006) and comparably to the findings of De La Liata et al. (2011). Indices on this result did not show any significant (P>0.05) difference on the feed conversion ratio though the value in diet 2 revealed that it is more technically advisable to adopt PKM.  Table 3: Nutrient Digestibility of Grower Pigs Fed Different Energy Based Agro By-Products   |  | | --- | | **Parameters Dietary Treatments**  **1 2 3 4**  **Maize (Control) PKM BDG WO SEM** | | Dry matter % 79.41cb  81.01c 82.11b 83.41a  0.31  Crude Protein % 80.43b 88.61a 74.34c 81.00b 1.21  Crude Fibre % 64.00bc 74.41a 63.44c 65.01b 1.43  Ether Extract % 82.51b 83.33a 82.00b 82.84b 1.31  Ash % 48.88b 53.41a 47.33b 48.11b 0.61  NFE % 89.14a 85.46b 81.34c 88.91a 1.43 | |

abc: means in the same row with different superscripts are significantly (P<0.05) different.

There were significant (P<0.05) differences on the apparent nutrients digestibility trials. Dry matter digestibility was highest in wheat offal compared to the control. Crude protein digestibility was significantly (P<0.05) highest in PKM diet and was followed by comparable values of 81.00 and 80.43 % in treatments 4 and 1 respectively. Other digestible nutrients assayed showed significant (P<0.05) effects across the treatments diets. Ether extract, crude fibre and ash were revealed to be highest in dietary treatment 2 with PKM. The results of this research was supported by the findings of Igene and Oboh (2006) and Awojobi et al., (2011) but differ on the report of Olomu (1995) and Wenk (2001) who reported none significant (P>0.05) difference on dry matter ash digestibilities.

CONCLUSION

The results above revealed that palm kernel meal (PKM) could be used to wholly replace maize which has been in use conventionally as energy product in grower pig diet.

RECOMMENDATIONS

Small farm holders and millers should be encouraged and educated on the use of PKM.

PKM should be investigated as alternative to maize in the growth and digestibility performance of weaners, fatteners and breeder pigs.

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## FREE RADICAL SCAVENGING ACTIVITY OF SELIM POD (*Xylopia aethiopica*)

Aliyu, M.1, Akande, K.E.1 and Egwim, E.C.2

1Department of Animal Production, School of Agriculture and Agricultural Technology,

Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria.

2Department of Biochemistry, School of Life Sciences,

Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria

\*Corresponding Author’s Email: [mijindadialiyu@gmail.com](mailto:aliyumijindadi@gmail.com)

ABSTRACT

*This study was carried out to determine the antioxidant activity of the selim pod (Xylopia aethiopica). Extracts of Xylopia aethiopica pods were investigated for their free radical scavenging activities in the presence of 2, 2-diphenyl-1-picrylhydrazyl (DPPH), using ascorbic acid as the standard antioxidant. The result revealed that with an increase in the concentrations of the selim pod extract from 0.2 to 1.0 mg/ml, the free radical scavenging activity of the selim pod extracts also increased from 16.04 to 48.17%. The DPPH free radical scavenging activity of the selim pod is observed to be dose-dependent. The antioxidant activity of the extract of Xylopia aethiopica was examined and the results were compared to that of ascorbic acid which served as the standard. The percentage inhibition of ascorbic acid (vitamin C) at the concentration of 1mg/ml was 97.05% meanwhile that of selim pod at the same concentration, the inhibition recorded was 48.17%. Although the free radical scavenging activity is lower than that of ascorbic acid, notwithstanding, the result suggests that Xylopia aethiopica has potential antioxidant properties which could be exploited as a natural antioxidant for use in animal nutrition and the food industry.*

**Keywords**: Scavenging activity; *Xylopia aethiopica*; phytochemicals; antioxidants

INTRODUCTION

Selim pod (*Xylopia aethiopica*) is a medicinal plant growing in various parts of Africa (Yin *et al.,* 2019) It is sometimes referred to as Negro pepper and Guinea pepper, and is one of the most valuable spices with numerous health benefits (Yin *et al*., 2019). *Xylopia aethiopica* is a spice that is used in flavouring local dishes and the pods are sold as condiments. It is a medicinal plant that has been utilized traditionally in the treatment of several diseases and ailments (Yin *et al*., 2019).

*Xylopia aethiopica* is a rich source of phytochemicals and possesses free radical scavenging abilities, it could, therefore, be utilized in the management of free radical-related degenerative diseases by exploiting them as natural antioxidants in food systems (Okechukwu-Ezike and Oly-Alawuba, 2020). John-Dewole *et al*. (2012) from their in vitro studies with the extracts of selim, reported that it exhibited some anti-microbial and pharmacological properties which might be due to the presence of phytochemicals in the plant.

According to Melo *et al*. (2021), *Xylopia aethiopica* contains phenolics and essential oils which might be linked with the remarkable antioxidant, antimicrobial, and moderate anti-SARS-CoV-1 and SAR-CoV-2 activities. *Xylopia aethiopica* has been reported to have antimicrobial and free radical scavenging activity and this could be associated with the presence of polyphenols in the plant (Apenteng *et al*., 2016). Literature is scarce on the antioxidant potential of Nigerian *Xylopia aethiopica* to the best of the authors' knowledge.

This research study was therefore conducted to evaluate the antioxidant activity of selim pod (*Xylopia aethiopica*) to determine its potential for possible application in animal nutrition.

MATERIAL AND METHODS

Sample extract preparation

Accurately 1g of the grounded selim pod was weighed into a conical flask. Then 100ml of ethanol was then added to the weighed samples. The samples were extracted using a digital 4 holes water bath (Model: E-Track England) at 70 degrees for 40 minutes, then later cooled at room temperature and transferred into a 100ml volumetric flask. The samples were filtered using a Whatman filter paper No. 1.

Assay of DPPH Free Radical Scavenging Activity

The DPPH radical scavenging activity of the selim pod extracts was examined in line with the procedure described by Mukherjee *et al*. (2011) with slight modifications. The concentration of 100 *µ*M of DPPH was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to check the IC50. The values of IC50 signify the concentration of the sample, which is required to scavenge 50% of DPPH free radicals. The IC50 values were calculated by linear regression of plots. The contents were mixed and incubated for 30 minutes at 37°C. To determine the absorbance at 517 nm, a UV spectrophotometer was used. Vitamin C (ascorbic acid) was used as the standard control antioxidant. All readings were taken in triplicate and the mean values were then recorded. The decrease in absorbance indicated increased radical scavenging activity. The percentage inhibition of the samples at the different doses was calculated using the formula;

% Inhibition = Ao – As x 100

Ao

Where Ao is the absorbance of the control and Asisthe absorbance of the test sample (selim pod)

RESULTS AND DISCUSSION

The results revealed that with an increase in the concentrations of the selim pod extract from 0.2 to 1.0 mg/ml, the free radical scavenging activity of *Xylopia aethiopica* extracts also increased from 16.04 to 48.17% (Figure 1)

The DPPH free radical scavenging activity of the selim pod is observed to be dose-dependent. The antioxidant activity of the extract of *Xylopia aethiopica* was examined and the results were compared to that of ascorbic acid which served as the standard. The percentage inhibition of ascorbic acid (vitamin C) the antioxidant used as standard, at the concentration of 1mg/ml was 97.05% meanwhile that of the selim pod at the same concentration the inhibition recorded was 48.17% (Figure 1).

The IC50 value recorded for *Xylopia aethiopica* was 0.94mg/ml against the IC50 value of 0.44mg/ml of ascorbic acid. However, contrary to the result obtained in this study for the IC50 for *Xylopia aethiopica*, Ngwoke *et al.* (2015) reported a lower value of 0.62.mg/ml for acetone extracted *Xylopia aethiopica* and a much lower value of 0.28mg/ml for aqueous extracted *Xylopia aethiopica*. This variation may be due to differences in the method of extraction used for the test sample while other likely factors contributing to the disparity in result may be; cultivar type, climatic and soil conditions, storage and handling, etc.

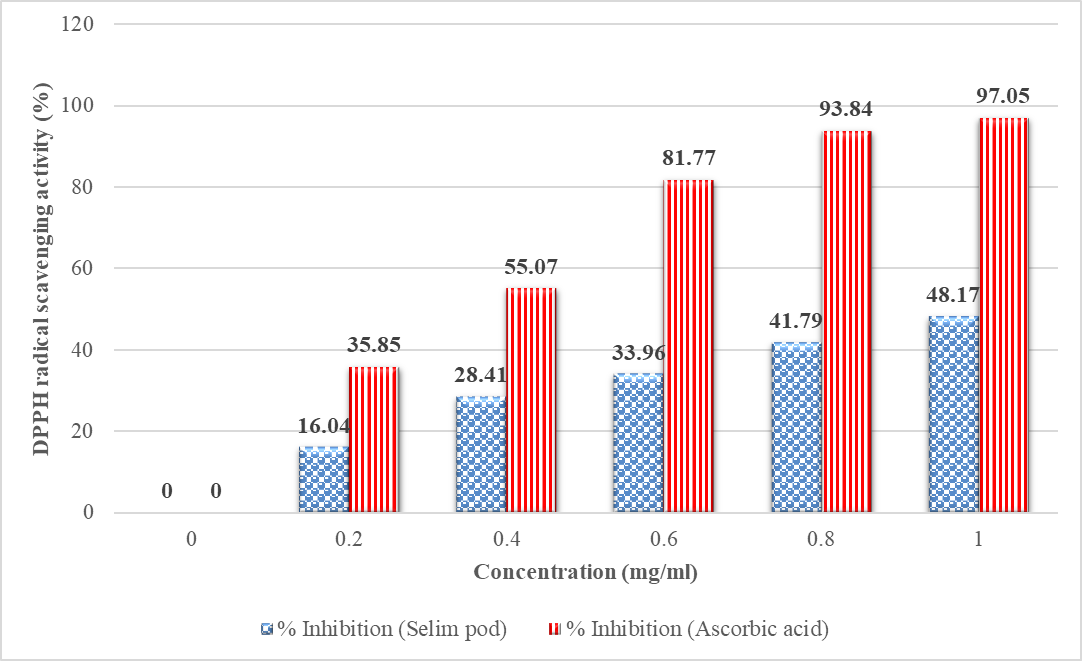


Figure 1: Antioxidant activity of selim pod(*Xylopia aethiopica*)

CONCLUSION

The findings of this study revealed that *Xylopia aethiopica* has antioxidant properties. Selim pod, therefore, has promising potential for use as an antioxidant agent in livestock feeds, food products, and the pharmaceutical industry.

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## ASSESSMENT OF DIFFERENT DOSES OF AQUEOUS RED HOT PEPPER EXTRACT ON THE GROWTH PERFORMANCE OF THREE BREEDS OF BROILER CHICKENS

O.E., Oche\*, S.S.A., Egena and O. J. Alabi

Department of Animal Production, Federal University of Technology Minna, Nigeria.

\*Corresponding author: mailochoche@gmail.com, 07036518296

ABSTRACT

*A four-week study was carried out to examine different doses of aqueous hot red pepper extract on the growth performance of three broiler breeds. A total of 216 Arbor acre, Ross 308 and Cobb 500-day old chicks were allotted into four treatments in a randomized complete block design using a 3 x 4 x 3 factorial arrangement. Treatment (T1) was the control without pepper extract; T2, T3, and T4 were the dosage level of 3, 3.5, and 4 mL, respectively. Parameters evaluated were mean final body weight, body weight gain, feed conversion ratio, daily feed intake, and daily weight gain. Results showed that they were all significantly (P< 0.05) affected. On the basis of breed effect, Cobb 500 performed better in the final weight gain, feed conversion ratio, final body weight, and daily weight gain when compared to Arbor acre and Ross 308. Based on level of inclusion, birds administered 3, and 3.5 mL were significantly (P>0.05) the same in terms of final body weight (1131.8g, 1165.3g); birds on 3 mL had the best feed conversion ratio (1.79) when compared to birds on the other dosage level. Breed x level interaction did not lead to any significant (P>0.05) effect on final body weight gain, total feed intake, final body weight, daily feed intake, and daily weight gain. It was concluded that, differing dosage of the aqueous extract improved productivity of the birds, which is related to the breed, and the level of inclusion.*

**Keywords:** Hot red pepper dosage, aqueous extract, growth performance, breeds and level.

INTRODUCTION

Poultry is one of the fastest growing segments of the agricultural sector in Nigeria today. In a bid to increase body weight gain, and feed efficiency, growth promoters are usually used as in-feed, or even in the water of birds. This growth promoters can be categorized as Antibiotic Growth Promoters (AGP) and Non–Antibiotic Growth Promoters (NAGP). AGPs in broiler chickens industry have been used to boost growth efficiency and feed conversion ratios (Miles *et al.,* 2006).

Red pepper is rich in vitamins C, E, and capsaicin (Lee *et al.,* 2010; Shahverdi *et al.,* 2013). Hot red peppers, also known as chili peppers, owe their “heat” to capsaicin (Al-Kassie *et* *al.,* 2011; Shahverdi *et al.,* 2013). Luqman and Razvi (2006) stated that capsicum was more active than vitamin E in inhibiting lipid peroxidation. Capsaicin can potentiate the activities of pancreatic and intestinal enzymes (Platel and Srinivasan, 2004), increase bile acid secretion (Abdel *et al.,* 2005), and increase body weight gain in broiler chickens (Puvača *et al.,* 2014, 2015). This active ingredient had been shown to have a defending purpose in the gastric mucosa as a stimulant of afferent nerve endings. Al-Kassie *et al.* (2012), explained that hot red pepper being rich in vitamin C, has a considerable impact in improving production through contributing to the reduction of heat stress.

Pepper has been used extensively as a growth promoter in broiler chickens production. It was used up to 2 mL in water by Abdulrasheed (2021) with great results in terms of final body weight but with a higher cost of producing 1 Kg of body weight gain. Reports on the evaluation of breed effect as it relates to the use of aqueous pepper extract is scarce. Hence, the aim of this study was to assess different dosage rates of aqueous red hot pepper extract on the growth performance of three breeds of broiler chickens

MATERIALS AND METHODS

The study which lasted for 28 days was conducted at the poultry section of the Department of Animal Production teaching and research farm, School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano Campus. Three different breeds of broiler chicks (Arbor acre, Ross 308, and Cobb 500) were used for the study. In total, 216 day old chicks were used for the experiment. On arrival, water containing Vitalyte® was administer to the birds, followed by brooding which lasted for two weeks.

A complete basal diet consisting of maize, maize bran, palm oil, and 30% broilers starter concentrate was formulated to supply 22% CP and 2850 Kcal/Kg Metabolizable Energy (ME) to the birds. The hot red pepper used for the work was purchased from Minna modern market. This was transported to the laboratory where it was washed, followed by blending which was done at a 1:1 ratio (1 Kg of pepper: 1 litre of water). The extract was collected after filtration using a muslin sheet and stored in a refrigerator to prevent spoilage until when required for use. The aqueous extract was administered via drinking water on a daily basis at a dosage rate of 0, 3, 3.5, and 4 mL, respectively in 4 litres of water. The day old chicks were allotted into the treatment groups and the design involve the use of a 3 x 4 x 3 factorial arrangement in a randomized completely block design (3 breeds, 4 levels of inclusion, and 3 replication of 18 birds per treatment.

Routine management practices were observed in rearing the birds. Parameters measured were: mean final body weight, body weight gain, feed conversion ratio, daily feed intake, and daily weight gain. All data obtained were subjected to a two-way analysis of variance using the General Linear Model procedure of the Statistical Package for Social Sciences (SPSS). The statistical model used for the experiment was;

Yij = µ + αi + βj + αβij + eijk

Where Yij is the observed response, µ is the overall mean, αi is the main effect (breed), βj is theeffect of the dosage rate, αβij is the effect of interaction between the breed and dosage rate, and eijk is therandom error effect.

RESULTS AND DISCUSSION

The main effect of treatment on the growth performance of three broilers breeds is presented in Table 1. The results revealed significant (P<0.05) main effect of treatment on final body weight, final body weight gain, daily body weight gain, and feed conversion ratio of the birds with Cobb 500 birds having the better performances (1258.60 g, 1222.60 g, 52.44 g, 1.66, respectively) compared to the Ross 308 and Arbor acre birds. The good performances observed for the birds following aqueous red hot pepper treatment is in agreement with previous findings (Al-Kassie *et al.,* 2011; Al-Kassie *et al.,* 2012; Shahverdi *et al.,* 2013 ) the authors reported that inclusion of hot red pepper in broiler chickens diet improved weight gain, feed intake and feed conversion ratio. No significant (P>0.05) main effect was observed for total and daily feed intake of the birds.

Based on dosage rate, significant (P>0.05) effect was observed for all the parameters evaluated, except for total and daily feed intake. Birds on 3 and 3.5 mL aqueous red hot pepper extract had better performances in final feed intake, total and daily body weight gain, while those on 3 mL had the best feed conversion ratio. El-Deek *et al.* (2012) observed that the body weight gain of broiler chicken was higher in birds whose diet was supplemented with hot red pepper at the level of 1.5 and 3 g/Kg of feed as compared to those on Oxytetracycline® and the control group. Wadasen (2012) observed the mean final weight gain of broiler chickens to be significantly higher in birds on diets supplemented with hot red pepper (0.5, 1.0, and 1.5 %) compared to the control group. The results of the current study seems to suggest a linear relationship between aqueous red hot pepper dosages with the performance indices as there’s improvement with increasing dosages compared to the control. Only the feed conversion ratio show breed x dosage rate interaction which is critical as it helps farmers in deciding the best combination of breed (Cobb 500) and dosage rate (3 mL) to be used for better performance.

Table 1: Growth performance of broiler chickens on different dosages of aqueous red hot pepper extract

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | IBW | FBW | FBWG | DWG | TFI | DFI | FCR |
| Main effect |  |  |  |  |  |  |  |
| Arbor acre | 33.85±0.40 | 1064.45c±32.14 | 1031.45c± 0.97 | 44.35c±1.24 | 2070.20±69.50 | 42.25±1.24 | 2.01c±0.04 |
| Ross 308 | 34.92±0.04 | 1086.38b±32.14 | 1051.38b±0.97 | 45.26b±1.24 | 2086.00±69. 85 | 42.46±1.24 | 1.98b±0.04 |
| Cobb 500 | 36.03±0.04 | 1258.60a±32.14 | 1222.60a±0.97 | 52.44a±1.34 | 2026.50±69. 85 | 45.46±1.24 | 1.66a±0.04 |
| LS | NS | ⁎ | ⁎ | ⁎ | NS | NS | \* |
|  |  |  |  |  |  |  |  |
| Dosage rate (mL) |  |  |  |  |  |  |  |
| 0 |  | 1051.b4±37.12 | 1016.57b±36.91 | 43. 81b±1.55 | 2220.70±69. 85 | 45.31±1.43 | 2.23c±0.04 |
| 3 |  | 1166.2a±37.12 | 1131. 8a±36.91 | 48.59a±1.55 | 2020.2±69. 85 | 41.23±1.43 | 1.79a±0.04 |
| 3.5 |  | 1200.4a±37.12 | 1165.3a±36.91 | 50.02a±1.55 | 2004.1±69. 85 | 44.98±1.43 | 1.90b±0.04 |
| 4 |  | 1127.7ab±37.12 | 1092.9ab±36.91 | 46.99ab±1.55 | 2066.2±69. 85 | 42.20±1.43 | 1.91b±0.04 |
| LS |  | ⁎ | ⁎ | ⁎ | NS | NS | ⁎ |
|  |  |  |  |  |  |  |  |
| Main x dosage rate interaction |  | NS | NS | NS | NS | NS | ⁎ |
| abc: means denoted by different superscripts are significantly different (P>0.05), IBW = initial body weight, FB = final body weight, FBWG = final body weight gain, DWG = daily weight gain, TFI = total feed intake, DFI = daily feed intake, FCR = feed conversion ratio, LS = level of significance, NS = not significant (P>0.05). | | | | | | | |

CONCLUSION

Inclusion of aqueous red hot pepper extract in drinking water influenced the performance of the broiler chickens with Cobb 500 being better. Dosage rate of 3 and 3.5 mL also led to better performances when compared to the control and are therefore, recommended to farmers.

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## **ANTIOXIDANT ACTIVITY OF SUN-DRIED TROPICAL LEMON (Citrus limon)** PEEL

Akande, K.E. 1 and Egwim, E.C. 2

1Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria.

2Department of Biochemistry, School of Life Sciences, Federal University of Technology, Minna, Niger State, Nigeria.

Corresponding Author’s Email: kemi777akande@gmail.com

ABSTRACT

The peels of lemon (Citrus limon) are the major by-products obtained during the processing of lemon and are most of the time discarded as food waste. Lemon peels have been reported to possess many bioactive substances with beneficial properties. These properties may probably have potential applications for use in agriculture, industry, aquaculture, medicine and food processing. This research was conducted to determine the antioxidant activity of lemon peels. The free radical used was 2, 2-diphenyl-1-picrylhydrazyl (DPPH), while ascorbic acid was used as the standard antioxidant for the analysis. The DPPH free radical scavenging activity of the lemon peel extracts increased from 6.29 to 53.32% with a corresponding increase in the concentrations of the peel extract from 0.2 to 1.0 mg/ml. The lemon peel extracts, therefore, exhibited DPPH free radical scavenging activity in a dose-dependent manner. The inhibition of ascorbic acid at the concentration of 1mg/ml was 98.65% while for the lemon peel at the same concentration the inhibition obtained was 53.32%. Lemon peels which are considered a waste product have been shown to possess some level of antioxidant activity. The half-maximal inhibitory concentration (IC50) is the value of the test sample that can scavenge 50% of DPPH free radical. The IC50 value recorded for the lemon peel was 0.93mg/ml as against the IC50 value of 0.41mg/ml of ascorbic acid. Lemon peels are by-products that may be used as a potential low-cost natural antioxidant source for human food and animal feed.

**Keywords**: lemon peel; scavenging activity; antioxidant; free radical; sun-drying

INTRODUCTION

Lemon (*Citrus limon*) is a typical citrus fruit. The plant is a potent source of vitamin C. The peels of lemon (*Citrus limon*) are the main by-products obtained during the processing of lemon fruit and are most of the time discarded as food waste. Lemon peel forms around 40–50% of the total fruit mass which is mostly considered a waste (Singh *et al.*, 2020). The peel of a lemon is made up of two distinct layers, the outer layer is called the flavedo (epicarp) while the inner layer of the peel (the white spongy part) is called the albedo (mesocarp). Nevertheless, lemon peels have been reported to demonstrate several bioactivities that are beneficial (Liu *et al.*, 2022). Lemon peels also contain pectin and fibre and can be useful as prebiotics (Jiang *et al.*, 2022).

Plants with free radical scavenging properties and antioxidant capacity are valuable for pharmaceutical, agricultural, and industrial applications and as food and feed additives. Research authors have employed many methods in processing lemon peel like; oven drying freeze drying, air drying/shade drying and microwave drying.

To the best of the authors' knowledge, literature is scarce on research work done on the antioxidant potential of sun-dried lemon peels. In the tropics, the sun-drying method may be advantageous, low-cost and a better option for processing lemon peels.

This research work aimed to evaluate the antioxidant activity of sun-dried lemon peels and to identify their potential for possible use as a food and feed additive.

MATERIALS AND METHODS

Processing of Test Sample

The lemon fruits were hand peeled and the peels were collected and cut into small pieces and sun-dried for 3 days. They were then grounded and packed in airtight polythene bags. The ground samples of the peels were taken for laboratory analysis for the determination of antioxidant activity.

Preparation of Sample Extract

The sample extract was prepared by weighing 1g of the dried sample into a conical flask. Then 100ml of ethanol was added to the weighed sample. The extraction of the sample was carried out by using a digital 4 holes water bath (Model: E-Track England) at 70 degrees for 40 minutes. This was then cooled at room temperature and transferred into a 100ml volumetric flask. Extracts were filtered using a Whatman filter paper (No. 1).

Free Radical Scavenging Assay

To determine the antioxidant activity of the extract, 2, 2-diphenyl-1-picrylhydrazyl (DPPH) was used as a free radical according to the method outlined by Mukherjee *et al*. (2011) with minor modifications. The concentration of 100 *µ*M of DPPH was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to check the IC50. In 96-well microplate total volume was 100 *µ*l which was consisting of 90 *µ*l of DPPH solution and 10 *µ*l of the test solution. Different concentrations (0.2, 0.4, 0.6, 0.8 and 1.0 mg/ml) of the extracts and ascorbic acid (the standard antioxidant) were used. The contents were mixed and incubated for 30 minutes at 37°C. To determine the absorbance at 517 nm, an ultraviolet (UV) spectrophotometer was used. The decrease in absorbance indicated increased radical scavenging activity which was determined by the following formula for DPPH:

AC= Absorbance of control

AS = Absorbance of sample

RESULT AND DISCUSSION

In this study, the DPPH free radical scavenging activity of the lemon peel extracts ranged from 6.29 to 53.32%. The antioxidant activity increased with the increasing concentrations of the peel extract from 0.2 to 1.0 mg/ml (Figure 1). The lemon peel extracts showed DPPH free radical scavenging activity in a dose-dependent manner.

The inhibition of ascorbic acid (the standard antioxidant used) at the concentration of 1mg/ml was 98.65% while for the lemon peel at the same concentration, the inhibition obtained was 53.32% (Figure 1). Abd El-ghfar *et al*. (2016) reported 52.64% free radical scavenging activity for dried lemon peel this value is close to the value obtained in this study.

In contrast to the value recorded in this study, Olyad *et al.* (2020) reported a much higher value of approximately 68% at the same concentration (1mg/ml). The differences in these results may be due to variations in cultivar, processing method and environmental factors. Other possible factors that may be responsible for variability in results generally are as follows; 1) different test models or assays used. 2) The composition of the lemon peel analysed, may be affected by the way the lemon is peeled, whether it was hand-peeled or knife peeled. This would affect the proportion of epicarp and mesocarp in the test sample. 3) Whether the lemon was ripe or not ripe before peeling. 4) The method of drying used. 5) The handling and storage conditions. 6) Growing conditions and soil fertility.

The IC50 which is the half-maximal inhibitory concentration that is the value of the test sample that can scavenge 50% of DPPH free radical. The value of IC50 is inversely proportional to the antioxidant activity of the sample that is, the lower the IC50 value the higher the scavenging activity.

The IC50 value recorded for the lemon peel was 0.93mg/ml against the IC50 value of 0.41mg/ml of ascorbic acid. These values are the concentration required to attain a 50% radical-scavenging effect.

According to Abd El-ghfar *et al.* (2016), the presence of natural flavonoids, phenolics, ascorbic acid and carotenoids is responsible for the antioxidant activity of lemon peels. As a result of the level of antioxidant activity exhibited by lemon peels, is it recommended for consideration as potential natural additives in food products and feeds to enhance the antioxidant activity and improve shelf-life.

Pieracci *et al.* (2022) in their experiment obtained 0.70mg/ml as the IC50 of lemon pulp waste while that of orange pulp waste was 0.81mg/ml. These values are lower than the values obtained for lemon peels in this study, probably because it was a pulp waste and not a peel waste, as there might be some difference in their composition although both are considered by-products of citrus fruits.

Figure 1: Free radical scavenging activity of sun-dried lemon peel

CONCLUSION

The sun-dried lemon peels used in this experiment are a cheap source of natural bioactive compounds with good antioxidant activities. This citrus by-product is not only cheap but considered safe and with health-promoting benefits, capable of protecting the cell against free radical damage. Also, the peels are natural by-products that can act as a good source of antioxidant for possible application in foods, drugs and feeds and may replace synthetic antioxidant derivatives.

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## EVALUATION OF *Syzygium aromaticum* (CLOVE BUD) AS A POTENTIAL SOURCE OF NATURAL ANTIOXIDANT

Danjuma, E., Akande, K.E. and Kudu, Y.S.

Department of Animal Production, School of Agriculture and Agricultural Technology,

Federal University of Technology, Minna, Niger State, Nigeria.

Corresponding Author's Email: danjumaezra124@gmail.com

ABSTRACT

Cloves are a group of aromatic plants that are used widely due to their positive effects on the growth and health of poultry, probably as a result of their immune-stimulatory properties. Clove (Syzygium aromaticum) has attracted attention due to its potent antioxidant activities standing out among other spices. The present study was carried out to determine the antioxidant activity of clove bud using ascorbic acid as standard and 2, 2-diphenyl-1-picrylhydrazyl (DPPH) as free radical. The DPPH inhibition activity was carried out using the standard method. The DPPH inhibition activity of the clove extract was observed to increase from 18.17% to 65.12% with increasing concentration of the clove extract from 0.2 to 1.0 mg/ml. The clove bud extract was observed to have DPPH inhibition activity and exhibited a dose-dependent trend. The IC50 value for the clove and ascorbic acid were 0.725 and 0.320 respectively. Clove bud has the potential to serve as a natural substitute for synthetic antioxidant feed additives.

**Keywords:** *Syzygium aromaticum*; natural antioxidant; feed additive; free radicals

INTRODUCTION

Spices are mostly used for seasoning and flavouring in food preparation. Clove is an ancient spice that is obtained from the scented dried flower bud from the clove tree. It is an invaluable multipurpose spice that possesses a strong spicy aroma (Hussain *et al*., 2017). The major bioactive volatile compound in clove bud is eugenol, this may one of the active substances in clove bud responsible for its antioxidant activity (Kamatou *et al.,* 2012; Gaspar *et al.,* 2018).

Clove bud is a good source of phenolic compounds such as eugenol, eugenol acetate, and gallic acid. The presence of these substances has been linked with their antimicrobial and antioxidant property (Cortés-Rojas *et al*., 2014).

There is a rising need for the replacement of synthetic antioxidants with natural sources that are easily available and safe. Therefore, the present research work was carried out to evaluate the antioxidant potential of the clove bud and the possibility of its inclusion as a natural food and feed additive.

MATERIALS AND METHODS

Source of Experimental Test Material

Clove bud (*Syzygium aromaticum*) was purchased from Kure ultra-modern market Minna, Niger state. The clove bud was sun-dried for three days and was thereafter ground to powder and stored in plastic containers.

Plant Extract Preparation

The extract preparation of the dried clove bud was carried out by weighing one gramme (1g) of the grounded sample into a conical flask. Afterwards, 100ml of ethanol was measured and then added to the weighed sample in the flask. Extraction was performed for 40 minutes with the use of a digital 4 holes water bath (Model: E-Track England) at 70 degrees. The resultant extract was allowed to cool at room temperature and then filtered using a Whatman filter paper (No. 1).

DPPH (2, 2-Diphenyl-1-Picrylhydrazyl) Radical Scavenging Assay

In this experiment, the free radical used to evaluate the antioxidant activity of clove bud was 2, 2-diphenyl-1-picrylhydrazyl (DPPH), in line with the procedure described by Mukherjee *et al*. (2011) with slight changes. 2, 2-diphenyl-1-picrylhydrazyl of 100 *µ*M concentration was dissolved in methanol to a final concentration of 0.03mM. Serial dilutions were made to determine the IC50. In 96-well microplate total volume was 100 *µ*l which was consisting of 90 *µ*l of DPPH solution and 10 *µ*l of the test solution. The contents were mixed and incubated for 30 minutes at 37°C. An ultraviolet spectrophotometer was used to determine the absorbance at 517 nm. Ascorbic acid was used as the standard antioxidant. All readings were taken in triplicate and the mean values were then recorded. A decrease in absorbance indicated increased radical scavenging activity which was determined by the following formula:

Ac = Absorbance of control

At = Absorbance of the test sample

RESULTS AND DISCUSSION

TheDPPH free radical scavenging activity of clove bud in the present study ranged from 19.65% to 67.23%. The inhibition activity of the clove bud against free radicals increased with increasing levels of its extract concentration from 0.2mg/ml to 1.0mg/ml. Implying that the inhibition activity of the clove bud was directly proportional to the level of its extract concentration. The anti-free radical activity was expressed as IC50 (mg/ml), which is defined as the extract concentration necessary to scavenge 50% DPPH free radicals (Selles *et al.,* 2020). The IC50 value of 0.725mg/ml was obtained for the clove bud extract, whereas that of ascorbic acid was 0.320mg/ml. These values are the concentrations needed to achieve a radical scavenging outcome of 50 per cent. The inhibition of DPPH was 67.23% at the concentration of 1.0mg/ml of clove bud extract, this value falls within the range reported by Ahmed (2016), although at a lower concentration.

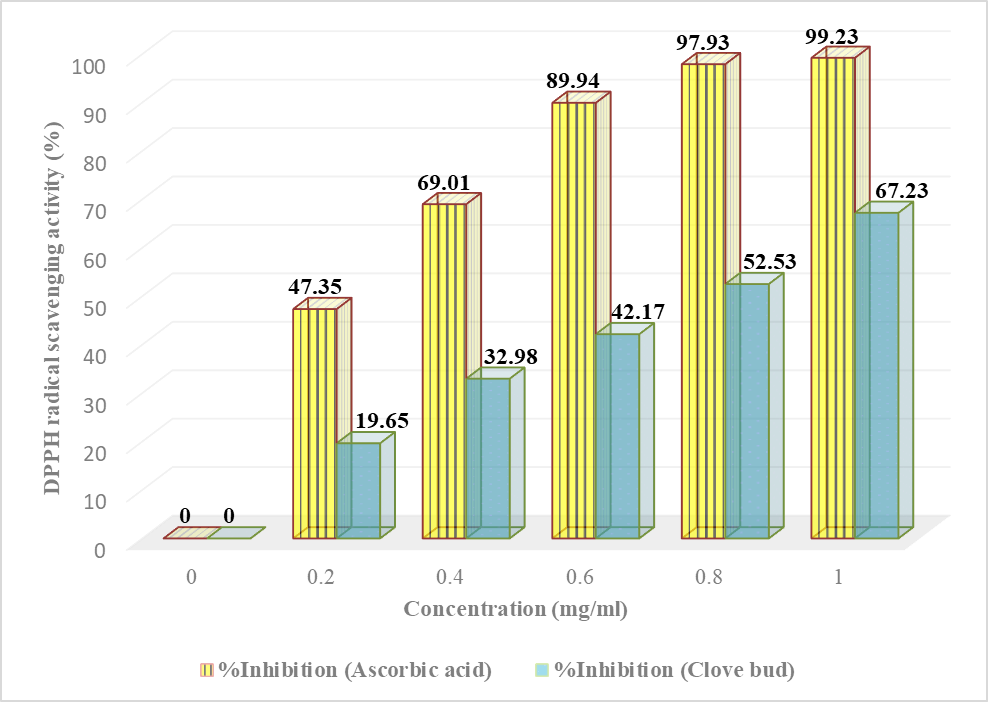


Figure 1: Clove bud antioxidant activity

CONCLUSION

The results obtained from the present study suggest that the clove bud possesses antioxidant activities and may therefore be used as a potent free radical scavenger and well as a natural preservative in food and feeds. *Syzygium aromaticum* (clove bud) may find a useful application in the management of oxidative stress-related health conditions probably in the future.

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## GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF RABBITS FED DIETS CONTAINING SHEA BUTTER CAKE FERMENTED WITH *Aspergillus niger*

\*Abu, M.H., Ajadi, A. O., Umar, N. O. and Jiya, E.Z.

Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State

\*Corresponding author: [matt4msp@gmail.com](mailto:matt4msp@gmail.com)

ABSTRACT

A study was carried out to evaluate the growth performance and nutrient digestibility of mixed breed weaned rabbits fed diets containing Shea butter cake fermented with Aspergillus niger. Thirty (30) rabbits of age 6 weeks were allocated to five dietary treatments. The control diet (T1) contained 0% fermented Shea butter cake, while T2, T3, T4 and T5 contained 5%,10%,15% and 20% fermented Shea butter cake. Each treatment had three (3) replicates in which two (2) rabbits were allocated per replicate in a completely randomized design. The study lasted for 8 weeks. The result of growth performance showed significant (p<0.05) differences in final body weight, total body weight gain, and average body weight gain. Results of nutrient digestibility also showed significant (p<0.05) difference in dry matter, crude protein, crude fiber, nitrogen free extract, and total digestible nutrients. It can be concluded that rabbits can tolerate and utilize up to 20% inclusion level of fermented Shea butter cake for efficient conversion to muscle, thereby increasing their live productive weight*.*

**Keywords:** Shea butter, diet, fermented, rabbits, growth, digestibility

DESCRIPTION OF PROBLEM

Animal protein intake has been reported to be dismally low in less developed countries (Denisova, 2015). Rabbits (*Oryctolagus cuniculus*) could be one of the preferred and sustainable means of producing high quality animal protein for the increasing population in countries like Nigeria and other parts of Africa. Raising rabbits is more advantageous because of their affordability, small body size, rapid growth rate, high fecundity, genetic diversity, short gestation period, adaptability to a wide range of ecological environment, ability to utilize forage and agricultural by-products (Okojie *et al*., 2004). Rabbit meat also contains high protein, low fat, low energy, and low cholesterol (Dalle zotte, 2000). Growing of rabbits is easy and has little or no religious barrier against the production and its consumption (Alemede *et al,* 2014).

The Shea tree (*Vitellaria paradoxa*) produces fruits which is cherished and eaten by humans and animals. The nuts are processed into Shea butter while the residue is known as the shea nut cake. It has been reported to contain 15.02 % CP, 26.00 % cellulose, 40 % acid detergent fibre and 29.30 % lignin (Belewu and Belewu, 2004). However, despite having good nutritional quality little research has been carried out on the utilization of Shea butter cake in growing rabbits. The presence of anti-nutritional factors like tannin and saponin could also prevent the availability of some nutrients like protein to the animal if not properly processed. As an agro-industrial by-product, Shea butter cake is a potential tropical feed resource but its optimum utilization by livestock (especially at high levels) has been hampered the presence of anti-nutritional factors (ANFs). This makes the cake unpalatable to livestock. The palatability of the cake could be improved through various processing methods such as fermentation which promotes the growth of microbes that helps break down anti-nutrients and enhance better utilization of desirable feed nutrients (Dei et al., 2007). Fermentation of crop residues using *Aspergillus niger* has been reported to enhance their nutritional quality through modification of their anti-nutritional factors (Hong *et al*., 2004; Aderemi and Nworgu, 2007; Dei *et al*., 2007).

However, despite the nutritional potentials of the shea nut cake, little information exists on its utilization by growing rabbits. Therefore, this study was undertaken to determine the growth performance and nutrient digestibility of rabbits fed diet containing Shea butter cake meal fermented with *Aspergillus niger.*

MATERIALS AND METHOD

Experimental site

This study was carried out at the Animal Production Teaching and Research Farm of the Federal University of Technology, Minna, Niger State in Nigeria. Minna is located between latitude 090 301 and 060 451 north and longitude 060 301 and 060 451 east of the equator. It falls within the southern guinea savanna agro-ecological zone of Nigeria. The mean rainfall varies from 1100 -1600 mm and mean temperature of between 210c and 350 (FMSN, 2015).

Source of Experimental Animals

A total of thirty (30) rabbits (mixed breed and sexes) were purchased from Ministry of Livestock Bosso, Minna, Niger State.

Source and Preparation of Test Ingredient

Shea butter cake was purchased from Bida, Niger State and *Aspergillus niger* was used as the fermenting agent. The *Aspergilus niger* that was used in this study is a laboratory strain isolate that was gotten from the Biochemistry Laboratory of Federal University of Technology Minna, Niger State. The sample was fermented for 7days inside a closed container to allow effective anaerobic fermentation, with effective turning to ensure proper mixture of the *Aspergillus niger* with Shea nut cake and also to enhance the fermentation process. This procedure was as stated by David *et al*. (2003). The fermented sample was spread on a dry clean concrete ground in an open place to dry for 5days up to about 90% of the dry matter.

Experimental diet and management of rabbit

A total of thirty rabbits (30) purchased at 6 weeks of age were weighed, and then randomly allotted to five treatment groups in a Completely Randomized Design (CRD). Each treatment had three replicate with two rabbits per replicate with a total of six rabbits per treatment. The rabbits were fed diet containing Shea butter cake fermented with *Aspergillus niger* at different inclusion level. The fermented Shea butter cake (SBC) was used to prepare four (4) different experimental diets except T1 **(**control diet**)** which had no inclusion level of the fermented Shea butter cake while T2 (5%), T3 (10%), T4 (15%) and T5 **(**20%) inclusion level of fermented Shea butter meal respectively. The diets were isocaloric (2900kcal/kg) and isonitrogenous (16% CP). Hutches were cleaned and equipped with feeders and drinkers prior to the arrival of the animals. The rabbits were allowed an acclimatization period of one week after purchase and were fed with commercial grower feed during this period. The rabbits were dewormed against ecto and endo-parasite before the start of the experiment.

Data Analysis

Data collected on all parameters were analyzed using one-way analysis of variance (SPSS, 2006). Where there were significant differences (P<0.05), Duncan test for multiple comparisons was used to separate the means.

RESULTS AND DISCUSSION

The proximate composition of diets containing shea butter cake fermented with *Aspergillus niger* is shown on table 1. The result indicated that T3 had the highest values for dry matter (94.60 %) while the lowest value was recorded at T5 (90.00 %). Crude protein content of the diets ranged from 15 % to 16 %.

T5 had the highest crude fibre (22.50 %) while T1 had the least crude fibre content (19.00 %). Ether extract content of the diets ranged from 7.50 % to 14.00 % with T4 having the most of these nutrients. The ash content of the diet was lowest at T1 (4.5 00 %) and highest at T3 (7.00 %). Nitrogen free extract (NFE) was most abundant in the control diet, T1 (43.25 %) while the least NFE values were recorded in T3 (38.60 %).

**Table 1: Proximate composition of diets containing shea butter cake fermented with *Aspergilus niger***

Parameter T1 T2 T3 T4 T5

Dry matter 90.00 90.20 91.20 94.60 90.60

Crude protein 15.75 15.75 16.10 16.10 16.10

Crude Fibre 19.00 20.00 20.00 21.50 22.50

Ether extract 7.50 7.50 9.50 14.00 12.50

Ash 4.50 6.50 7.00 6.00 5.50

NFE 43.25 40.45 38.60 37.00 34.00

T1: 0% Fermented shea butter cake inclusion, T2: 5% fermented shea butter cake inclusion, T3: 10% fermented shea butter cake inclusion, T4: 15% fermented shea butter cake inclusion, T5: 20% fermented shea butter cake inclusion SBC: Shea Butter Cake

Growth performance of the rabbits fed diets containing shea butter cake fermented with *Aspergilus niger* is shown on Table 2. The final body weight, total body weight gain, and average body weight gain were significantly (p<0.05) influenced by the dietary treatments. However, initial body weight, feed conversion ratio, average feed intake, protein efficiency ratio, and energy efficiency ratio were not significantly (p>0.05) influenced by the dietary treatment. Rabbits in T3 (10 % fermented Shea nut cake) had the highest (P<0.05) final body weight (1775 g) while the body weight values for other treatment groups were statistically similar.

The impressive body weight recorded in T3 could be as a result of the higher feed intake observed relative to other treatment groups. This improved feed intake may have promoted consumption of adequate quantity of nutrients in the feed which may have positively affected the rabbits in enhancing live weight Fermentation promotes the growth of microbes which partake in vital processes in the body of animals (Dei *et al*., 2007). The better weight gain in T3 (10 % fermented Shea nut cake) could also be due to the fact that sufficient amount of protein was supplied into the small intestine and this may have enhanced the level of microbial protein synthesis in gut leading to improvement in live weight. This also agrees with the findings of Belewu *et al*. (2003) who reported improved weights when fungus-treated crop residues were administered to goats.

The result on Table 3 shows that the nutrient digestibility of the rabbits were significant (P<0.05) in dry matter, crude protein, crude fibre, nitrogen free extract and total digestible nutrient. However, ether extract and ash were statistically similar (P> 0.05). The high digestibility of dry matter, crude protein and crude fibre in T5 (20 % fermented Shea butter cake) could be due to the fact that *Aspergillus niger* degraded the antinutritional factors in the diet before it was fed to the rabbits. This corroborates the findings of Jacquiline and Vesser (1991) who reported that structural modification of feed proteins enables degradation of antinutritional factors in the feed.

Table 2: Growth performances of rabbits fed diets containing shea butter cake meal fermented with *Aspergilus niger*

Parameters T1 T2 T3 T4 T5 SEM LOS

Initial body weight (g) 620.00 616.67 600.00 622.50 622.50 5.18 NS

Final body weight (g) 1592b 1417b 1775a  1492b 1525b 38.64 \*

Total weight gain (g) 971.67ab 800.00b 1148a 891.67b 915.00b 40.45 \*

Average weight gain/Wk 121.46ab 100.00b 143.54a 111.46b 114.38b 5.06 \*

Average feed intake/Wk 359.43 380.75 407.37 344.45 348.59 12.84 NS

Feed Conversion Ratio 2.96 3.89 2.85 3.09 3.07 0.17 NS

Protein Efficiency Ratio 16.93 13.62 17.61 16.40 16.31 0.64 NS

Energy Efficiency Ratio 0.93 0.74 0.96 0.89 0.88 0.35 NS

ab: means in the row with different superscript are significantly (p<0.05) different; SEM: Standard Error Mean; LOS: Level of Significance, \*Significant, NS: Not Significant, T1: 0% Fermented shea butter cake inclusion, T2: 5% fermented shea butter cake inclusion, T3: 10% fermented shea butter cake inclusion, T4: 15% fermented shea butter cake inclusion, T5: 20% fermented shea butter cake inclusion

Table 3: Nutrient digestibility of rabbits fed diet containing Shea butter cake fermented with

Aspergillus niger

Parameter T1 T2 T3 T4 T5 SEM LOS

Dry matter 81.67a 76.93a 75.46ab 72.85b 82.38a 1.31 \*

Crude protein 71.51a 71.98a 65.76ab 56.96b 73.23a 2.08 \*

Crude fibre 84.47ab 86.65a 78.26b 70.32c  87.04a 1.86 \*

Ether extract 83.89 88.78 86.89 75.72 90.28 2.95 NS

Ash 43.78 52.33 51.31 34.88 52.86 2.98 NS

NFE 87.83a 76.36c 80.36bc 80.64bc 85.51ab 1.28 \*

TDN 79.46ab 74.54b  75.83ab 77.98ab 85.84a 1.56 \*

abc :means in the row with different superscript are significantly(p<0.05)different; LOS: Level of Significance, \*Significant, NS: Not Significant,TDN: Total Digestible Nutrient; NFE: Nitrogen Free Extract; SBC: Shea Butter Cake, T1: 0% Fermented Shea butter cake inclusion,T2: 5% fermented Shea butter cake inclusion, T3:10% fermented Shea butter cake inclusion, T4: 15% fermented Shea butter cake inclusion, T5: 20% fermented Shea butter cake inclusion

CONCLUSIONS

Based on the study, it can be concluded that weaned rabbits can tolerate up to 20% inclusion of shea butter cake fermented with *Aspergillus niger* in their diets without extreme adverse effects on growth performance.

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## MEAT QUALITY CHARACTERISTICS OF WEANER RABBITS FED DIETS CONTAINING SHEA BUTTER CAKE FERMENTED WITH *Aspergillus niger*

**\*Abu, M.H., Arubuola, S. I. and Jiya, E.Z.,**

Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State

\*Corresponding author: [matt4msp@gmail.com](mailto:matt4msp@gmail.com)

ABSTRACT

*The study was conducted to evaluate the meat quality characteristics of weaner rabbits fed diet containing Shea butter cake fermented with Aspergillus niger. Thirty (30) rabbits of age 6 weeks were allocated to five dietary treatments. The control diet (T1) contained 0% fermented shea butter cake, while T2, T3, T4 and T5 contained 5%, 10%, 15% and 20% fermented shea butter cake. Each treatment had three (3) replicates with two (2) rabbits in each replicate allotted in a completely randomized design. The study lasted for 8 weeks. Determination of meat quality characteristics were carried out. The result showed variations in quality parameters across treatment groups. Cooking yield was significantly higher (P<0.05) in rabbits fed 20% fermented shea butter cake. There were significant differences (P<0.05) in juiciness, flavor, tenderness, overall acceptability, moisture and crude protein content in rabbits fed 15 % Shea butter cake fermented with Aspergillus niger (T3) compared with the control group (T1). Based on the findings of this study, it was concluded**that 15 % inclusion level of Shea butter fermented with Aspergillus niger give the best meat qualities characteristics in terms of juiciness, flavour, tenderness, crude protein content and overall acceptability.*

**Keywords:** Meat, Shea butter, diet, fermented, rabbits

DESCRIPTION OF PROBLEM

There is an increased interest in meat from other animal species, due to some reasons which includes quality of meat, ease of breeding, total meat production and availability of animal species. These sources of meat include fallow deer, horses, pigeon, ostrich, and rabbits (Poławska *et al*., 2013). Rabbit (*Oryctolagus cuniculus*) has been identified as a promising way of alleviating and bridging the massive gap in animal protein deficiency in Nigeria. They can produce about 20.80% protein levels (Biobaku and Oguntona, 1997) and about 47 kg of meat per doe yearly (Kalio *et al*., 2008). Rabbits maximally convert feed to meat and can use up to 30 % crude fiber as against 10 % by most poultry species due to the presence of caeca microbes which is absent in most non-ruminant species (Vantus *et al*., 2014). Nutrition is a key component of animal production system which controls several aspect of meat quality. Such qualities as meat tenderness, bright attractive colours, affordability and low fat have brought about different feed regimes (Kandepan *et al*., 2009).

Shea butter cake is a by-product of Shea butter industry extracted from Shea nut (*Vitellaria paradoxa*, Gaertner or *Butyrospermum parkii*, Kotschy). It is used internationally in the production of chocolate, sweets, baking fat and cosmetics. The cake contains some fibre, cellulose, lignin and acid detergent fibre (Dei *et al*., 2008). The high content of anti-nutritional factors such as tannins, saponins and hydrogen cyanide makes it unpalatable to animals and as well masking the nutrient content of the cake. The percentage of these tannins can be reduced by fermentation (Reddy and Pierson, 2004).The fermentation process can create conditions for the growth of microbes (*Bacillus, Corynebacterium, Klebsiella, Aspergillus, Psenicillium, Fusarium, and Candida*) that break down these tannins (Reddy and Pierson, 1994). The type of feed offered to animals during the rearing phase has a great influence on the quality of the final product. In rabbits, the influence of feed on meat quality characteristics can be affected by gender (sex) of rabbits (Trocino *et al*., 2018). Information on carcass characteristics of rabbis fed non-conventional feedstuff is therefore helpful for the effective utilization of rabbit meat. This study was therefore designed to evaluate the effect of sex on meat quality characteristics of weaner rabbits fed diet containing Shea butter cake fermented with *Aspergillus niger.*

MATERIALS AND METHODS

Experimental Site

This study was carried out at the Animal Production Teaching and Research Farm of the Federal University of Technology, Minna, Niger State in Nigeria. Minna is located between latitude 090 301 and 060 451 north and longitude 060 301 and 060 451 east of the equator. It falls within the southern guinea savanna agro-ecological zone of Nigeria. The mean rainfall varies from 1100 -1600 mm and mean temperature of between 210c and 350 (FMSN, 2015).

Source and Preparation of Experimental Materials

Thirty weaned (5 – 6 weeks old) rabbits weighing 600g were purchased from a rabbit farm in Minna metropolis, Niger state, Nigeria. Shea butter cake was collected from a dumping site around Bida area of Niger State. *Aspergillus niger* was used as the fermenting agent. The *Aspergillus niger* used in this study was a laboratory strain isolate obtained from the Biochemistry Laboratory of Federal University of Technology Minna, Niger State. The samples were fermented for 7 days inside a closed container to allow effective anaerobic fermentation. This was done following the protocol described by David *et al*. (2003). The fermented samples were spread on a polythene sheet in an open place and dried for a period of five days until a steady moisture content of 10 % was attained.

Management of Rabbits/Experimental Diets

Thirty rabbits were randomly allotted to five (5) dietary treatment groups in a completely randomized design (CRD). Each treatment had 3 replicates with 2 weaned rabbits per replicate. The rabbits were fed *ad-libitum* throughout the experimental period. Five diets were formulated and each contained Shea butter cake fermented with *Aspergillus* niger in varying proportions. T1 contained 0% inclusion of fermented Shea butter cake and T2 – T5 contained 5%, 10%, 15% and 20% of the fermented Shea butter cake respectively. The diets were formulated to contain a crude protein of 16% and a metabolizable energy of 2900kcal/kg.

Data Collection and Analysis

At the end of the growth studies, 2 rabbits were selected from each treatment for meat quality and sensory characteristics. The water holding capacity, meat pH, cooking loss, sensory evaluation and proximate composition of the meat samples were determined.All data collected were subjected to Analysis of Variance (ANOVA) using SAS (1998).

RESULTS AND DISCUSSION

There were some variations in quality parameters due to the effects of the experimental diets. Meat from rabbits in T1 (0% shea butter cake) had significantly (p<0.05) higher water holding capacity and cooking loss compared with other treatment groups. However, pH was higher at T1 while cooking yield was best in rabbits fed T5 diets (Table 1). The higher cooking loss observed at T1 could be due to the quality of the meat samples prior to cooking. This is in agreement with the findings of Fakolade (2007) who reported that cooking losses in meat depends largely on the quality of meat before cooking. In this study, there is a positive correlation between pH and colour of the meat. At T3 meat samples with the highest pH also showed higher values for colour. This could be that the colour of rabbit meat is positively correlated to its pH

Table 1: pH, WHC, CY and CL of rabbit fed shea butter cake fermented with *Aspergillus niger*

Parameters T1 T2 T3 T4 T5 SEM P-VAL

pH 7.11b  7.12b  7.20a 7.18a  7.11b 0.02 0.001

WHC 45.20a 43.10b  28.15e 36.65d 40.70c 0.23 0.001

CY 71.54e 80.02c  80.44b 75.96d 82.85a 0.07 0.001

CL 28.46a  19.98c  19.56d 24.05b 17.15e 0.07 0.001

abcd: means with different superscripts in the same column are significantly(p<0.05) different.

WHC: Water holding capacity, CY: Cooking yield, CL: Cooking loss T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Table 2: Sensory properties of rabbits fed shea butter cake fermented with *Aspergillus niger*

Parameter T1 T2 T3 T4 T5 SEM P-VALUE

Colour 6.81 6.40 6.37 6.87 6.56 1.02 0.14

Juiciness 6.90ab 6.08c 6.40bc 7.23a 6.46bc 1.17 0.01

Flavour 6.69ab 6.27b 6.56ab 6.88a 6.34ab 1.00 0.12

Tenderness 6.83ab 6.50ab 6.67ab 7.12a 6.46b 1.16 0.15

Overall acceptability 7.37a 6.67b 7.19ab 7.32a 6.98ab 1.07 0.05

abcd: means with different superscripts in the same column are significantly (p<0.05) different, SEM: Standard error of mean T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Table 3: Proximate composition of meat from the hind leg of rabbits fed shea butter cake fermented with *Aspergillus niger*

Parameters T1 T2 T3 T4 T5 SEM P-VALUE

Moisture 28.21b 30.30ab  33.57a 32.09a  32.09a 3.10 0.171

Crude Protein 31.50c  35.88b 35.35b  41.13a  28.73d 2.22 0.001

Ash 1.00a 0.50b  0.50b  1.00a 1.250a 0.68 0.002

Ether extract 25.00 25.00 26.00 26.00 25.75 2.02 0.901

abcd: means with different superscripts in the same column are significantly (p<0.05) different, CP: crude protein, EE: Ether extract, SEM: standard error of mean, SEM: Standard error of mean, T1= 0% fermented shea butter cake, T2 =5% fermented shea butter cake , T3=10% fermented shea butter cake, T4= 15 % fermented shea butter cake, T5=20% fermented shea butter cake

Results of the sensory properties of meat from rabbits fed different levels of shea butter cake fermented with *Aspergillus niger*is presented on Table 2. There were significant differences (P<0.05) in juiciness, flavour, tenderness and overall acceptability. However, the values for meat colour were statistically similar. Water holding capacity was highest at the T1 (45.20) and lowest at T3 (28.15). Also, cooking loss was highest at T1 (28.46) and lowest at T5 (17.15). Water holding capacity is often linked with juiciness in meats. Responses from the panelists in this study did not reflect this assertion. This may be attributed to the high cooking loss recorded at T1 which may have affected the juiciness of the meat

The proximate composition of meat from hind leg of the rabbits (Table 3) showed that moisture and crude protein were significantly (p<0.05) influenced by the diets. Moisture and crude protein were higher in rabbits fed fermented Shea butter cake (T2, T3, T4 and T5) compared with the control (T1). The high crude protein of the meat could be attributed to the activities of fermentation microbes in the feed. This corroborates earlier reports that fermentation which promotes the growth of microbes and enhance better utilization of desirable feed nutrients (Dei et al., 2007).

CONCLUSIONS

Based on the findings of this study, it was concludedthat raising rabbits with 15 % inclusion level of shea butter cake fermented with *Aspergillus niger* will give the best meat qualities characteristics. It is recommended that more research should be carried out to determine the economic profitability and health benefit of feeding rabbit on shea butter cake fermented with *Aspergillus niger*.

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## GROWTH PERFORMANCE AND CORRELATION MATRIX OF SAVANNA BROWN GOATS FED ENZYME TREATED SAWDUST DIETS AS REPLACEMENT FOR MAIZE OFFAL

Ogbiko, A., Tsado, D. N., Alabi, O. J. and Adama, T. Z.

Department of Animal Production, School of Agriculture and Agricultural Technology,

Federal University of Technology, P. M. B 65, Minna, Niger State, Nigeria.

Corresponding author:anthoniaogbiko@gmail.com: 07031940208

ABSTRACT

*This study was conducted to determine the growth performance and correlation matrix of Savanna Brown goats fed enzyme treated sawdust diets managed semi-intensively. A total of thirty (30) goats weighting between 5.8 and 7.3 kg were arranged in a completely randomized design. The animals were divided into five dietary treatments (T) groups with three replications. Treatment one (T1) comprises of animals fed 0 % enzyme treated sawdust diet while Treatment 2 (T2), Treatment 3 (T3), Treatment 4 (T4) and Treatment 5 (T5) comprises of animals fed diets containing 10, 20, 30 and 40 % enzyme treated sawdust diets respectively. Data on growth performance parameters and correlation matrix were measured. All data collected were analyzed using one way analysis of variance****.*** *No significant difference (p>0.05) was observed among the treatment groups in all growth performance parameters. However, chest girth was found to be most correlated to body weight (1.00) and this was observed in SBG fed 40 % enzyme treated sawdust diet. It was, therefore, concluded that enzyme treated sawdust can be used in the diets of Savanna Brown goats up to 40 % replacement for maize offal and chest girth can be used to predict the body weight of savanna brown goat.*

**Keywords:** sawdust diets, Savanna Brown goat, growth performance, correlation matrix

INTRODUCTION

The population of goats in Nigeria is about 53.8 million and they serves as sources of meat and milk for local consumptions as well as hides for export earnings. Ruminant animals feed mainly on forages such as crop residues and pastures obtained from rangelands (Anifowose *et al*., 2016). These forages are scarce, especially, during drought period resulting to malnourishment and reduce productivity in ruminant animals. The poor quality of feed resources in the tropics was reported by Leng (1990) who observed that ruminant feeding in the tropics and subtropics considerably depended on low-quality materials (i.e. grazing pastures and crop residues) and also, despite the adaptation of most of indigenous animals to the nutrient stress, it can be argued that these adaptation mechanisms are only often sufficient to balance nutrient requirements for maintenance. This leads to poor productive and reproductive performance of the animals. Supplementation with protein and energy diets is, therefore, common strategies often used in improving ruminant productivity. The supplementation strategies have ranged from aiming at improving intake of plant material with higher anti-nutritional factors (Dziba *et al*., 2007) and improving fibrous feed utilization (Leng, 1990). Sawdust is one of such fibrous feed resources.

Sawdust is a by-product of sawmill industries and is made up of cellulose, lignin and hemicellulose. Treatment of sawdust may assist in degrading lignin, cellulose and hemicellulose to usable materials that can be utilized by ruminant animal (Akinfemi and Ladipo, 2013).

Several researches have demonstrated the beneficial effects of supplementing ruminant diets with exogenous enzymes more specifically, exogenous fibrolytic enzymes in means of improving fiber digestibility and consequently, the efficiency of [**feed utilization**](https://ascidatabase.com/result.php?searchin=Keywords&cat=&ascicat=ALL&Submit=Search&keyword=feed+utilization) by ruminants in [***in-vitro***](https://ascidatabase.com/result.php?searchin=Keywords&cat=&ascicat=ALL&Submit=Search&keyword=in+vitro) ([Azzaz, 2009](https://scialert.net/fulltext/?doi=ajas.2015.85.99#7550_tr)) and *in-vivo* ([Arriola *et al*., 2011](https://scialert.net/fulltext/?doi=ajas.2015.85.99#1204807_ja)).

This experiment was, therefore, aimed at determining the effect of enzyme degraded sawdust-based diets on the growth performance and body linear measurement of Savanna Brown goats under semi-intensive management system.

MATERIALS AND METHODS

Location of the Study

The study was conducted at the Teaching and Research Farm of the Department of Animal Production, Federal University of Technology Minna, Nigeria. Minna is situated between latitude 9° 31 1 and 9o 45 1 North and longitude 7° 31 1 and 6 o 45 1 East, it has an altitude of 75 m above sea level and located in the Southern Guinea Savanna zone, with temperature range of 38 – 40 degree centigrade, the annual rainfall ranges from 1,200 to 1,300 mm and has two (2) seasons of wet from April to October and dry from November to March (Climatemp, 2019).

Experimental Animals, Management and Design

A total of 30 Savanna Brown goats were used in this study, they had weights ranging from 5.7 to 7.2 kg, and were sourced from within Minna. They were managed semi-intensively, concentrate diets were offered at 1.5 % body weight in the morning, between the hours of 7 and 9 am before they are allowed to go out for grazing from 9 am to 5 pm and 1.5 % of body weight of concentrates feed in the evening after grazing as recommended by Mamoon (2008). Fresh water was provided *ad libitum.*

The goats were randomly allotted to five dietary treatments with six goats per treatment and each treatment group were replicated thrice with two goats per replicate. Treatment 1is the control with 0 % inclusion of xylanase and cellulase enzymes treated sawdust meal, while, Treatments 2, 3, 4 and 5, contained 20, 30 and 40 % inclusion of xylanase and cellulase enzymes treated sawdust meals, respectively. Completely randomized design (CRD) was used for this experiment.

Data Collection

Initial live weights of the goats were taken at the commencement of the experiment while correlation matrix was calculated. Weekly mean live weights, feed intakes, were taken until termination of the experiment which lasted for four (4) months. Daily mean live weights and feed intakes were calculated from the weekly measurements. Feed conversion ratios and correlation matrix were also calculated.

Feed intake, Body weight and

Daily feed intake was measured by subtracting the leftover feed from the total feed given to the animals per head per day. Body weight (kg) was taken using weighing scale.

RESULTS AND DISCUSSION

The growth performance of Savanna Brown goats fed enzyme treated sawdust diets as replacement for maize offal managed semi-intensive system is presented in Table 1. The results showed no significant (p>0.05) difference in all parameters measured across all the treatment groups. This, however, disagrees with Salim *et al.* (2003) who observed significant difference in live weight gain when goats and sheep were given supplement diet under grazing condition. The results are also not in line with the report of Wahyuni *et al*. (2012) who observed that enzyme supplementation in the diets of goats result in higher average daily gain. The no significant difference observed in total feed intake and average feed intake in this experiment agrees with Wahyuni *et al*. (2012) who reported that enzyme supplementation did not affect dry matter intake, this could mean that the diet was accepted by the animals.

Table 2 shows the results of correlation matrix between body weight and body linear measurement of Savanna Brown goats fed enzyme treated sawdust based diets as replacement for maize offal managed under semi-intensive system. Positive and significant (p<0.01) correlations were observed between body weight and other body linear measurements. The highest correlation (1.00) was observed between body weight and chest girth in animals fed 40 % enzyme treated sawdust diets, these suggest a positive effect of treated sawdust in the diets and can be used to predict the live weight of Savanna Brown goats under semi-intensive management. This result disagrees with the report of Babale *et al*. (2015) who reported no significant correlation between body weight and chest girth when they replace corn cobs for maize bran with cowpea husk as basal diets to check the performance and linear body measurement of Red Sokoto male goats managed intensively. This might be because their study was done under intensive management. However, this result is in the line with the result of Dereje *et al.* (2013) who reported significant correlation between body weight and heart girth for both male and female Haraghe highland goats.

Table 1: Growth performance of Savanna Brown Goat fed Enzyme Treated Sawdust Based Diets as Replacement for Maize Offal Managed under Semi-intensive System

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameters (g) | T1 | T2 | T3 | T4 | T5 | SEM | p-value |
| Initial body weight | 7250.00 | 6500.00 | 6375.00 | 6500.00 | 5750.00 | 275.00 | 0.60 |
| Final body weight | 9475.00 | 10125.00 | 9825.00 | 9150.00 | 8500.00 | 296.40 | 0.50 |
| Total body weight gain | 2225.00 | 3625.00 | 3250.00 | 2650.00 | 2750.00 | 199.60 | 0.20 |
| Average daily weight gain | 22.70 | 36.99 | 33.16 | 27.04 | 28.06 | 2.04 | 0.20 |
| Average total feed intake | 2952.03 | 3089.63 | 3335.03 | 2978.65 | 3091.50 | 76.70 | 0.58 |
| Average daily feed intake | 210.86 | 220.69 | 238.22 | 212.76 | 220.82 | 5.48 | 0.58 |
| Feed conversion ratio | 11.41 | 6.34 | 7.29 | 8.56 | 8.04 | 0.74 | 0.26 |

**Keys**

T1 = 0 % Inclusion of enzyme-treated sawdust

T2 = 10 % Inclusion of enzyme-treated sawdust

T3 = 20 % Inclusion of enzyme-treated sawdust

T4 = 30 % Inclusion of enzyme-treated sawdust

T5 = 40 % Inclusion of enzyme-treated sawdust

SEM = Standard error of Mean

Table 2: Correlation Matrix of Savanna Brown Goat Fed Enzyme Treated Sawdust Based Diets as Replacement for Maize Offal Managed under Semi-intensive System

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| PARAMETERS | T1 | T2 | T3 | T4 | T5 |
| Body weight and Height at withers | 0.85\*\* | 0.95\*\* | 0.86\*\* | 0.91\*\* | 0.99\*\* |
| Body weight and Body length | 0.84\*\* | 0.91\*\* | 0.88\*\* | 0.93\*\* | 0.98\*\* |
| Body weight and Chest girth | 0.87\*\* | 0.91\*\* | 0.90\*\* | 0.92\*\* | 1.00\*\* |
| Body weight and Hind leg length | 0.87\*\* | 0.93\*\* | 0.90\*\* | 0.94\*\* | 0.99\*\* |
| Body weight and Fore leg length | 0.88\*\* | 0.93\*\* | 0.90\*\* | 0.93\*\* | 0.99\*\* |
| Body weight and Facial length | 0.85\*\* | 0.91\*\* | 0.89\*\* | 0.95\*\* | 0.99\*\* |

\*\* Correlation is significant at 0.01 level (2-tailed)

CONCLUSION AND RECOMMENDATION

The findings of this study demonstrated that enzyme treated sawdust can be used in the diets of Savanna Brown goats up to 40 % replacement for maize offal and chest girth can be used to predict the body weight of savanna brown goat.

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## PROXIMATE COMPOSITION OF RAW AND PROCESSED FULL-FAT LEBBECK (*Albizia lebbeck*) SEEDS

Ibrahim, L., Akande, K.E., Ayanwale B.A. and Tsado, D.N.

Department of Animal Production, School of Agriculture and Agricultural Technology,

Federal University of Technology, Minna, Niger State, Nigeria.

ABSTRACT

This study was carried out to determine the proximate composition of the full-fat composition of raw and processed (boiled) Albizia lebbeck seeds. The crude protein was in the range of 28.03 to 28.35% for the raw and processed seeds respectively. There was the occurrence of slight changes in the content of crude protein, moisture and nitrogen-free extract after the processing of the lebbeck seeds but this was with the exemption of the crude fibre, ether extract and ash contents. It was observed from the results that the crude fibre dropped from 18.50 in the raw seeds to 16.98% in the processed seed with a change of 8.22%, and the ash content reduced from 4.52 in the raw seeds to 4.02% in the processed seeds, with a percentage reduction of 11.06 and the ether extract increased from 11.06% in raw seeds to 12.0% upon processing. In this experiment, the proximate analysis showed that Albizia lebbeck can be a potential plant protein source for incorporation in livestock feeds with proper processing.

**Keywords:** Proximate composition; full-fat; *Albizia lebbeck;* processing; raw

INTRODUCTION

Conventional feed sources in Nigeria can no longer meet the ever-growing poultry industry. Additionally, these feedstuffs are expensive. Notwithstanding, in Nigeria, there are several non–conventional leguminous seeds which are underexploited. One of such is lebbeck (*Albizia lebbeck*), which is a leguminous plant that produces seed grains that is readily available. It is also a tropical legume and one of the most widespread species worldwide. Lebbeck is an unconventional feed source that may be capable of boosting poultry production. There is a need to utilize this unconventional feed ingredient that is not fully exploited as a possible potential protein source for poultry. Raw lebbeck seeds contain antinutritional substances that could be toxic when consumed by animals as such there is the need to know the best processing method that will eliminate these factors and make it safe as well as palatable for the animals. The use of processed lebbeck seed could serve as a potential protein source for poultry feeding.

According to Fagbemi *et al.* (2005), processing can effectively reduce the antinutritional factors in seeds, notably boiling as a processing method increased the *in vitro* multienzyme protein digestibility of seeds. Proper processing is required to improve the nutritional quality of legume grains, sometimes a combination of more than one processing method may be employed (Akande and Fabiyi, 2010).

Nutritional data on boiled lebbeck seeds is limited to the best of the authors' knowledge, therefore, this experiment was carried out to determine the proximate composition of lebbeck seeds for possible consideration as a potential unconventional feedstuff.

MATERIALS AND METHODS

Sample collection and procedure employed for processing lebbeck seeds

Dry pods of *Albizia lebbeck* were harvested from lebbeck trees in Minna, Niger State, Nigeria. Raw seeds were removed from lebbeck pods by threshing with a mortar and pestle. After threshing seeds were separated from the chaff and other debris. About ten kilogrammes (10 kg) of raw lebbeck are boiled in 20 litres of water at 100℃ for 30 minutes. The lebbeck seeds were then poured into a sieve to drain the water from the seeds. After cooling the seeds were sun-dried for 3 days. After drying, the lebbeck seeds were grounded with the use of a hammer mill.

Proximate analyses

The proximate analyses of lebbeck seeds (both raw and processed seeds) were carried out at the Animal Production Laboratory, Federal University of Technology, Minna, Niger State, Nigeria using the methods outlined by the Association of Official Analytical Chemists (AOAC, 2000). The parameters determined were: moisture content, crude protein, ether extract, crude fibre, ash and nitrogen-free extract.

RESULTS AND DISCUSSION

The proximate composition of the raw and processed lebbeck seeds is presented in Table 1. The values obtained from the results showed that some proximate content of raw and processed lebbeck seeds were generally comparably close, for instance, the crude protein, moisture content and nitrogen-free extract, except the crude fibre, ether extract and ash content. The crude protein was in the range of 28.03 to 28.35% for the raw and processed seeds respectively. The crude fibre dropped from 18.50 in the raw seeds to 16.98% in the processed seeds with a change of 8.22%, and the ash content reduced from 4.52 in the raw seeds to 4.02% in the processed seeds, with a percentage reduction of 11.06 whereas the ether extract increased from 11.06% in raw seeds to 12.0% upon processing. The reduction in some proximal content may be due to the loss of nutrients through leaching during the boiling process. Akande (2004) reported a similar observation for raw and processed jack bean seeds. Tsado *et al.* (2018) reported a crude protein of 22.93% for fermented and toasted lebbeck seed, this value is rather lower than the crude protein of 28.35% obtained in this study. However, the crude protein obtained by Adegbehingbe *et al.* (2018) was 36.31% which is much higher than the value recorded in this research study. This variation in the crude protein may

probably be due to differences in the method employed in processing the lebbeck seeds.

Table 1: Proximate composition of raw and processed full-fat lebbeck (*Albizia lebbeck*) seeds

|  |  |  |  |
| --- | --- | --- | --- |
| **Nutrients** | **Raw lebbeck seeds** | **Processed lebbeck seeds** | **Percentage change (%)** |
| Moisture content | 8.19 | 8.20 | 0.12 |
| Crude protein | 28.03 | 28.35 | 1.14 |
| Crude fibre | 18.50 | 16.98 | 8.22 |
| Ash | 4.52 | 4.02 | 11.06 |
| Ether extract | 11.06 | 12.00 | 8.50 |
| Nitrogen free extract | 29.70 | 30.45 | 2.53 |

CONCLUSION

In this study, the proximate analysis revealed that lebbeck seeds can be a promising plant protein feed resource for livestock with proper processing. In addition, processing (boiling) did not negatively affect the major proximate fractions which are the crude protein, crude fat and nitrogen-free extract.

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## GINGER (*Zingiber officinale*) AS FEED SUPPLEMENT: INFLUENCE ON GROWTH PERFORMANCE AND HEALTH OF GROWING RABBITS – A REVIEW

1Abu, M.H., 2Jokotola, .T.P., 2Oladesu, K.O., 3Eboh, S. and 1,4Okolo, G.P.

**1**Departmrnt of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, P.M.B 65, Minna, Niger State, Nigeria

2State Veterinary Clinic, Mokola, Ibadan, Oyo State, Nigeria

3Department of Animal Health and Production Technology, School of Agricultural Technology, Kogi State Polytechnic, P.M.B 1101, Lokoja, Kogi State, Nigeria

4Department of Agricultural Technology, School of Agricultural Technology, Kogi State Polytechnic, P.M.B 1101, Lokoja, Kogi State, Nigeria.

Corresponding author: [matt4msp@gmail.com](mailto:matt4msp@gmail.com)

ABSTRACT

*Ginger (Zingiber officinale) is a plant that has gained wide usage as a spice in foods. This is due to its appealing aromatic flavor and spicy kick it gives to foods when used as condiment. In recent times, investigations have revealed that there are other valuable uses to which the ginger roots can be put to. The use of ginger as supplement in feeds of rabbits has been successful as the plant was found to enhance growth performance and the quality of life of the animals used in such feeding trials. Not only has it been used as feed supplement for monogastrics (poultry, rabbits etc.), it has also been found to command immense therapeutic qualities. Production of rabbits can be marred by disease outbreaks and this can affect the overall return on investment of the livestock producer whose aim is to make profit. The roots of Z. officinale have been found to possess anti-oxidative, antimicrobial and anti-inflammatory qualities. With the rising cost of drugs and the potential risks of antibiotics on human health, effective utilization of Z. officinale in disease prevention and control in rabbits could be a viable and cost effective means of ensuring wholesome production of animals and animal products. This review therefore, itemized the benefits of ginger and how it affects the growth performance and health of rabbits.*

**Keywords:** rabbits, ginger, growth, health, nutrient, feed

INTRODUCTION

The task of attaining food security in any nation does not only involve making food available for the populace but to also ensure that such food is of good nutritional profile (Gavrilova, 2020). Human diet devoid of sufficient animal protein predisposes consumers of such diets to nutritional health challenges (Pezeshki *et al.,* 2016). In Nigeria, the daily animal protein intake averages 10g per person per day and this is a far cry from the recommended daily intake of 50g-60g per person per day (Denisova, 2015). This has led to an increase in efforts of researchers and livestock producers at developing nutritional strategies that could help ameliorate this shortfall. Rabbit production has been reported to possess the potential for upgrading animal protein intakein Nigeria (Kalio *et al.,* 2008). Production of rabbits is favourable due to their fast growth rate, limited space requirement, high reproductive ability, ability to survive on kitchen wastes and a quick return on investment (Okojie *et al.,* 2004)

Ginger (*Zingiber officinale*) is the rhizome of a plant commonly utilized as a spice because of its rich flavour (Taiwo *et al.,* 2005) or for its medicinal or therapeutic importance (Balogun *et al.,* 2019). Ginger rhizome contains useful nutrients appropriate for feeding to monogastrics (Ajayi et al., 2013). Ginger has been reported to contains certain ingredients with growth promoting abilities that could make it fitting for use as an Antimicrobial Growth Promotant in feed (Imaseun et al., 2014). The use of ginger as supplement in feed of growing rabbits, has been reported to significantly enhance growth performances (Bakr et al, 2016; Jubril, 2019). The health benefit of ginger supplementation has been widely investigated. Addition of ginger in diets of growing rabbits has been reported to exert antimicrobial (Azu and Onyeagba, 2007), anti-inflammatory (Rahmnani *et al.,* 2014) and antioxidant activities (Santos-Sánchez, *et al.,* 2019).

This review therefore attempts to investigate the effects of ginger (*Zingiber officinale*) supplementation on growth and health of growing rabbits.

DISCUSSION

Influence of ginger (*Zingiber officinale*) on growth performance of rabbits

The major indicators of growth performance include the extent of an animal’s daily feed and water intake, body weight gain and ultimately, the frequency at which ingested feed is converted into meat. The use of ginger as supplement in the feed of animals has been shown to promote palatability of feed thereby encouraging animals to consume more feed (Choudhury, 2015). Supplementation of rabbit diets with natural antioxidants such as ginger has been reported to produce varied effects (Abdel-Khalek, 2013). According to Omage *et al.* (2007) when ginger waste meal was supplemented in the diets of growing rabbits, feed and water intake of rabbits increased but the increases did not influence weight gain, final live weight and feed conversion efficiency in the rabbits. Similarly, Emmanuel and Ochefu (2020) reported that supplementation of dried ginger root meal enhanced feed intake in growing rabbits. According to the authors, feed and water intake in the rabbits increased with increasing inclusion levels of the dried ginger root meal diets across treatment groups. According to Jubril (2019), an increase in feed and water intake which led to a significant (P<0.05) influence on body weight gains of growing rabbits was observed when powdered ginger was supplemented in rabbis diets. The author reported that the higher feed intake by the rabbits could have been due to the attractive flavour of the powdered ginger. Similarly, Ocampo-Lopez *et al.* (2022) showed that growing rabbits fed ginger at 0.5g/100g of feed had showed higher daily weight gain and feed conversion ratios across all treatment groups. Studies have shown that growth performances and health of rabbits can be improved through supplementation of diets with aromatic herbs and essential oils (Gerencser *et al.,* 2014). Ginger has been shown to be rich in essential oils useful in feeding rabbits because of their influence on the growth performances, health and meat quality of growing rabbits (Elazab et al., 2022). Constituents of ginger essential oil enhance immune function in animals, thereby promoting health (Mahomoodally, 2021). In a study with New Zealand White (NZW) rabbits, Elazab et al. (2022) showed that dietary supplementation of ginger essential oils significantly promoted better growth performance and feed utilization efficiency of the growing rabbits. Supplementation with higher doses of essential oils could be beneficial since a sharp increase in growth performance and feed utilization values were observed when the essential oils were supplemented at a high dose of 0.5%.

Ginger and its antioxidant effect in rabbits

Ginger is abundant in oleoresin, terpene, carotenoids, and phenolic compounds (Hassan, *et al.,* 2012). Phenols found in ginger include paradols, gingerols, and shogaols. These phenols act as antioxidants in the system of rabbits by binding with free radicals. Free radicals in the body have the capacity to damage rabbits' DNA and active proteins. To prevent this, phenols present in Ginger will inhibit oxidation caused by these radicals (Santos-Sánchez, *et al.,* 2019). By exerting its antioxidant properties, the phenolic compounds present in ginger help to decrease the incidence of neurodegenerative conditions in rabbits. Such conditions include stomach cancer (Yoshida *et al.,* 1990) and cardiovascular diseases (Paran, *et al.,* 2009). To limit the occurrence of cardiovascular diseases, phenols present in ginger causes vasorelaxation. This decreases the tension on the walls of rabbits' blood vessels. The antioxidant effect of ginger also works synchronously with its anti-allergy effects (Sakakibara *et al.,* 2003).

Ginger and its anti-inflammatory effects

The major inflammatory mediators present include interleukin-1 (IL1), cytokines, and tumour necrosis factor (TNF) (Rahmnani *et al.,* 2014). Although there are anti-inflammatory drugs that can be used to battle inflammation in rabbits, they have side effects like ulcers while some are contraindicated in some conditions (Rahmnani *et al.,* 2014). Hence, it is best to resort to the use of natural anti-inflammatory agents like ginger. Ginger can be constituted in various forms to derive its active ingredients. These forms include ginger oil and ginger powder. A study has shown that when ginger oil was administered at a dosage of 33mg/kg, it aided in repressing joint swellings which may be due to arthritis, synovitis, and other inflammatory conditions (Sharma et al., 1994). Ginger has also been clinically proven to inhibit the synthesis of cytokines like IL-8 and IL-1 (Verma *et al.,* 2004). Another study has revealed that the manner in which TNF is increased when rabbits have cancerous hepatic cells is blocked by using ginger extracts (Habib, *et al.,* 2008). It further inhibits COX activity and prevents the induction of genetic codes that controls inflammation (Tjendraputra *et al.,* 2001).

Ginger and its anti-microbial activity

The rate at which microbes are getting resistant to antimicrobials is alarming and this can be attributed to the abuse of antimicrobials. Previous research has revealed that ginger and its active ingredients play a pivotal role in the inhibition of the growth of microbes. A study has shown that ginger specifically inhibits the growth of *Bacillus subtilis,* *Salmonella typhi,* and *Escherichia coli* (Azu and Onyeagba, 2007).Ginger extract dipped in ethanol has shown a very wide inhibition zone against *Salmonella typhi* and *Streptococcus spp* (Giriraju and Yunus, 2013). Not only does ginger have the capacity to prevent bacteria growth, its rhizome also possesses some anti-fungal properties. As mentioned earlier, phenols are an active constituent in ginger plants. Shagelol and gingerol, a subform of phenols fight actively against fungal agents. Phenolic compounds present in ginger extract inhibit the action of *Candida albicans,* a fungus that causes cutaneous candidiasis in rabbits (Teodoro *et al.,* 2015). Phenols present in ginger act against the above factors. However, their degree of activity varies from one phenolic compound to another. Some phenolic compounds prevent hyphae formation (Zhang, *et al.,* 2011) while some prevent biofilm formation (Teodoro, *et al.,* 2015). Gingerol from the rhizome of ginger has also been proven to limit the growth of periodontal bacteria in rabbits (Miri *et al.,* 2008) and also inhibit *Mycoplasma tuberculosis* in vitro (Hiserodt *et al.,* 1998). Microbes that cause periodontal infection in rabbits are usually gram-negative and they grow anaerobically.

CONCLUSION

The ultimate goal of livestock producers is the production of wholesome animals that will serve as good quality meat, promote health and improve the quality of life of consumers of such animal products. There is an increasing interest on the part of researchers to find out suitable alternatives to most drugs used in livestock production in recent times. Ginger (*Z.officinale*) has been shown to possess active ingredients that enhance growth performance in rabbits and also deplete a wide range of disease-causing microbes. *Z. officinale* could be a suitable alternative to most anti-microbial, anti-inflammatory and anti-oxidant drugs because of the immense protection it offers to rabbits. The use of ginger as feed supplement in rabbit production is therefore a means of achieving cost effective rabbit production since ginger is readily available and affordable to most rabbit farmers. Because of its therapeutic qualities, the use of *Z. officinale* in rabbit production will also promote production of healthy rabbits thereby improving the farmers’ returns on investment.

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## ASSESSMENT OF MIXTURES MEAL OF BREWERS DRIED GRAINS AND SORGHUM BREWERS DRIED GRAINS ON GROWTH AND NUTRIENT DIGESTIBILITY OF WEANER RABBITS

Ibrahim, H.

Department of Animal Production, Faculty of Agriculture, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria

Corresponding Author: [ihadiza080@gmail.com](mailto:ihadiza080@gmail.com). Tel No.: +2348036101761

ABSTRACT

*Seventy-five (75) weaned rabbits aged between 5 and 6 weeks and of mixed breeds and sexes, with average initial weights of 450g were used to assess the growth performance and nutrient digestibility of mixtures meal of brewers dried grains and sorghum brewers dried grains of weaner rabbits (Oryctolagus cuniculus) fed at varying levels of inclusion. The rabbits were allotted into five dietary treatments; T1 (0 % as the control diet), T2, T3, T4 and T5 (containing 10, 20, 30 and 40% of mixtures of brewers dried grains) and sorghum brewers dried grains of three (3) replicates with five (5) rabbits per replicate in a completely randomized design. Data were collected on growth performance and nutrient digestibility, the trial lasted twenty weeks. Data generated from the trial were subjected to analysis of variance (ANOVA). The result showed that all the parameters determined (initial weight, final weight, total weight gain, daily weight gain, total concentrate intake, total feed intake, weekly feed intake and feed conversion ratio) were not significantly (p>0.05) affected by the test ingredients in all the treatment groups. The parameters measured were all significantly affected in all the treatment groups.*

**Keywords**:Sorghum, brewers dried grain, nutrient, growth, digestibility

INTRODUCTION

In recent times, Nutritionists have highlighted the vital role of animal protein in human health, especially during pregnancy and subsequent development of children. Maternal protein intake throughout pregnancy is related to birth size, and future viability of children. Where protein shortage occurs, dietary protein from any source is important in human development; but increased intake of animal protein appears superior for future development. shortage of dietary protein in particular have had a greater effect on prenatal development and size of the new-born child (Moore, 2002). Sorghum Brewers Dried Grains (SBDG) on the other hand is the by-product of brewery based on sorghum grains (other grains such as barley, maize and rice are sometimes included). It can be used fresh or dried (artificially or sun-dried). Sorghum has been the basis for traditional African beers such as the local beer of West-Africa *dolo, burukutu, pito* and the opaque beer of the Southern Africa. Though the power of the sorghum malt is very low; certain stout and larger beers are now produced in Africa using malted sorghum rather than the imported and expensive barley.

In this research work, Brewers dried grains (BDG) industrially sourced from barley and Sorghum brewers dried grains (SBDG) locally sourced from red sorghum 50:50 Mixture of BDG and SBDG were used to assess the performance and nutrient digestibility of rabbits in the humid tropics of Nigeria.

Aim of the Study

The aim is to assess the growth performance and nutrient digestibility of weaner rabbits fed mixtures meal of brewers dried grains and sorghum brewers dried grains

The objectives of the Study are to:

1. to evaluate the effects of different levels of mixtures of industrially produced brewers dried grains (BDG), locally produced sorghum brewers dried grains (SBGD) (50:50) on growth rabbits.
2. to examine the effects of different levels of mixtures of industrially produced brewers dried grains (BDG), locally produced sorghum brewers dried grains (SBGD) (50:50) on growth rabbits.

METHODS AND MATERIALS

Experimental Site

The research was conducted at the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria. Minna is situated between latitude 9o 31ʹ and longitude 90 45ʹ North, and Longitude 6031ʹ and 6045ʹ East of the equator (Usman, 2011).

Source of Experimental Animals, Test Ingredients and Their Management

Seventy-five (75) weaner composite breeds of rabbits were obtained from the rabbitry unit of Ministry of Livestock and fisheries Department, Bosso, Minna Niger State. They were of mixed breeds and sexes (forty-five females and thirty males), aged 5-6 weeks and weighing between average of 449.00-490.70 g were randomly allotted to five treatment groups. Each treatment had three replicates with five rabbits per replicate (two males and three females), five diets were formulated and designated as T1, T2, T3, T4 and T5 (0, 10, 20, 30 and 40 % dietary inclusion of BDG respectively). T1 was the control diet and contained ground nut cake and maize as the main protein and energy sources with no brewers dried grains inclusion while T2, T3, T4 and T5 contained 10, 20, 30 and 40 % inclusion levels of industrially produced brewers dried grains respectively. All diets were supplemented with equal amount of bone meal, salt and vitamin-mineral premix. The diets were supplemented with 10 g of *Amaranthus hybridus* (about 10 g dry matter) per rabbit each day in addition to concentrate ration to improve the fibre supply in the diet. The rabbits were housed intensively in well-constructed hutches that were made of wire and woods with trays to collect the faeces as well as for easy cleaning of the hutches. The hutches were equipped with feeders and drinkers. They were cleaned twice a day throughout the study period. The rabbits were dewormed against endoparasites using ivermecin, Coccidiosis was treated using Sulphadimidine and multivitamin soluble powder (Vitalyte) were given as an anti-stress. In addition, medications were administered where and when necessary. Prior to the start of the experiment, the animals were fed common diets and allowed an adjustment period of one week (seven days) to enable the animals get acclimatized to their cages and diets

Data Collection

Data were collected using the following formulae on Total feed intake (g) = Total quantity of feed served (g) – Total quantity of leftover (g)Weight gain (g) = Final body weight at twenty weeks (g) – Initial body weight at first week (g)

Feed conversion ratio = Total feed intake (g)

Total weight gain (g)

Nutrient Digestibility Trial

ADN - Amount of nutrient in feed consumed - Amount of nutrient in droppings voided X 100

Amount of nutrient in feed consumed 1

Statistical Analysis

Data generated from the study were subjected to analysis of variance (ANOVA). Using statistical package (SAS) 2002. The package based on the Completely Randomized Design (CRD) model

RESULTS AND DISCUSSION

Table 1: Proximate composition and energy contents of the mixture diets of BDG and SBDG meal

**Levels of the mixture meal (%)**

**Composition TI T2 T3 T4 T5**

**0 10 20 30 40**

Dry matter 93.99 87.42 94.12 94.51 93.93

Crude Protein (%) 19.21 20.75 20.75 20.87 22.75

Crude fibre (%) 17.60 17.80 17.40 17.80 18.10

Ether extract (%) 7.37 7.02 7.48 7.69 7.90

Ash (%) 5.19 9.87 8.37 10.26 13.94

Nitr0gen free extract 44.62 31.98 40.12 37.89 31.24

ME (Kcal/kg) 2621.00 2638.00 2572.00 2583.10 2518.00

Table 2: Effects of different dietary inclusion of mixture meal of industrially produced brewers dried grains and locally produced sorghum brewers dried grains on growth performance of rabbits (*Oryctolagus cuniculus)* 0-20 weeks

**Levels of mixture meal (%)**

**T1 T2 T3 T4 T5**

**Parameters 0 10 20 30 40 SEM CV LS P Value**

Initial weight (g) 450.00 445.80 451.70 453.11 458.17 0.06 2.81 \* 0.00

Final weight (g) 1819.67 1851.67 1964.00 1919.60 1979.92 542.39 4.89 NS 0.38

Total weight gain (g) 1369.67 1405.87 1512.30 1469.49 1521.75 31.13 3.56 NS 0.49

Daily weight gain (g) 9.78 10.04 10.80 10.47 10.87 0.23 5.06 NS 0.37

Total conc. Intake (g) 10426.67 10427.33 10426.00 10426.67 10358.00 59.83 0.99 NS 0.88

Total forage intake (g) 1400.00 1400.00 1400.00 1400.00 1400.00 0.00 0.00 \* 0.00

Total feed intake (g) 11826.67 11827.33 11826.00 11826.67 11758.00 59.83 0,88 NS 0.89

Daily feed intake (g) 84.48 84.48 84.47 84.48 83.99 0.52 1.06 NS 0.85

Feed conversion ratio 8.64 8.41 7.82 8.07 7.73 0.31 5.002 NS 0.29

Table 3: Effects of different dietary inclusion levels of the mixture meal of BDG and SBDG on nutrient digestibility of rabbits (*Oryctolagus cuniculus)*

**Levels of mixture meal %**

**T1 T2 T3 T4 T5**

**Parameters 0 10 20 30 40 SEM CV LS P Value**

Dry matter 69.75a 70.35a  67.16ab 64.77c 68.34ab 0.73 1.85 \* <.00

Crude protein (%) 54.94c 62.62a 55.58c 56.14c 59.43b 0.95 2.85 \* <.00

Crude fibre (%) 63.28b 74.07a 57.13c 54.43c 48.18d  0.99 2.91 \* <.00

Ether extract (%) 54.46c 50.36d 48.66d 61.44a 57.69b  0.95 3.03 \* <.00

Ash (%) 28.29a 16.19b 16.74b 16.90b 12.12b 1.74 16.72 \* 0.00

Nitrogen free extract 79.40b 78.08b 83.43a 82.35a 74.66c 0.45 0.99 \* <.00

Total digestible nutrient (TDN) 55.60c 64.27b 64.82b 67.74a 67.73a 1.21 15.50 \* 0.00

abcMeans with the same superscript (s) in the same row are not significantly (P>0.05) different

SEM = Standard Error Mean

CV = Coefficient of Variation

LS = Level of Significance

\* = Significant

DISCUSSION

Effects of Different Dietary Inclusion Levels of the Mixture Meal of BDG and SBDG on Growth Performance of Rabbits (*Oryctolagus cuniculus*) 0 – 20 Weeks

The results of growth performance of rabbits fed diet containing BDG and SBDG mixture meal are presented in Table 2. The result revealed that all the parameters determined (initial weight, final weight, total weight gain, daily weight gain, total concentrate intake, total feed intake, weekly feed intake and feed conversion ratio) were also not significantly (p>0.05) affected by the test ingredients in all the treatment groups. Final body weight gain (1819.67 - 1979.92 g) obtained in this trial were within the values (1805 – 2040 g) obtained by Abubakar *et al*. (2006) and higher than 1160.00 – 1470.70 g recorded by Igwebuike *et al.* (2013) when rabbits were fed two varieties of sorghum as replacement for maize as energy source in tropical environments. These differences could be probably due to breeds, diets and duration of the research may be among other factors responsible for the differences in the final weights.

The daily weight gain (g) obtained in this study 9.78 - 10.93g were also within 8.86-15.54 g recorded by (Igwebuike, 2013) and far lower than (22.37- 25.72 g) and (10 – 20 g) obtained by Abubakar *et al*., (2006) and Cheeke (1987) for rabbits reared in tropical countries. These variations could be attributed to effect of high ambient temperature about 340c on feed intake at the time of the study. Despite the non-significant difference observed, Olorumisoro *et al. (*2002) concluded that sorghum brewers dried grains stimulate better weight gain when the authors fed weaner rabbits sorghum brewers dried grains diets.

The variation in values of fed intake might be due to tannin content in the diet that was high. Despite the non-significant effects recorded and could be an indication that mixture diet has better feed conversion ratio.

Nutrient Digestibility of Rabbits (*Oryctolagus cuniculus)* Fed Diets Containing Varying Levels of Mixture Meal of BDG and SBDG

The results of the nutrient digestibility of rabbits fed diets containing varying levels of BDG and SBDG mixture meals are presented in Table 4.26. The parameters measured were all significantly affected in all the treatment groups. Crude protein was within the range of 54.94 % to 62.62 % (T1 to T2) digestibility. Crude fibre had a higher digestibility in T2 and lowest in T5 (74.07 % and (48.18 %). Eather extract had digestibility values ranged between 48.66 % to 61.44 % (T3 and Tt4). Also highest value for ash was recorded in T1 (28.29 %) and the lowest in T5 (12.12 %) and all significantly (p<0.05) different in all the treatment groups. The range of Crude Protein digestibility in this study (54.94- 62.62 %) were lower than (69.28 – 84.47 %) and (64.88 – 65.35) recorded by Igwebuike *et al*. (2013) Crude Protein digestibility result further showed that rabbit fed 10 % (T2) recorded higher value (62.62%). This may be linked to better feed conversion ratio in the diets. The result of crude fibre obtained (48.18 % - 64.07 %) from this study were within the range of 37.44 to 68.15 % reported by Igwebuike *et al.* (2013), Igwebuike *et al.* (1998) and Jegede (2008). Ether extract digestibility also showed significant difference among the treatment groups. Diet 5 (40 % inclusion level) produced a significant higher value 61.44 % than other treatments. The result was within the range of 48.66 to 61.44 % and were below the value of 57.97 to 74.81 % and 65.63 to 85.41 % reported by Igwebuike *et al*. (1998) and Adama *et al.* (2007) when broilers were fed diets containing varying levels of sorghum brewers dried grains and (78.81 to 80.19 %) reported by Murin *et al.* (2002). Ash digestibility values recorded in this trial were in the range (16.19 – 18.29 %) lower than (58.47 to 60.88 %) and 11.70 to 35.60 % reported by Igwebuike *et al.* (2013) and Uko *et al.* (1999) when rabbits were fed cereal by-products as energy source .The variation could probably be attributed to higher dry matter digestibility as reported by Murin *et al.* (2002) in their trial. Total digestible nutrient of the diet was in the range of 55.60 – 67.74 and treatment four and five recorded similar highest values of digestible nutrient of 70.17 each.

CONCLUSIONS

The findings of this study can be concluded that mixture of industrially produced brewers dried grains (BDG) and locally produced sorghum brewers-dried grain (SBDG) included at varying inclusion levels is of good nutritional quality. The mixture can be included in the diets of rabbits without any deleterious effects on the growth performance and nutrient digestibility of rabbit.

RECOMMENDATIONS

Based on the conclusions drawn from this study, it is recommended that mixture meal can be included in the diet of weaner rabbits up to 40 % level of inclusion for optimum growth performance and nutrient digestibility rabbits (*Oryctolagus cuniculus*)*.*

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## MODELLING OF PHENOTYPIC TRAITS AS DETERMINANTS OF BREEDING POTENTIALS OF CATTLE UNDER LOW EXTERNAL INPUT

1S. Saheed, 2A.B. Sikiru, 1S.S.A. Egena, 1B.O. Otu, and 3O.J. Makinde

1Department of Animal Production, Federal University of Technology, Minna, Nigeria.

2Department of Animal Science, Federal University of Agriculture, Zuru, Nigeria.

3Department of Animal Science, Federal University, Gashua, Nigeria.

Corresponding Author: S.S.A Egena[acheneje.egena@futminna.edu.ng](mailto:acheneje.egena@futminna.edu.ng) 09076417947

ABSTRACT

*The breeding potentials of bulls and cows are determined by relationships between body and testicular measurements which are being used as traits for selection of the cattle. Therefore, the objective of this study is to determine the relationship between the body condition score (BCS), live weight (LW), scrotum circumference (SC) and linear body measurements, body length (BL) and heart girth (HG) in bulls under low external input operation for modelling predictive equation for breeding selection. A total of 40 bulls and cows each selected in two agroecological zones of Nigeria were used for the study. Data collected on body measurements and were subjected to Pearson’s correlation to establish relationships between the LW, BL, HG, BCS and SC in bulls and between the LW, BL, HG and BCS in cows; while Multiple regression analysis was used to develop selection models for both the bulls and cows. Pearson’s correlation results indicated that BCS had positive statistical correlation with SC (r = 0.54) and LW also indicated statistical correlation with HG (r = 0.99) in the bulls. In the cows, the result obtained indicated that LW was positively correlation with HG (r = 0.97), BL (r = 0.69) and BCS (r = 0.60). The regression model developed were Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score for bulls, and Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty for the cows. The correlation findings suggest that increasing SC, BCS, LW and HG, and the models developed for these traits could be used for selection of bulls and cows for breeding.*

**Keywords:**Breeding potentials, Low external input, modelling, Phenotypic traits, Body linear measurement

INTRODUCTION

The increase in population and decrease in fertility rates of bulls are factors associated with limiting cattle production in developing countries including Nigeria (Faith et al., 2016). Bull fertility can be a major limiting factor in a breeding program. Infertility rates in bulls are estimated to be between 15 to 25 percent in the United States and Canada (Thundathil et al., 2016). The cattle production system in developing countries is not robust enough to overcome this challenge because the production system is smallholder operated and thrives on the use of low external input (Leroy et al., 2016). Hence, for cattle producers to be economical and contribute effectively to food security, this research focuses on the relationship between scrotal circumference, body condition score, age, and body measurement using regression analysis to determine if the breeding potentials of bulls under low external input production system support selection and determining the potential bulls to be used in reproduction programme.

The low external input production system of cattle is described with poor availability of quality pasture, veterinary services, and indiscriminate use of drugs and vaccines; this is because most farmers often buy drugs at local markets from unskilled traders and majorly the efficiency of these therapeutic agents are erratic (Vaarst and Alrøe, 2012). Therefore, the primary aims of low external input operations are herd survival and sustained productivity to generate income for the provision of off-farm basic needs of the household (Thundathil et al., 2016). The evaluation of bull for breeding soundness is a vital aspect of reproductive management practice to exploit the maximum genetic potential in any livestock industry there is utmost need to assess the male (Asmare et al., 2013).

Sperm production is related to testicular development as shown by a positive correlation between testicular weight, sperm production and gonadal and extragonadal sperm reserves (Ommati et al., 2022). The heavier and larger the testes amount to the rate of sperm production. Testicular weight provided an accurate amount of the sperm-producing parenchyma in the testis of bulls (Ommati et al., 2022). The testicular weight was greater in certain breeds of animals with higher ovulation (Waqas et al., 2019). Since the testis weight cannot be measured directly in the male, scrotum circumference was found to be significantly correlated to testis weight (Chacko & Schneider, 2019), the circuitous technique of measuring scrotal circumference has been exploited. Scrotal circumference dimensions are well correlated with paired testis weight, which in turn is directly and extremely correlated with daily sperm production and high semen quality traits (Waqas et al., 2019).

A body condition score is an essential measure of the fitness of an animal for evaluating the body reserves in an animal (Silva et al., 2021). Condition score uses physical palpation of tissues cover over the backbone and the short ribs behind the last long ribs. Body condition score is not exercised on the farms, and its relationship with body weight and testicular traits is not known (Tyasi, 2022).

METHODOLOGY

The current study was conducted in two different agroecological zones of Nigeria namely; the southern guinea savanna and the Derived guinea savanna. The southern guinea savanna is characterized by the annual rainfall of 1140mm – 1520mm (March – November) while the derived savanna receives an average of 1275 – 1030 mm rainfall per annum. Qualitative data was collected by exploring both individual questionnaires and Focus group discussions (FGD) among the local farmers on the farms. In the FGD conducted, 6 – 10 farmers were interviewed as described by Nabukenya et al. (2014). Fifty farmers were interviewed and four FGD were conducted in both agroecological zones. Indigenous bulls kept raised on a low external input system of production of age 2 – 5 years were used as experimental animals. Body length (BL) was measured diagonally across the body of the bull using a flexible measuring tape in centimetres. Heart Girth (HG) measurement was taken by measuring the circumference of the girth using a measuring tape in centimetres. Scrotal circumference (SC) was measured with a flexible tape in centimetres (cm) at the maximum point of dimension round the pendulous scrotum after pushing the testes firmly into the scrotal sac as described by Nwachi Akpa (2013). Body condition score (BCS) was taken on the bulls based on the procedure for body condition scoring recommended by Soares & Dryden (2011) which states that a range of 1-9 scores.

Data

Data were collected from 80 indigenous cattle comprising 40 bulls and 40 cows from the southern guinea savanna and derived savanna using a measuring tape for phenotypic measurements. Statistical Package for Social Sciences version 26.0 (IBM SPSS, 2019) was used for data analysis. Descriptive analysis (average mean, standard deviation, standard error of mean and coefficient of variance) were calculated for the traits measured in both bulls and cows. Pearson’s correlation was used to calculate the relationship between live weight, heart girth, body length, and body condition score in cows but with testis circumference in bulls.

Descriptive Data

Data from the measured traits were used in predictive modelling. Multiple regression was used to develop different models for selection of bulls and cows for breeding program using y = a + b­1X1 + b2X2 + b3X3 + b4X4­ + ….. bnXn, Where y is the dependent variable, a is the regression intercept, b1 – bn is the coefficients of regression, and X1 – Xn is the independent variables.

The following models were developed for bulls:

Testis Circumference = -71.84 + 2.32Age + 2.73Hearth Girth + 0.03Body Length – 0.32Live Weight + 2.56Body Condition Score

BCS = 9.96 – 0.57Age – 0.45HG + 0.08BL + 0.05LW + 0.21TC

LW = -356.15 + 2.10Age + 8.58HG + 2.68BL – 1.31TC + 2.68BCS

HG = 41.25 + 0.72Age – 0.31BL + 0.12LW + 0.15TC – 0.30BCS

BL = 77.25 + 0.72Age – 1.19HG + 0.14LW + 0.01TC + 0.21BCS

Age = 0.11 – 0.27HG + 0.19BL + 0.03LW + 0.14TC – 0.40BCS

Models developed for cows are as follows:

LW = -546.55 – 0.44Age + 9.60HG + 5.92BL – 6.14BCS – 1.44Age at Puberty + 0Age at first calving

BCS = -24.88 – 0.03Age + 0.50HG + 0.19BL + 1.30Age at puberty + 0Age at first calving – 0.04LW

Age = 4.78 + 0.19HG – 0.21BL + 0.26Age at puberty + 0Age at first calving – 0.01LW – 0.05BCS

HG = 53.60 – 0.51BL – 0.06Age at puberty + 0Age at first calving + 0.01LW + 0.76BCS + 0.19BCS

BL = 73.27 + 0.09Age at puberty + 0Age at first calving + 0.11LW + 0.53BCS – 0.37Age – 0.96HG

Age at Puberty = - 0.75 + 1Age at first calving – 1.4LW + 2.37BCS + 4.39Age + .19HG + 7.76BL

Age at first calving = 0.75 +1.22LW + 4.73BCS – 3.2Age – 1.07HG -7.76BL + 1.00Age at puberty

Where TC is testis circumference, LW is live weight, BCS is body condition score, HG is heart girth and BL is body length.

RESULTS

Table I shows the phenotypic correlation between LW, BCS and body linear measurements of indigenous bulls while Table II shows the correlation between LW, BCS and phenotypic body measurements of cows. The result indicated that HG had a high positive correlation (p < 0.01) with LW. Also, the result presents a positive statistical correlation (p< 0.05) between TC and BCS.

Table I. Phenotypic correlation between live weight, body condition score, testis circumference and body measurements of bulls

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Traits | LW | HG | BL | BCS | TC |
| LW | - |  |  |  |  |
| HG | 0.99\*\* | - |  |  |  |
| BL | 0.35 | 0.24 | - |  |  |
| BCS | 0.37 | 0.38 | 0.15 | - |  |
| TC | 0.04 | 0.05 | -0.30 | 0.54\* | - |

\*\*, Significant at P < 0.01; LW, Live weight (kg); \*, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score; TC, Testis circumference (cm).

Table II indicated a high positively statistical correlation (p < 0.01) between LW and HG, BL and BCS. The result also shows that there is a high correlation (p < 0.01) between BCS and HG. Lastly, BL had a positive correlation (p < 0.05) with HG.

Table II. Phenotypic correlation between live weight, body condition score and body measurements of cows

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Traits | LW | HG | BL | BCS |
| LW | - |  |  |  |
| HG | 0.97\*\* | - |  |  |
| BL | 0.69\*\* | 0.52\* | - |  |
| BCS | 0.60\*\* | 0.72\*\* | 0.17 | - |

\*\*, Significant at P < 0.01; LW, Live weight (kg); \*, Significant at P < 0.05; HG, Heart girth (cm); BL, Body length; BCS, Body condition score.

DISCUSSION

Cattle are mostly reared for meat, milk and farm power, and they play a worthy role in food security, and socio-economic activities in the lives of farmers and masses (Rehman et al., 2017). This study was conducted to build models and examine the relationship between LW, Body linear measurements in cows and testicular measurement traits in bulls as a result of breeding value dependency on those traits. Our result obtained from the study shows that there is a highly remarkable relationship between LW and HG because LW can be estimated more accurately as reported by Tyasi (2022) . Similarly, there is a significant relationship between BCS and the TC of the bulls. A similar report was reported by Tyasi (2022) in Dorper Sheep. Faith et al. (2016) reported that LW had a significant correlation with SC. Tariq & Bajwa (2012) also reported that BCS had a remarkable correlation with the LW of indigenous Mengali sheep of Pakistan. The variation might be due to age, breed, and management differences. Faith et al. (2016); Tyasi (2022) reported that rams with larger testicular measurement traits might have larger LW. The results also showed that there remarkable correlation between LW, BCS, and body measurements. This study suggests that TC can be used to improve the BCS in bulls while the increase in LW and HG can be used in improving the BCS in cows. Phenotypic variations in traits of animals are due to joint effects of genetics and environment, and genetic and environmental factors independently (Barghi et al., 2020).

CONCLUSION

Pearson’s correlation results suggest that Body Condition Score are positively and highlycorrelation with testis circumference. Correlation findings suggested that increasing testis circumference might improve the body condition score while the body condition score might improve the live weight of the bulls. The results also suggested that the body condition score is highly correlated to the heart girth, and live weight of the cows and this denotes that an increase in live weight improves the body condition score, heart girth and body length. Therefore, the findings of this study might be useful in the selection of bulls and cows for breeding purposes.

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## PHYLOGENY BETWEEN *Clarias gariepinus* AND *Heterobranchus Bidosalis* INFERRED FROM SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) DNA MARKERS

\*N. O. Yusuf; 1S. M. Tsadu; 1A. T. Yisa; 1S.O.E. 1Sadiku

\*National Biotechnology Development Agency, Abuja, Nigeria

1Department of Water Resources, aquaculture and Fisheries Technology, Federal University of Technology, Minna, Nigeria

\*E-mail: [napemi\_a@yahoo.com](mailto:napemi_a@yahoo.com); +23408036497793

ABSTRACT

*The phylogeny between Clarias gariepinus and Heterobrachus bidosalis species collected from three water bodies in Minna, Niger State, Nigeria, was carried out using SNPs DNA markers. SNPs growth-related gene primer was used for genotyping the DNA. All the samples from the three water bodies show the presence of the growth gene, two samples of each species from the various sampling sites were sequenced, and the UPGMA dendrogram was constructed from the sequence data. The UPGMA dendrogram (Bioedit) divides the population into main clades, the first clade consists of Clarias gariepinus, and the second clade consists of Heterobranchus bidosalis from three different water bodies; the two main clades indicate that both species are evolutionarily distant apart. The dendrogram reveals the genetic distance between Clarias gariepinus and Heterobranchus bidosalis reaffirming the taxonomic placing of the species in different species and genera.*

Keywords: Phylogeny; SNPs DNA markers; *Clarias gariepinus*; *Heterobrachus bidosalis*; Sequencing

INTRODUCTION

*Clarias* and *Heterobranchus* species are commonly referred to as catfish, they are the most important aquaculture fish in Nigeria because they are the most cultured species, and the development of aquaculture in Nigeria is based on their production (Adewumi and Olaleye, 2011). They are widely distributed across Africa, with their total global production reaching 246,476 tonnes in 2015 and increasing annually (FAO, 2017). Nigeria took second position after Malaysia as the catfish producing country, with a total production of 160,295 tonnes in 2015 (FAO, 2017). DNA marker is a DNA sequence used to mark or track a particular location (locus) on a specific chromosome or marker gene. It is a gene with a known location or clear phenotypic expression detected by analytical methods or an identifiable DNA sequence that facilitates the study of the inheritance of a trait or a gene (Okumu and Ciftci, 2003). Single nucleotide polymorphisms (SNPs) marker is a single base change or base variation among individuals at any point in a DNA sequence. Single nucleotide polymorphisms (SNPs) are co-dominant, lack ambiguity, and very useful in scanning large and disparate regions of the genome due to their abundance in both coding and non-coding regions of the genome (Williams *et al*., 2010). Genetic data improve or even allow the elucidation of phylogeny and provide the basic knowledge for understanding taxonomy, domestication, and evolution (Nwakanma *et al*., 2003). As a result, information from molecular markers or DNA sequences offers a good basis for better conservation approaches. The genetic information and evolutionary relationship between these valuable species for management and conservation are scarce; thus, this research will investigate the evolutionary relationships between *Clarias gariepinus* and *Heterobranchus bidosalis*.

MATERIALS AND METHODS

Sample collection: For the SNPs genotyping, ten samples of *C. gariepinus* and *H. bidosalis* were collected from three water bodies, namely Agaie/Lapai dam reservoir, Shiroro dam reservoir and Tagwai dam reservoir in Minna, Niger State, Nigeria and two samples of *C. gariepinus* and *H. bidosalis* were collected from the same three sampling sites with the help of fishermen were used for the sequencing. For the sampled fish for the experiment, the caudal fin was clipped into the well-labelled micro tube and stored at -170C in the refrigerator until used.

Extraction, purity, and quantification of genomic DNA: Quick-DNATM Miniprep Plus kit protocol was used to extract the genomic DNA from the caudal fin, revised 2021([www.zymoresearch.com](http://www.zymoresearch.com)), the guidelines were followed step by step with few modifications. The purity of the genomic DNA extracted was determined by measuring the optical density at 260nm to the optical density at 280nm to be 1.7-2.0 using a Nano-drop spectrophotometer. The genomic DNA was quantified by electrophoresis using 1% agarose gel buffered with 0.5x TBE at 80 volts for 1.5 hours and stained with 5µl ethidium bromide. The gel image was viewed under UV light (thermos scientific, UAS), captured, and stored in the computer. 200µl DNA was extracted from each sample and stored at -170C before being used for SNPs genotyping. These were carried out at the Bioscience center of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria.

SNPs genotyping, electrophoresis, and sequencing: The SNPs genotyping was carried out using four growth-related gene SNPs primers; the genotyping reaction contained 2.5µl of 10x PCR buffer,1µl of 25m MgCl2, 1µl each of forward and reverse primers, 1µl of DMSO, 2µl of 2.5mM DNTPs, 0.1µl of 5ng/µl Tag DNA polymerase and 3µl of 10ng/µl DNA, the total reaction volume was made up to 25µl using 13.4µl Nuclease free water. The electrophoresis of the genotyped products was conducted using 2% agarose gels buffered with 0.5x TBE at 80 volts for 1.5hrs and stained with 5µl ethidium bromide; the gel image was viewed under UV light (thermos scientific, USA), captured and stored in the computer. The gel image revealed the presence of the growth-related gene in the sampled fish. The sequencing was carried out using the protocol for BigDye terminator v 3.1 cycle sequence kit in an automated sequencing machine (ABI 3500). The sequencing amplification reaction contained 0.5 µl of BigDye sequencing buffer, 1.0 µl of Buffer, 2.0 µl of PCR, 1.0 µl of primer, and 5.5 µl of deionized water. These were carried out at the Bioscience center of the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria.

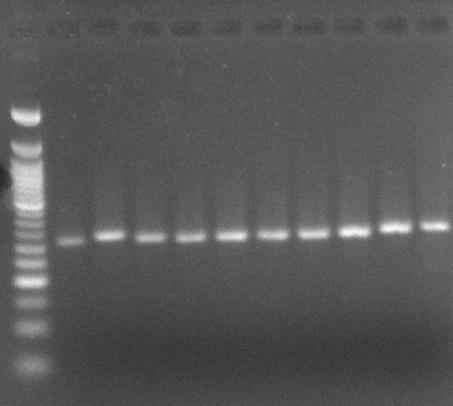
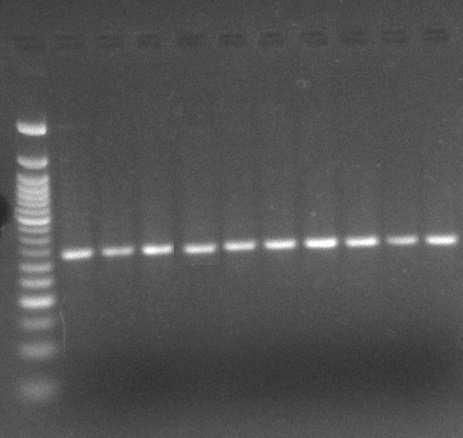
The sequence products were saved in a sequencing machine, then downloaded, edited, and aligned using BioEdit software. The phylogenetic tree (dendrogram) was drawn using BioEdit software and viewed using treeviewX software.

RESULTS AND DISCUSSION

SNPs genotyping products generated using SNPs growth-related gene obtained from GenBank (<https://www.ncbi.nlm.nih.gov>) with accession number Af416488.1 to reveal the growth gene of *Clarias gariepinus* and *Heterobranchus bidosalis* from three water bodies as shown in plate 1-4.

The primer shows bands in all the samples obtained for the experiment from the three water bodies, indicating high growth potential in our indigenous fish species when all other water quality parameters are optimum.

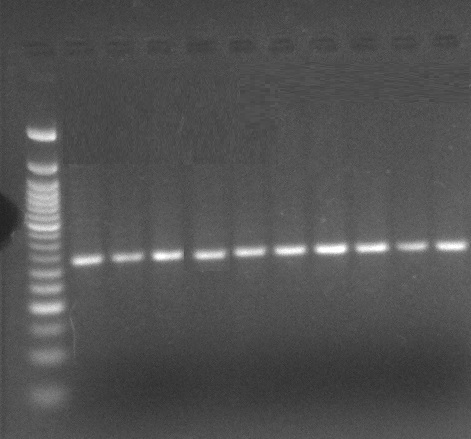
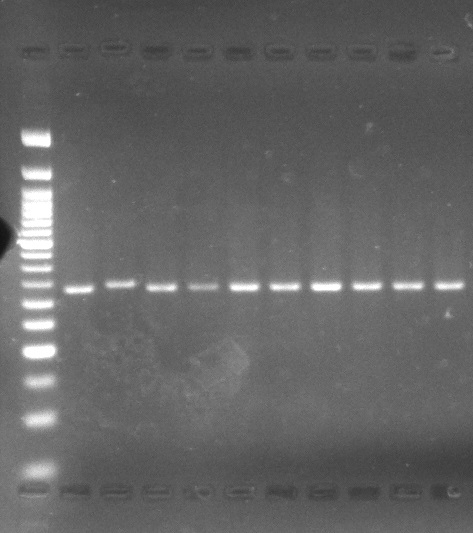
Phylogeny: The phylogeny between *Clarias gariepinus* and *Heterobranchus bidosalis* was constructed using the Unweighed Paired Group Method of Arithmetic Mean (UPGMA) dendrogram (BioEdit). The UPGMA dendrogram separates the two species into two main clades. The first clade comprises six (6) samples of Clarias gariepinus and the second clade includes six (6) samples of *Heterobranchus bidosalis,* as shown in fig.1.



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Agaie/ Lapai samples Shiroro samples

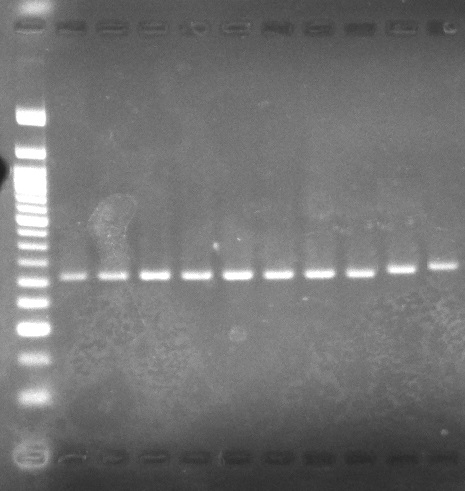
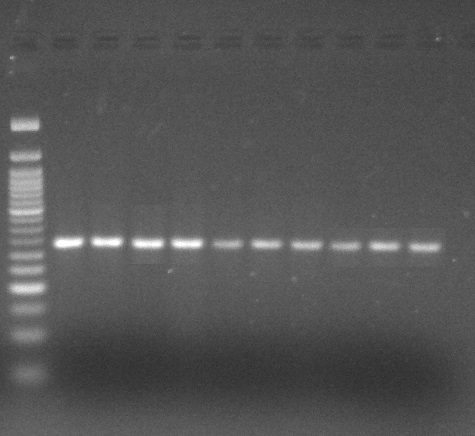
Plate 1: SNPs genotyping *Clarias gariepinus* SNPs genotyping *Clarias gariepinus*



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Tagwai samples Agaie/Lapai samples

Plate 2: SNPs genotyping *Clarias gariepinus* SNPs genotyping *Heterobranchus bidosalis*



M 1 2 3 4 5 6 7 8 9 10 M 1 2 3 4 5 6 7 8 9 10

Shiroro samples, Tagwai samples

Plate 3: SNPs genotyping *Heterobranchus bidosalis* SNPs genotyping *Heterobranchus bidosalis*

Plate 1-3: SNPs genotyping of *Clarias garipinus* and *Heterobranchus bidosalis*, M: DNA ladder (50bp), and 1-10: fish samples.



Fig 1: phylogenetic tree (dendrogram) between *Clarias garipinus* and *Heterobrachus bidosalis* from three water bodies, namely Agaie/lapai (1 and 2), shiroro (3 and 4) and Tagwai (5 and 6).

The UPGMA dendrogram (Bioedit) divides the population into main clades, the first clade consists of *Clarias gariepinus,* and the second clade consist of *Heterobranchus bidosalis* from three different water bodies. The two main clades indicate that both species are evolutionarily distant apart. The dendrogram also shows that Agaie/ Lapai samples are genetically closer to shiroro samples than Taqwai samples in both species. Tagwai samples are genetically closer to Shiroro than Agaie/Lapai samples in both species. The result of this research agrees with the report by Sokenu et al. (2020), who conducted a comparative study on *Oreochromis niloticus* and *Sarotherodon melanotheron* using the SNPs growth gene (IGF-I), revealing genetic distance between the two species. SNPs have gained recognition recently and are considered next-generation DNA markers in fisheries due to their abundance in many gene chips, which can be utilized in fisheries genomic studies and diagnosis of diseases (Okumus and ciftci, 2003).

CONCLUSION

In conclusion, the dendrogram reveals the genetic distance between *Clarias gariepinus* and *Heterobranchus bidosalis* reaffirming the taxonomic placing of the species in different species and genera.

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## EFFECTS OF CRUDE OR SYNTHETIC ENZYMES ON THE DIGESTIBILITY OF BROILER FINISHER CHICKENS FED GROUNDNUT-COWPEA SHELL BASED DIETS

\*Owuna, I. K. and Alu, S. E.

Department of Animal Science, Faculty of Agriculture, Nasarawa State University, Keffi, P.M.B. 135, Shabu-Lafia campus , Nasarawa State, Nigeria.

\*Corresponding Author: [*kokiowuna@gmail.com*](mailto:kokiowuna@gmail.com) Phone N0: +2347066729019

ABSTRACT

A 28 day evaluation of the effect of crude or synthetic enzymes on the growth performance of broiler chickens (Cobb 500) fed groundnut-cowpea shells (GCSM) based diet was conducted using a total of two hundred and forty birds randomly allotted to five dietary treatments replicated four times with 12 birds each in a Completely Randomized Design (CRD). Diet T1 had 0% GCSM: 0%dried rumen content (DRC), 0% mushroom and 0ppm synthetic enzyme and served as the control; diet T2 had 25% GCSM, 0% DRC, 0% mushroom, and 0ppm enzyme; diet T3 contained 25% GCSM, 5% DRC, 0% mushroom and 0ppm synthetic enzyme; Diet T4 contained 25% GCSM, 5% mushroom 0% DRC and 0ppm synthetic enzyme and diet T5 had 25% inclusion of GCSM, 200ppm synthetic enzyme, 0% DRC and 0% mushroom. Feed and water were provided ad-libitum. The nutrient digestibility for finisher proved that Prude protein (CP), Nitrogen Free Extract (NFE) and Dry Matter (DM) are not significant (P>0.05), the significant (P<0.05) values are in Ether Extract (EE), Ash and Crude Fibre (CF).

**Keywords***:* Digestibility, Broiler finisher, crude enzyme, Synthetic enzyme.

INTRODUCTION

Copious efforts have been put in place to make food available for global populace particularly the utilization of farm by-products to feed livestock. It was observed that undernourishment is more pronounced in underdeveloped nations (FAO, 2008) and this has always led to reappearance of interest in the sourcing of less expensive alternative feed ingredients as replacement for the more expensive conventional ones in livestock feed formulation. The aim is to increase the availability and affordability of animal products in order to alleviate universal food predicament.

Alternative feed ingredients also referred to as non-conventional feedstuffs are mostly agro-industrial by-products. The importance of agro-industrial by-products and the so-called “wastes” in meeting the energy and protein needs of farm animals is best appreciated when it is realized that feeding alone accounts for about 60 to 85% of the cost of intensively reared mono-gastric animals (Sanni and Ogundipe, 2005).

There was an observation by Alu (2010) that says in order to enhance the utilization of agro-waste products in poultry and monogastric diets, the high fiber contents must be broken down and its nutrient composition improved through processing. One of the ways of accomplishing this is through the using of enzyme supplementation or fermentation. McAllister *et al.* (2001) described the enzymes as naturally occurring biocatalysts which are produced by living cells to bring about specific biochemical reactions.

MATERIALS AND METHODS

Study area

The experiment was carried out at IBAS Poultry Farm Ltd Keffi, Nasarawa State. Keffi is located on Latitude 8051 and 8050 north of the equator and Longitude 7050 and 7051 east of the Greenwich meridian. The town had an average altitude of 850m beyond the sea level. The minimum yearly rainfall of the area is 1100mm and maximum of about 2000mm. (Lyam, 20007).

Experimental diets

Five different experimental diets: T1, T2, T3, T4 and T5 were compounded to be isocaloric (3000 kcal/kg ME) and isonitrogenous (18%CP) for finisher chicks. Diet T1 which did not contain Groundnut-cowpea shell meal (GCSM): Dried Rumen Content (DRC), mushroom and enzyme and served as control. Diet T2 had 25% GCSM, no DRC, mushroom, and enzyme, Diet T3 contained 25% GCSM, 5% DRC, mushroom and enzyme were not included also diet T4 contained 25% GCSM, 5% mushroom and none inclusion of DRC and enzyme, and diet T5 had 25% inclusion of GCSM, 200 ppm Quantum blue®; DRC and mushroom were not included. Broiler finisher chickens were fed with experimental diets for 28 days.

Table 1: Gross composition of experimental diets of broiler chicks (Finisher)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Ingredients | T1  0G, 0D 0M+0S | T2  25G, 0D, 0M+0S | T3  25G, 5D, 0M+0S | T4  25G, 0D, 5M+0S | T5  0G, 0D, 0M+200S |
| Maize (%) | 32.00 | 37.00 | 33.00 | 34.25 | 37.00 |
| Soya bean (Full fat) (%) | 17.00 | 20.00 | 23.00 | 23.00 | 20.00 |
| Groundnut cake (%) | 16.00 | 5.00 | 3.00 | 1.75 | 5.00 |
| Maize bran (%) | 16.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Rice bran (%) | 10.00 | 2.00 | 0.00 | 0.00 | 2.00 |
| Groundnut shells (%) | 0.00 | 15.00 | 15.00 | 15.00 | 15.00 |  |
| Cowpeas shells (%) | 0.00 | 10.00 | 10.00 | 10.00 | 10.00 |
| Bone meal (%) | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Blood meal (%) | 1.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Salt (%) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Palm oil (%) | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 |
| Lysine (%) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Methionine (%) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Premix (%) | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Dried Rumen Content (DRC) (%) | 0.00 | 0.00 | 5.00 | 0.00 | 0.00 |
| Mushroom (%) | 0.00 | 0.00 | 0.00 | 5.00 | 0.00 |
| Enzyme | 0.00 | 0.00 | 0.00 | 0.00 | ++ |
| Toxin binder | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| Total | 100 | 100 | 100 | 100 | 100 |
| Nutrient and energy composition | |  |  |  |  |
| Energy kcal/kg (ME) | 3090.89 | 3009.03 | 2992.04 | 2964.45 | 3009.03 |
| Crude protein | 20.49 | 20.07 | 20.16 | 20.08 | 20.07 |
| Crude fibre | 4.22 | 5.14 | 5.45 | 8.24 | 9.14 |
| Ether extract (%) | 8.53 | 10.89 | 11.702 | 10.89 | 10.98 |
| Ash (%) | 2.99 | 3.26 | 3.29 | 3.01 | 2.99 |
| Calcium | 1.11 | 0.42 | 0.44 | 0.52 | 0.42 |
| Phosphorus | 0,81 | 0.36 | 0.34 | 0.46 | 0.36 |
| Lysine (%) | 1.12 | 1.27 | 1.28 | 1.27 | 1.27 |
| Methionine (%) | 0.51 | 0.54 | 0.53 | 0.53 | 0.54 |

G= %Groundnut cowpea shell meal M=%Mushroom, S=ppm Synthetic enzyme, D=%Dried rumen content

Collection and processing of experimental materials

The cowpea and groundnut shells were collected from the rural farmers in Kokona Local Government Area of Nasarawa State, Nigeria. The cowpea and groundnut shells were milled into powder to form a meal using a locally made miller machine (unbranded) and sun-dried at 35oC for 5 hours as recommended by Ogbe and George (2012). Mushrooms were collected from the farmers in Kokona Local Government Area, Nasarawa State, and milled into powder form using pestle and mortar manually.

The rumen content was collected from the Keffi abattoir in Nasarawa state and sun dried for 3 days. The sundried material was milled using a hummer mill to produce finely ground dried rumen content meal. The Quantum blue® which was referred as synthetic enzyme was purchased from a registered dealer of agro industrial products known as Global Feeds Ltd located at New Nyanya, Karu LGA, Nasarawa State.

Experimental birds, management and design

Two hundred and forty (240) unsexed broiler chickens (Cobb 500 Strain) were used and their initial body weight was taken. The birds were reared in a deep litter system into five different compartments separated from each other by wire-mesh and was supported with wooden frame-work. They were provided with 200 watt bulbs to supply light and heat through electricity. Feed and water was provided to the birds throughout the experiment (*ad libitum),* all the management routine practices were strictly adhered to for ultimate performance. The design for the research was Completely Randomized Design (CRD) and the birds were distributed randomly to five treatments at the rate of 12 birds per replicate. Each treatment was replicated four times.

Digestibility trial

Samples of the feaces were collected for a period of seven (7) days for finisher stage. Two birds per replicate were used for the nutrient digestibility trial and the feaces collected were weighed and dried in an oven at the temperature of 600c dailyand dried samples were pooled together at the expiration of 7 days based on their treatment groups and grounded. Dried feaces samples were used to determine the proximate compositions as described by (AOAC, 2006).

Chemical analysis

Samples of the DRC, mushroom, groundnut and cowpea shells were taken to International Institute of Tropical Agriculture (IITA) Ibadan for proximate analysis using standard methods (AOAC, 2006). Nitrogen Free Extract (NFE) was calculated using the formula: NFE (%) = 100 – CP + CF + EE + Moisture + Ash. Metabolizable energy (ME) was calculated using Pauzenga Formula ME =37 x % CP + 81 x %EE + 35.5 x % NFE. (Pauzenga, 1985).

Table 2: Chemical composition of groundnut shells, cowpea shells, dried rumen content and mushroom

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nutrient | Groundnut shell | Cowpea shell | Dried Rumen Content | Mushroom  *(G. lucidum)* |
| Crude protein (%) | 5.43 | 19.82 | 9.25 | 16.07 |
| Ether extract (%) | 0.71 | 0.63 | 2.95 | 1.43 |
| Crude fibre (%) | 55.60 | 33.01 | 30.28 | 8.02 |
| Ash (%) | 3.17 | 4.11 | 11.41 | 9.01 |
| Dry matter (%) | 90.31 | 88.46 | 90.33 | 88.85 |
| Nitrogen Free Extract (NFE) (%) | 25.41 | 36.99 | 36.44 | 35.92 |

Statistical analysis The data obtained during the research were subjected to One Way Analysis of Variance (ANOVA) and significant means were separated using Duncan’s Multiple Range Test (DMRT) (Duncan, 1955).

RESULTS AND DISCUSSION

The effect of crude or synthetic enzymes on digestibility of broiler finisher chickens fed groundnut-cowpea shell-based diet shown in Table 3. The digestibility of ether extract and crude fibre were significantly (P<0.05) depressed as the level of treatment increase in the diets. Birds fed the control diet had better ether extract digestibility of 89.44% whereas those fed the control T2 and T3 had better crude fibre digestibility of 39.04%, 40.45% and 40.63%, respectively. Ash digestibility was significantly (P<0.05) highest in birds fed diet T3 (52.75%). The significant increase in crude fibre in birds fed diet T3 may be attributed to the addition of crude enzyme. This observation is in agreement with the previous work of Alu *et al.* (2012) who investigated the growth and nutrient digestibility of groundnut shell meal-based diet treated with alkali fed to broiler chickens and recorded a better crude fibre digestibility in all treatment diets compared to control.

Table 3: Effect of crude or synthetic enzyme on digestibility of broiler finisher fed groundnut-cowpea shells meal based diet

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PARAMETERS | T1  0G, 0D, 0M+0S | T2  25G, 0D, 0M+0S | T3  25G, 5D, 0M+0S | T4  25G, 0D, 5M+0S | T5  0G, 0D, 0M+200S | SEM | LOS |
| NUTRIENT DIGESTIBILITY | | | | | | | |
| Crude protein | 88.99 | 89.34 | 89.00 | 90.01 | 90.89 | 0.29 | NS |
| Ether extract | 89.44a | 87.41b | 86.37b | 86.47b | 86.87b | 0.41 | \* |
| Crude fibre | 39.04a | 40.45a | 40.63a | 33.33c | 36.51b | 0.93 | \* |
| Ash | 54.00b | 57.81a | 52.75bc | 50.29d | 51.36cd | 0.89 | \* |
| Nitrogen free extract | 63.35 | 63.97 | 64.24 | 63.39 | 64.67 | 0.24 | NS |
| Dry matter | 68.40 | 68.18 | 68.28 | 68.45 | 69.24 | 0.19 | NS |

ab means on the same column having different superscript differ significantly (p<0.05); NS = not significantly different (p>0.05); SEM = standard error of mean; LOS = level of significant. %G= Groundnut cowpea shell meal %M=Mushroom, ppmS= Synthetic enzyme, %D=Dried rumen content

CONCLUSION

The result of this study has revealed that there was significant increase in crude fibre in birds fed diet T3 indicated that the addition of crude enzyme has improved the digestibility of the fibre content of the feed.

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## UTILIZATION OF MAIZE BRAN CHEMICAL HYDROLYSATE USING MINERAL ACID IN THE PRATICAL DIETS OF *Clarias gariepinus*

A. S Fayemiwo, S.O.E Sadiku and A.M Orire.

Department Of Water Resources Aquaculture and Fisheries Technology

Federal University of Technology, Minna, Nigeria

Corresponding author’s address: [fayemiwoabimbola@gmail.com](mailto:fayemiwoabimbola@gmail.com)

ABSTRACT

*The study was carried out to ascertain utilization of maize bran chemical hydrolysate using mineral acid in the practical diets of Clarias gariepinus. Two hundred and twenty five fingerlings of Clarias gariepinus was used in a complete randomized design. Five experimental diets were used. Whole Maize Meal (WMM), Maize Starch (MS), Maize Bran (MB), Hydrolysed Maize Bran (HMB) and commercial feed as the control. The fish were weighed and stocked at 15 fishes per tank for the treatments in triplicates. The fishes were fed three times daily and bulked weighed forth nightly. They were fed to satiation for 56 days. Data on growth performance and utilization was collected and analyzed by one way analysis of variance. No Significant difference was observed for the Mean Weight gain, The Apparent net protein utilization (ANPU) and protein efficiency ratio (PER) for diet 1, 3 and diet 4 but diet 5 had a significantly high value (p<0.05) while diet 2 has significantly (p<0.05) low value. It was concluded that maize bran hydolysates can be utilized in Clarias gariepinus. However, Maize Bran Hydrolysates was utilized but at a lower rate comparing with commercial feed and their use in fish feed could address the challenge of high cost of fish feed.*

**Keywords**: Growth Performance, Utilization, Hydrolysate, Maize Bran, *Clarias gariepinus*

INTRODUCTION

The total production of aquafeeds for all aquaculture species is predicted to increase by 75% from 49.7 million tons in 2015 to 87.1 million tons in 2025 (Tacon, 2015). Maize is a common energy source in formulated feeds for fish like *Clarias gariepinus*. Maize is one of the major sources of metabolizable energy in most compounded diets for catfish species and this is because it is readily available and digestible. In recent times, the global pandemic and high rate of insecurity in Nigeria has given a hike in cost of plant source and ingredients used in feed formulation for fish especially the use of maize. Maize Bran which is removed during processing of whole maize or maize starch is highly fibrous and contains celluloses, hemicelluloses and lignin which monogastric such as fish cannot digest (Haghighi, 2018). It is often discarded, given to ruminants, poultry birds or allowed to waste away. More so, these by-products are currently not only underutilized but many times represent a disposal problem which compromises environmental sanity. However, hydrolyzing maize bran and incorporating them into fish diets could enhance their digestibility and utilization in the body *of Clarias gariepinus* and achieve zero waste in feed formulation.

MATERIALS AND METHODS

Experimental System

The experiment was conducted in a recycling water system of the Department of Water Resources, Aquaculture and Fisheries Technology laboratory of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Gidan Kwano Campus, Niger State, Nigeria. A total of five (5) treatments were used, five (5) treatments in triplicates of maize meal (MM), Maize Starch (MS), maize bran (MB), chemically hydrolysed Maize Bran (HMB) and commercial reference control diet (CRCD). The experimental design used is complete randomized design (CRD) with one fish per liter in a 15-liter tank.

Experimental Fish

Total of (225) fingerlings of *Clarias gariepinus* were purchased from Tagwai Fish Farm, Niger State and transported to the Department of Water Resources, Aquaculture and Fisheries Technology (WAFT) laboratory. As feeding trial commenced, fish at fingerling stage was weighed and stocked at 15 fishes per tank for the five treatments in triplicates. The fishes were fed three times daily between the hours of 8am, 12pm and 4pm. The fishes were bulked weighed forth nightly and at the end of experiment, all fishes were weighed and counted individually of which five was selected for the determination of final whole-body composition. The duration of experiment was for 56 days (8 weeks). The fish were fed to satiation and their percentage body weights were adjusted bi weekly to fit into their satiation level.

**Experimental Feed and Preparation of Hydrolysed Maize Bran**

The feed ingredients were purchased from Minna, Central Market, Niger State which includes fish meal, groundnut cake, maize and vitamin mineral premix. The maize bran extracted from whole maize was processed further after by adding 1.25% of Sulphuric acid in a ratio of solid to liquid of 1:4. 100g of maize bran was weighed and soaked into 400ml of 1.25% Sulphuric acid solution and boiled for 30 minutes. Thereafter, the mixtures were washed thoroughly and 400mls of sodium hydroxide was added to the washed mixture and then boiled for another 30 minutes to stabilize the pH and washed after boiling. The hydrolysed bran was sieved and used for formulation of feed.

Feed Formulation and Diet Preparation

Using the equational method of feed formulation, five diets were formulated at 40% crude protein (CP). The diets are Diet I Whole Maize Meal (MM), Diet II Maize Starch (MS), Diet III, Maize Bran (MB), Diet IV Hydrolysed Maize Bran (HMB).

Proximate Analysis and Statistical Analysis

The experimental diet were analysed to check for proximate composition according to A.O.A.C 2005.The data obtained was subjected to one way analysis of variance (ANOVA) using Turkey’s test (Steel, 1981) at 5% probability level. Multiple parameters mean comparison of treatments will be according to Duncan multiple range tests (Duncan, 1955) using the software SPSS 23.

RESULTS

The mean initial weight (MIW) of the experimental fishes for all diets were not significantly different (p>0.05). There was no significant difference ­­­(P>0.05) observed for the mean final weight for Diet 1(11.48g),3(10.67g), 4(11.14g) but diet 5 had a significantly high value (p<0.05) of 31.89g while diet 2 has significantly (p<0.05) low value of 8.87g and it was same with their Mean Weight gain, The Apparent net protein utilization (ANPU) as well as protein efficiency ratio (PER) as seen in table 4. The Specific growth rate was significantly high (p<0.05) for the control diet 5 (5.17%/day) while there was no significant difference between diet 1 (3.33%/day), 2(2.88%/day), 3(3.21%/day) and diet 4(2.95%/day). The survival rate had no significant difference (p>0.05) between diet 3(86.66%), diet 4(86.66%) and diet 5(86.66%) while there was no significant difference (p>0.05) between diet 1(76.65%) and diet 2 (70%) in table 4

Table 1: Proximate Composition of Feed Ingredients

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Proximate (%)** | **Fish Meal** | **GNC** | **Maize** | **Maize Starch** | **Maize Bran** | **HMB** |
| Crude Protein | 60.38 | 30.62 | 11.00 | 4.81 | 10.06 | 10.06 |
| Crude Fibre | 0.05 | 1.25 | 0.45 | 0 | 6.80 | 0 |
| Crude Lipid | 19.73 | 31.08 | 8.14 | 0.8 | 3.86 | 0.8 |
| Ash | 6.70 | 7.35 | 1.4 | 0.05 | 0.35 | 1.2 |
| Moisture | 6.87 | 3.52 | 7.45 | 2.95 | 1.24 | 7.34 |
| NFE | 6.27 | 26.18 | 71.45 | 91.39 | 60.36 | 80.6 |

**Table 2: Composition of experimental diets fed *Clarias gariepinus* for 56 days**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ingredients** | **Diet 1** | **Diet 2** | **Diet 3** | **Diet 4** |
| Fish Meal | 8.39 | 8.56 | 8.42 | 8.42 |
| GNC | 75.59 | 76.99 | 75.76 | 75.62 |
| Whole Maize | 11.02 | 0.00 | 0.00 | 0.00 |
| Maize Starch | 0.00 | 9.45 | 0.00 | 0.00 |
| Maize Bran | 0.00 | 0.00 | 10.82 | 0.00 |
| HMB | 0.00 | 0.00 | 0.00 | 10.82 |
| Vitamin Premix | 5.00 | 5.00 | 5.00 | 5.00 |
| **Total** | **100** | **100** | **100** | **100** |

**Table 3: Chemical composition and proximate analysis of the formulated diets**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Proximate** | **Diet 1** | **Diet 2** | **Diet 3** | **Diet 4** | **Diet 5** |
| CP | 40.16 | 40.09 | 40.07 | 40.11 | 40 |
| Ash | 14.8 | 14.6 | 14.20 | 15.65 | 8.00 |
| Lipid | 13.88 | 12.30 | 12.44 | 12.6 | 12.00 |
| Fiber | 2.5 | 1.16 | 6.67 | 1.83 | 4.00 |
| Moisture | 4.62 | 5.2 | 4.76 | 6.74 | 3.42 |
| NFE | 24.12 | 26.65 | 21.86 | 23.07 | 32.58 |

**Table 4: Growth Parameters and Nutrient Utilization of Experimental Diets fed *Clarias gariepinus* fingerlings for 56 days**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Growth Parameters | Diet 1  (WMM) | Diet 2  (MS) | Diet 3  (MBM) | Diet 4  (HMB) | Diet 5  (CRCD) | SD± |
| MIW(g) | 1.76±0.01 | 1.76±0.02 | 1.76±0.01 | 1.77±0.01 | 1.7±0.2 | 0.01 |
| MFW(g) | 11.48±0.43b | 8.87±0.41c | 10.67±0.19b | 11.14±0.71b | 31.89±0.82a | 0.55 |
| MWG(g) | 9.71±0.42b | 7.11±0.42c | 8.92±0.18b | 9.37±0.72b | 30.14±0.82a | 0.56 |
| SGR(%/Day) | 3.33±0.06b | 2.88±0.09b | 3.21±0.03b | 2.95±0.59b | 5.17±0.05a | 0.27 |
| FCR | 2.48±0.05b | 3.70±0.83a | 2.45±0.04b | 2.30±0.11b | 0.9±0.03c | 0.37 |
| PER | 1.00±0.01b | 0.69±0.17c | 0.99±0.00b | 1.08±0.06b | 2.76±0.08a | 0.09 |
| ANPU(%) | 38.1±0.70b | 28.98±5.94c | 39.00±2.19b | 43.84±2.08b | 133.30±6.90a | 4.30 |
| Survival(%) | 76.65±3.35b | 70.00±10.00b | 86.66±0.00a | 86.66±0.00a | 86.66±0.00a | 4.72 |

KEY: MIW: Mean Initial Weight; MFW: Mean Final Weight; MWG: Mean Weight Gain; SGR: Specific Growth Rate; FCR: Feed Conversion Ratio; ANPU: Apparent Net Protein Utilization; PER: Protein Efficiency Ratio and SD: Standard Deviation. WMM: Whole Maize Meal; MS: Maize Starch; MBM: Maize Bran Meal, HMB: Hydrolysed Maize Bran, CRCD: Commercial Reference Control Diet.

DISCUSSION

The growth performance and utilization of diet 1, diet 3 and diet 4 for MWG, SGR, FCR, ANPU was with no significant difference (p<0.05) but positive as feed was utilized. There was a high significant growth (p>0.05) in control diet 5 which gave the best result possibly because of its superiority over the experimental diets. This result agrees with the report of (Olaniyi 2009 a&b) who indicated that the higher the SGR and the smaller the FCR values, the better the feed quality. Diet 2 had lower values for MWG, SGR, and PER. Alegbeleye *et al*., (2008) reported significant decrease in weight gain when maize was replaced with corn flour (*Colocassia esculenta*). The high survival rate in this study indicates that feeding *Clarias gariepinus with HMB* does not lead to mortality of fish. The nutrient quality, which translated into good growth in the fish fed with HMB could be as a result of the processing method adopted.

CONCLUSION

It was therefore concluded that maize bran hydolysates can be utilized in the feed of *Clarias gariepinus*. However, Maize Bran Hydrolysates performed and was utilized but at a lower rate comparing with commercial feed. The use of maize bran hydrolysates in fish feed will address the challenge of high cost of fish feed and also help the environmental challenge of bran disposal in the environment.

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## GROWTH PERFORMANCE AND EGG PRODUCTION OF JAPANESE QUAILS FED DIFFERENTLY PROCESSED (*Leucaena leucocephala*) BASED DIETS

Ejaife, O.C., Alabi, O.J., Adeyanju, K.M.

Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State

[Jakpin001@gmail.com](mailto:Jakpin001@gmail.com)

08165389278

ABSTRACT

*A study was conducted to determine the effects of differently processed Leucaena leucocephala based diets on the growth performance and egg production of Japanese quail birds. A total of 135 unsexed two week – old Japanese quail chicks were distributed into three equal groups. Group was the control while groups 2 and 3 contained 5 % boiled Leucaena leucocephala (BLL) and 5 % Roasted Leucaena leucocephala (RLL), respectively. Each group was replicated three times using completely randomized design. Data on growth performance at both starter and laying phases and egg production parameters were taken and subjected to one way analysis of variance. Where differences occurred at P<0.05 they were separated using Duncan multiple range test. After 12 weeks of feeding trial, results showed that dietary treatment had no (P>0.05) effect on all the growth parameters measured at the starter phase. However, at the laying phase, the total weight gain, total feed intake and daily feed intake were affected (P<0.05) by dietary treatments with birds on the control diet performing better than those on RLL. Dietary treatment had no (P>0.05) effect on all the egg production parameters measured. It can therefore be concluded, that boiled L. leucocephala at an inclusion level of 5 % is an ideal replacement for conventional feed sources in the diet of Japanese quails.*

INTRODUCTION

The poultry industry has flourished as a result of rapid growth of the human population in developing and third-world countries, however, since the mid-eighties, poultry production has been on the decline mainly due to high cost of feed, drugs, disease, inadequate supply and poor quality of day-old chicks amongst other factors (Musa *et al*., 2008). As a result, people in most of these countries consume significantly less animal protein than recommended. Thus, there have been requests in emerging countries for a significant increase in animal protein consumption. Animal scientists in general, and nutritionists in particular, have focused on promoting the rearing of species that were formerly viewed as less significant in their drive to make animal protein more accessible and inexpensive to the average man. One of such poultry birds is the Japanese quail. They are fast growing birds that reach maturity between five and six weeks of age and lay their first eggs. In addition, the meat from the birds is lean and the egg is low in cholesterol, which is beneficial to public health. Like other poultry birds, feeding is a major challenge faced by quail farmers. Because of the seasonality of their production and competition for man and livestock consumption, their high inclusion rates translate into high feed costs. In light of this, any alternative crop that could be used to reduce the amount of these energy (maize) and protein (soya bean) sources in the diet will greatly lower the cost of producing feed for livestock, provided the crop is available in reasonable quantities, is inexpensive, easy to process, and potentially contributes as much, if not more, nutrients than the conventional ones in the diet. One of such is *L. leucocephala,* they are rich in crude protein and are readily available. This research work was aimed at determining the effect of differently processed *L. leucocephala* meal-based diet on the growth performance and egg quality of Japanese quails.

MATERIALS AND METHODS

The research work was carried out at the Teaching and Research Farm at the Department of Animal Production Federal University of Technology, Bosso campus, Minna, Niger state, Nigeria. Minna lies between the Latitude 9 0 23 ’ to 6 0 33 ’E with annual rainfall of 1000 – 1500 mm and a temperature range 28 0 – 30 0c. The mean annual rainfall varies from 1102.6 to 1361.7 mm. *L. leucocephala* pods was harvested within the Federal University of Technology, Gidan kwano Campus, Minna. The seeds were gathered and sorted to remove the dirt and stones. Maize, maize bran and salt were purchased from Kure Ultra-Modern Market, Minna. Groundnut cake, vitamin-premix, lysine, methionine, fishmeal and bone meal were purchased at Farida shop No. 7, Gidan Matasa, Bosso, Minna. A total of 135 two weeks old Japanese quails used for this study was purchased from Jigina Farms located in Bwari Area Council, Abuja.

Ingredients processing, experimental design and data collection

Five kg of *L. leucocephala* was roasted at 85 0 c for 30 minutes using stove with iron pot mixed sand as described by Ojo *et al.* (2013). During roasting the seed was stirred continuously to ensure uniform roasting to prevent burning till they were brown. The seed was then spread out to cool after which they were milled using a hammer mill with the size of 3 mm and labeled roasted *Leucaena* seed meal (RSLM). Another five kg of each seed was subjected to boiling at 100 0 C for 25 minutes as described by Jimoh *et al.* (2014) after which water was drained off by means of a 10 mm sieve and the seeds were sun – dried. The seeds were then milled using hammer mill and then sieved with a 3 mm sieve sized and labeled boiled *Leucaena* seed meal (BLSM). It was stored in an airtight container before use.

A total of 135 unsexed two week – old Japanese quail chicks were distributed into three equal groups. Group 1 was the control while groups 2 and 3 contained 5 % Boiled *L. leucocephala* (BLL) and 5 % Roasted *Leucaena leucocephala* (RLL), respectively. Each group was replicated three times using completely randomized design. On arrival, the birds were weighed and randomly assigned to their treatments, provided with water and feed *ad libitum*. Light was also provided for 18 hours. Diet containing 2700 kcal/kg ME and protein 22 and 18 %, were used at the starter and laying phases, respectively.

Data on body weight and feed intake were measured and used for calculating the body weight gain daily, weekly feed intake and feed conversion ratio using the procedure of Peter *et al*. (2006). The egg production performance characteristics determined included the hen-housed and hen-day egg production. All data collected were subjected to one way analysis of variance (ANOVA) using SAS (2015) at 5% probability level. Significantly different means were separated using Duncan Multiple Range Test (SAS, 2015).

RESULTS AND DISCUSSION

The results of the growth performance of quails fed processed *L. leucocephala* seed meal-based diets at the starter phase are presented in Table 1. The results showed that dietary treatment had no effect (p>0.05) on all parameters measured at the starter phase.

The results of the growth performance of quails fed processed *L. leucocephala* seed meal-based diets at the laying phase are presented in Table 2. The results showed that dietary treatments had effects (p<0.05) on the total weight gain, total feed intake and the daily feed intake of Japanese quails at laying phase. However, all other parameters (initial weight, final weight, daily weight gain and FCR) were not affected (p>0.05) by the dietary treatments.

Birds on Roasted *Leucaena leucocephala* (RLL) and Boiled *Leucaena leucocephala* (BLL) had similar (p>0.05) total weight gains, total feed intakes and daily feed intakes. There were no significant different (p>0.05) in the quails fed with control and BLL diets. However, birds on RLL had lower (p<0.05) total weight gain, total feed intake and daily feed intake than the birds on the control diet.

The results of egg production performance of the quails fed processed *L. leucocephala* seed meal-based diets at the laying phase are presented in Table 3. The results showed that dietary treatments had no effect (p>0.05) on all egg parameters (egg lay, hen day, hen house, haugh unit and egg weight) at the laying phase.

Roasted *L. leucocephala* diets exerted negative influence on the total weight gain at the laying phase. This could be because roasting destroyed some vital nutrients which were needed for growth in monogastric animals. Studies have shown that heat denatures protein in feed stuff, particularly, heat liable nutrients (OECD, 2001). This was in line with the report of Ari *et al*. (2012) when they evaluated the chemical composition and anti-nutritional factor levels of differently processed soyabeans. Their results showed that heat affected the amino acid profiles, indicating that proteins are less denatured by cooking processes compared to roasting processing method. Reduction in the anti-nutrients present in *L. leucocephala* was observed to be more efficient when processed by boiling (Agbo *et al*., 2017). The present finding were in line with the works of Wafar *et al*. (2016, 2018) that showed weight losses in broilers and rabbits when they were fed with roasted *mucana* and kapok seed meal diets, respectively. The similar results observed in the total weight gain in birds fed the control and boiled *L. leucocephala* seed meal diets at the laying phase could be an indication that the diets provided similar nutrients needed by the birds. This was in agreement with those of Akanji *et al*. (2016) that worked on the performance of broilers fed raw and processed cowpea diets. Wafar *et al*. (2016, 2018) also noted increases in the total weight gain for broilers and rabbits when fed diets containing boiled *mucana* and kapok seed meals, respectively. The reason for the dietary treatments having negligible effects on the egg production parameters observed in this study may imply that the requirements for egg production were adequate since there were no differences between the birds fed with treated and the control diets.

CONCLUSION

It could be concluded from the results of feeding differently processed *L. leucocephala* seed meal diets to Japanese quails that the dietary treatments had effect on the total weight gain, total feed intake and daily feed intake with boiling method and control exerting similar impact. However, roasted *L. leucocephala* feed meal diet had negative influence on these parameters at the laying phase. Also, the dietary treatments had no effects on the egg production parameters of Japanese quails. Thus, boiled *L. leucocephala* meal at an inclusion level of 5 % is recommended as a replacement for soya bean meal in the diet of Japanese quails.

Table 1 Growth Performance of Japanese quails fed Processed *Leucaena leucophala* seed meal Based Diets at the starter phase

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Control | BLL | RLL | SEM | P-value |
| Initial weight (g) | 74.44 | 76.67 | 77.87 | 1.032 | 0.464 |
| Final weight (g) | 113.16 | 113.66 | 113.78 | 4.311 | 0.999 |
| Weight gain (g) | 38.72 | 36.99 | 36.00 | 4.074 | 0.972 |
| Daily weight gain (g) | 1.11 | 1.06 | 1.03 | 0.116 | 0.970 |
| Total feed intake (g) | 260.53 | 265.10 | 255.38 | 3.264 | 0.527 |
| Daily feed intake (g) | 6.20 | 6.32 | 6.08 | 0.780 | 0.528 |
| FCR | 5.69 | 6.91 | 7.00 | 0.861 | 0.830 |
| Mortality (%) | 0.00 | 0.33 | 0.67 | 0.167 | 0.296 |

Keys:-BLL-Boiled *Leucaena leucophala,* RLL -Roasted *Leucaena leucophala,* SEM -Standard Error Mean, FCR Feed Conversion Ratio

Table 2 Growth Performance of Japanese quails fed Processed *Leucaena leucophala* seed meal Based Diets at the Laying phase

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Control | BLL | RLL | SEM | p-value |
| Initial weight (g) | 126.23 | 126.23 | 126.23 | 0.293 | 1.000 |
| Final weight (g) | 273.35 | 271.72 | 267.02 | 1.331 | 0.119 |
| Total weight gain (g) | 147.11a | 145.4ab | 140.78b | 1.270 | 0.046 |
| Daily weight gain (g) | 3.50 | 3.46 | 3.35 | 0.301 | 0.099 |
| Total feed intake (g) | 470.22a | 444.06ab | 417.29b | 8.915 | 0.019 |
| Daily feed intake (g) | 9.60a | 9.06aab | 8.52b | 0.182 | 0.018 |
| FCR | 2.74 | 2.62 | 2.54 | 0.046 | 0.208 |

Keys:-BLL Boiled *Leucaena leucophala,* RLL Roasted *Leucaena leucophala,* SEM Standard Error Mean, FCR Feed Conversion Ratio

Table 3 Egg Production Parameters of Japanese quails fed Processed *L. leucocephala* seed meal Based Diets.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | Control | BLL | RLL | SEM | P-value |
| No. of egg lay | 37.67 | 35.33 | 27.33 | 4.243 | 0.645 |
| Hen Day | 7.84 | 8.29 | 6.65 | 1.073 | 0.852 |
| Hen House | 5.55 | 5.56 | 5.67 | 0.955 | 0.999 |
| Haugh unit | 90.76 | 99.68 | 98.79 | 2.406 | 0.278 |
| Egg weight | 5.76 | 5.97 | 7.22 | 0.370 | 0.238 |

Keys:-BLL Boiled *Leucaena leucophala,* RLL Roasted *Leucaena leucophala,* SEM Standard Error mean,

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## EFFECT OF PROCESSED SELECTED MEDICINAL PLANTSDIETS ON HAEMATOLOGICAL PARAMETERS OF *Clarias gariepinus* (BURCHELL, 1822)

\*A. M. Suleiman, A. M. Orire; S. O. E. Sadiku; G. G. Bake

\* Department of Fisheries and Aquaculture, Bayero University Kano, Nigeria

Department of Water Recourses, Aquaculture and Fisheries Technology, Federal University of Technology, Minna, Nigeria

samohammed.faq@buk.edu.ng

ABSTRACT

*An experiment was conducted to test the effect of some processed medicinal plants on haematological parameters of Clarias gariepinus. The plants were processed with aqueous ethanol and hexane solvent. Thirteen diets with 3% and 5% inclusion level of the processed plants were formulated and diet with zero medicinal plant serving as a control. Water quality parameters measured were within the recommended standard range. The results of the tested diets were within the haematological recommended range. There were significant difference (P>0.05) among the tested diets. There were increase in RBC count 3% EAQ (4.00±0.20×106/l), (4.10±0.10×106/l) and 5% MHX (4.00±0.10×106/l) based diets. The RBC count of all the tested diets were observed to be significantly higher than control diet (2.40±0.20×106/l). There were varying increase in White Blood Cell (WBC) Count among the experimental based diets while 3% EET (10.30±0.30×109/l), 3% MAQ (10.60±0.20×109/l) and 5% EET (10.30±0.10×109/l) were least significant (P>0.05) among the tested processed Medicinal plants diets. There were significant difference (P>0.05) among haemoglobin (Hb), MCV and MCH while no significant difference were observed in PCV, MCHC counts. The tested shows haematological significant contribution to fish survival due to high immunity and resistance against anaemic condition. 3% and 5% inclusion levels of medicinal processed diet both have similar haematological positive impact on Clarias gariepinus but 3% is recommended for use due to the growth performance of the fish measured during the study.*

**Keywords:** Haematology; Aqueous; Ethanol; Hexane; and *Clarias gariepinus*

INTRODUCTION

Aquaculture production in Africa has been on a steady increase, growing more rapidly in Sub-Saharan African countries than the rest of Africa countries on the continent (FAO, 2012). According to Halwart (2020), the contribution of Africa to the global production of aquaculture in 2018 was estimated at 21,296 metric tons representing an insignificant 2.67% and was mainly dominated by freshwater finfish production. Nigeria population as at July, 2021was estimated to be 211,400,708 and the highest demand for fish in Africa and has also been identified to have been the largest producer of African catfish (Adeleke *et al*., 2021).

However, during the past few years, aquaculture has encountered repeated problems of diseases emanated from feed due to poor availability of suitable constituent, lack of adequate knowledge on feed preparation, poor formulation and processing of ingredients and lack of knowledge and understanding of dietary requirement of targeted fish species (Fagbenro *et al*., 2013). The best way to curtail the challenges of fish losses in this regard is to improve their resistance to infections in addition to improving husbandry with good health management (Anjusha *et* *al*., 2019). Disease is a considerable constraint in aquaculture expansion, production and development. Recent research has been demonstrating the positive effect of medicinal plants incorporation with aqua-feed formulation in fish culture (Anjusha *et al*., 2019).

Haematology investigation serves mainly for diagnostic purpose. It can be used to appraise suitability of feeds and examine the stress situation of fish (Fagbenro *et al*., 2013). It is one of the diagnostic tools for identifying diseases. Normal variation from intrinsic or extrinsic factors or diseases affecting blood cells and counts may be evaluated by clinical haematology (Grant, 2015). Most of the fish have nucleated erythrocytes which play an important role in oxygen transport, which depends on the amount of haemoglobin concentration within the cell and the gas exchange mechanism (Fauci, 1993; Anjusha *et al*., 2019).

MATERIALS AND METHODS

Feeding trial was conducted at the indoor hatchery of the farm complex of the Department of Fisheries and Aquaculture, Bayero University Kano, Nigeria. Latitude 11.978422°N and longitude 8.424395°E. *Eucalyptus globulus* and *Moringa oleifera* leaf meals were subjected to Aqueous, Ethanol and Hexane processing methods. Each was measured 250g into 1000 ml labelled bottle using Ohaus sensitive weighing balance (PA313). The meals were soaked with 500 ml of the aforementioned solvents (Suleiman *et* *al*., 2018) in a tightly covered bottles s and agitated at interval of 8 hours for a period of 72 hours and filtered using muslin (Ezearigo *et* *al*., 2014). The filtrate was evaporated to dryness under pressure at 45°C using rotary evaporator (RE300). The extracts were labelled as Eucalyptus Aqueous (EAQ), Eucalyptus Ethanol (EET), Eucalyptus Hexane (EHX), Moringa Aqueous (MAQ), Moringa Ethanol (MET) and Moringa Hexane (MHX) respectively. The extracts were preserved at -4°C until further usage (Chakraborty *et al*., 2018).

Diet Formulation

Thirteen diets (40% Crude Protein) were formulated for the experiment. It was done based on the determination of proximate compositions of the ingredients using AOAC (2010) with incorporation of 3% and 5% inclusion levels of processed plants (Table 1a and 1b). The extract were dissolved in 350 ml of warm water which was used to form a uniform dough-like paste. The feeds were pelleted to 2 mm size using improvised manual pelletiser and dried at 26°C for 72 hours (Ochang *et al*., 2015; Jiomh *et al*., 2022).

Table 1a: Feed Formulation Showing Inclusion Levels of Processed Medicinal Plants (Eucalyptus and Moringa) Diets

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Ingredients** | **D1**  **ZMD** | **D2**  **(3%EAQ)** | **D3**  **(3%EET)** | **D4**  **(3%EHX)** | **`D5**  **(3%MAQ)** | **D6**  **(3%MET)** | **D7**  **(3%MHX)** |
| **FM (61.45%)** | 25.71 | 24.90 | 24.90 | 24.90 | 24.90 | 24.90 | 24.90 |
| **SBM (40.05%)** | 51.42 | 49.80 | 49.80 | 49.80 | 49.80 | 49.80 | 49.80 |
| **MM (9%)** | 17.87 | 17.30 | 17.30 | 17.30 | 17.30 | 17.30 | 17.30 |
| **Moringa** | 0.00 | 0.00 | 0.00 | 0.00 | 3.00 | 3.00 | 3.00 |
| **Eucalyptus** | 0.00 | 3.00 | 3.00 | 3.00 | 0.00 | 0.00 | 0.00 |
| **Oil** | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| **Lysine** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Methionine** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Bone Meal** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **VMP** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Total** | **100** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |
| **Proximate Compositions (%) of the Experimental Diets formulated at 3% and 5% Inclusion Levels of Medicinal Plants** | | | | | | | |
| **Ash (%)** | 12.63 | 12.66 | 12.52 | 12.38 | 12.65 | 9.45 | 11.92 |
| **Crude**  **Fibre (%)** | 4.07 | 4.17 | 4.4.00 | 4.63 | 2.28 | 5.83 | 6.05 |
| **Fat (%)** | 16.52 | 11.76 | 11.97 | 12.18 | 8.95 | 10.84 | 10.54 |
| **Crude**  **Protein (%)** | 43.22 | 38.05 | 40.01 | 39.72 | 42.34 | 42.00 | 41.50 |
| **Moisture (%)** | 7.05 | 5.45 | 5.31 | 5.63 | 5.93 | 5.03 | 6.10 |
| **Carbohydrate (%)** | 16.51 | 27.91 | 25.79 | 25.46 | 24.85 | 26.85 | 23.89 |
| **Total** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** | **100.00** |

FM = Fishmeal, SBM = Soybean Meal, MM = Maize Meal, VMP = Vitamin and Mineral Premix, ZMD = Zero Medicinal Diet, EAQ = Eucalyptus Aqueous, EET = Eucalyptus Ethanol, EHX = Eucalyptus Hexane, MAQ = Moringa Aqueous, MET =Moringa Ethanol and MHX = Moringa Hexane

Table 1b: Feed Formulation Showing Inclusion Levels of Processed Medicinal Plants (Eucalyptus and Moringa) Diets

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Ingredients** | **D8**  **(5%EAQ)** | **D9**  **(EET5%)** | **D10**  **(5%EHX)** | **D11**  **(5%MAQ)** | **D12**  **(5%MET)** | **D13**  **(5%MHX)** |
| **FM** | 24.36 | 24.36 | 24.36 | 24.36 | 24.36 | 24.36 |
| **SBM** | 48.71 | 48.71 | 48.71 | 48.71 | 48.71 | 48.71 |
| **MM** | 16.93 | 16.93 | 16.93 | 16.93 | 16.93 | 16.93 |
| **Moringa** | 0.00 | 0.00 | 0.00 | 5.00 | 5.00 | 5.00 |
| **Eucalyptus** | 5.00 | 5.00 | 5.00 | 0.00 | 0.00 | 0.00 |
| **Oil** | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 |
| **Lysine** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Methionine** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Bone Meal** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **VMP** | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** |
| **Proximate Compositions (%) of the Experimental Diets formulated at 3% and 5% Inclusion Levels of Medicinal Plants** | | | | | | |
| Ash (%) | 13.38 | 13.88 | 12.54 | 12.75 | 10.31 | 13.92 |
| Crude  Fibre (%) | 6.09 | 6.09 | 4.64 | 5.35 | 4.88 | 4.45 |
| Fat (%) | 12.22 | 12.22 | 12.91 | 14.24 | 12.65 | 13.09 |
| Crude  Protein (%) | 41.60 | 41.80 | 38.36 | 39.2 | 38.82 | 40.36 |
| Moisture (%) | 4.76 | 4.79 | 5.93 | 5.40 | 5.48 | 6.09 |
| Carbohydrate (%) | 21.95 | 21.22 | 25.62 | 23.06 | 27.86 | 22.09 |
| **Total** | **100** | **100** | **100** | **100** | **100** | **100** |

Experimental Design

*Clarias gariepinus* fingerlings (9.66 ± 0.15 g) were acclimatize to experimental condition for two weeks before being distributed to various experimental units. Fish were starved 24 hours prior to the commencement of feeding trials in order to increase their appetite and eliminate variation in weight due to residual feed content that may be left in their gut (Ochang *et al*., 2015). Fish are weighed equally and distributed into various experimental units using an electronic digital sensitive weighing balance (MP300) at a stocking density of 20 fish per experimental unit. Water quality parameters were monitored weekly, they were fed 5% of their body weight daily with equal meals being fed between 10 am and 16 pm.

Blood Sample Collection and Haematological Determination

Haematological parameters was conducted before and after the experiment suing (Kelly, 1979) procedures. Fish were carefully caught randomly, one at a time with least disturbance. Each fish was held at the head region, carefully lifted with one hand to a comfortable handling position while the other hand was used to hold 2 ml syringe and needle which was inserted into the fish at a perpendicular angle of 45° to the anal fin to the vertebral column and desirable blood sample was collected and transferred into anticoagulant Ethylene Di Amine Tetra Acetic Acid (EDTA) labelled tubes (Argungu *et al*., 2017). The tubes containing the samples were gently mixed with the anticoagulant after covering them and kept in a sample box containing ice prior to haematology analysis.

Statistical Analysis

The experimental data were subjected one way Analysis of Variance (ANOVA) using Statistical Package for Social Scientists (SPSS) version 16.0 to test the effect among the treatment means at 0.05 significant difference. Multiple comparisons among the treatments were achieved using “R” statistical packages.

RESULTS

Table 2a and 2b shows the haematological parameters of the *Clarias gariepinus* fingerlings that were fed 3% and 5% inclusion levels of processed medicinal plants diets. Definite variations were dictated among the various treatments. High levels of Red Blood Cell (RBC) count were observed in 3% EAQ (4.00±0.20×106/l), 3% MAQ (4.10±0.10×106/l) and 5% MHX (4.00±0.10×106/l) as they were not significantly different (P>0.05) from each other. The RBC count of all the tested diets were observed to be significantly higher than the control diet ZMD (2.40±0.20×106/l). There were varying increase in White Blood Cell (WBC) Count among the experimental based diets while 3% EET (10.30±0.30×109/l), 3% MAQ (10.60±0.20×109/l) and 5% EET (10.30±0.10×109/l) were least significant (P>0.05) among the tested processed Medicinal plants diets. Haemoglobin (Hb) in all the tested diets were observed to be significantly (P>0.05) higher than the control diet (6.60±0.20×10g/dl). The Mean Cell Volume (MCV) and Mean Cell Haemoglobin (MCH) counts in this study appeared to be significantly (P>0.05) different among all the tested diets. However, the Mean Cell Haemoglobin Concentration (MCHC) count for all the experimental diets were not significantly (P>0.05) different from each other. The water quality parameters measured during the experiments are Temperature (27-30°C), pH (6.6 – 8.4) and Dissolved Oxygen (3-5 mg/l).

**Table 2a: Haematological Parameters of *Clarias gariepinus* fed Processed Medicinal Plants Diets**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **D1**  **ZMD** | **D2**  **(3% EAQ)** | **D3**  **(3%EET)** | **D4**  **(3%HEX)** | **D5**  **(3%MAQ)** | **D6**  **(3%MET)** | **D7**  **(3%MHX)** |
| **RBC×106/l** | 2.40±0.20ef | 4.00±0.20ab | 3.27±0.15cd | 2.10±0.10f | 4.10±0.10a | 3.60±0.20abc | 2.80±0.00de |
| **WBC×109/l** | 14.60±0.10de | 16.80±0.20cd | 10.30±0.30f | 18.07±0.15bc | 10.60±0.20f | 13.73±0.31e | 15.93±0.15cde |
| **PCV (%)** | 20.00±1.00j | 34.00±0.00a | 29.00±1.00bcd | 22.00±1.00**ij** | 30.00±1.00bc | 33.00±1.00ab | 25.00±1.00gh |
| **Hb (g/dl)** | 6.60±0.20h | 11.30±0.10ab | 9.60±0.20def | 7.30±0.20h | 10.00±0.10de | 11.00±0.10bc | 8.30±0.20g |
| **MCV(fl)** | 83.97±11.21bc | 85.17±4.25bc | 89.03±7.27b | 104.77±0.25a | 73.23±4.25c | 91.83±4.57b | 89.30±3.60b |
| **MCH (pg)** | 27.67±3.15bcd | 28.30±1.20bcd | 29.43±2.02bc | 34.8667±2.60a | 24.43±0.85d | 30.63±1.63ab | 29.63±0.75bc |
| **MCHC (%)** | 33.03±0.65a | 33.20±0.30a | 33.13±0.45a | 33.27±2.40a | 33.33±0.75a | 33.33±0.75a | 33.23±0.55a |

Average values on the same row with similar superscripts are not significantly different (P>0.05) from each other. RBC = Red Blood Cell, WBC = White Blood Cell, PCV = Pack Cell Volume, Hb = Haemoglobin,

**Table 2b: Haematological Parameters of *Clarias gariepinus* fed Processed Medicinal Plants Diets**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Parameters** | **D1**  **ZMD** | **D8**  **(5%EAQ)** | **D9**  **(5%EET)** | **D10**  **(5%EHX)** | **D11**  **(5%MAQ)** | **D12**  **(5%MET)** | **D13**  **(5%MHX)** |
| **RBC×106/l** | 2.40±0.20ef | 3.33±0.49cd | 2.80±0.10**de** | 3.10±0.10**cd** | 3.10±0.10**cd** | 3.47±1.10**bc** | 4.00±0.10**ab** |
| **WBC×109/l** | 14.60±0.10de | 10.30±0.10**f** | 20.10±0.10**b** | 24.20±0.20**a** | 24.20±0.20**a** | 15.57±4.99**de** | 16.30±0.30**cd** |
| **PCV (%)** | 20.00±1.00j | 28.00±1.00**ef** | 23.00±1.00**hi** | 27.00±1.00**fg** | 27.00±1.00**fg** | 31.00±5.20**bc** | 33.00±1.00ab |
| **Hb (g/dl)** | 6.60±0.20h | 9.30±0.10**ef** | 7.30±0.10**h** | 9.00±0.00**fg** | 9.00±0.00**fg** | 10.30±1.73**cd** | 11.00±0.10**bc** |
| **MCV(fl)** | 83.97±11.21bc | 84.93±9.63**bc** | 82.13±0.65**bc** | 87.10±0.40**b** | 87.10±0.40**b** | 93.13±17.72**ab** | 82.50±0.40**bc** |
| **MCH (pg)** | 27.67±3.15bcd | 28.30±4.09bcd | 26.10±1.30cd | 29.03±0.95bc | 29.03±0.95bc | 30.97±5.83**ab** | 27.53±0.95bcd |
| **MCHC (%)** | 33.03±0.65a | 33.23±1.55a | 31.77±1.80a | 33.33±1.25a | 33.33±1.25a | 33.20±0.00a | 33.37±1.30**a** |

**Figure 2: Weekly Growth Performance of the Experimental Fish**

DISCUSSION

The water quality parameters measured in this study were within the optimal recommended range as observed by Afia and Ofor (2016) the temperature of fish changes according to its environment which affect metabolism, dissolved oxygen is needed to aid aerobic generation of energy for body maintenance and physiological functions of aquatic organisms. According to Fagbenro *et al.* (2013) haematological Parameters on catfish species are to determine their health status with well establish ranges. The RBC count were in disagreement with Eyiwumi *et al* (2018). The latter reported that decrease in low RBC were due to decrease in inclusion levels of Moringa Leaf Meal (MLM) while in this research the lower RBC were within the medicinal diets processed with hexane solvents for 3% and 5% inclusion level (Table 2) and may be as a result of non-polar nature of the hexane solvent.

The Increased values recorded in WBC count contributed to the better survival rate of the experimental fish in this study and were in agreement with Eyiwumi *et al.* (2018) who discovered that 15% MLM diet recorded high increase in WBC and Lymphocyte count increases fish survival rate which also increases the iron content of the diet fed as major sources of Haemoglobin in the fish diets. WBC are the defence cells of the fish body. Therefore, the increase recorded attributed to increase in leucocytes synthesis as defence mechanism against the destruction of erythrocytes (Oniya *et al*., 2013; Afia and Ofor, 2016; Suleiman *et al*., 2018). All the PCV counts recorded in this study may likely be as a result of sign of healthier fish with high immunity which is an indication that the increase in PCV of fish under study had high immunity or resistance anaemic condition. The values recorded for the experimental based diets were higher than control-based diets and were in opposition to Eyiwumi *et al.* (2018) who reported low PCV counts on fish fed experimental diets of 0.5% and 1% MLM inclusion levels. The highest MCV (104.77±0.25 fl) was recorded in 3% Eucalyptus Hexane (EHX) based diet which was also an indication that the fish under study had high immunity or resistance to disease (Fagbenro *et al*., 2013). It however concluded that 3% and 5% inclusion levels of medicinal processed diet both have similar haematological positive impact on *Clarias gariepinus* but 3% is recommended for use due to the growth performance of the fish measured during the study.

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## EFFECTS OF THE METHANOL LEAF EXTRACT OF *Newbouldia laevis* ON OESTROGEN LEVELS DURING PREGNANCY IN RABBIT DOES IN KADUNA STATE, NIGERIA

**Darma, M. B., D. Ogwu & Saulawa, M. A.**

Faculty of Veterinay Medicine, Bayero University Kano, Kano State, Nigeria.

Email:mbdarma.vth@buk.edu.ng ;[maryambashird@gmail.com](mailto:maryambashird@gmail.com); [amsaulawa@yahoo.com](mailto:amsaulawa@yahoo.com)

Phone No: +2348034486391, +2348036078605

ABSTRACT

*This study evaluated the effects of the methanol leaf extract of Newbouldia laevis on oestrogen levels during pregnancy in rabbit does. The leaves of N. laevis were collected, authenticated and identified at the Herbarium in the Botany unit, Department of Biological Science, Faculty of Life Science, A.B.U. Zaria. The leaves were later extracted using 99.8 % methanol and the median lethal dose (LD50) of extract was determined using Lorke’s method. Twenty, 6 ± 2.0 months old does, with average body weight of 1.40 kg were housed individually and randomly assigned into 4 groups comprising 5 does each. Rabbits in groups A, B and C were administered the methanol leaf extract of N. laevis at dose rates of 1000mg/kg, 500mg/kg and 250mg/kg, respectively, while those in group D (control) were fed rabbit diet and water ad libitum for 48 days. Does were bred through natural mating at day 27 of extract administration, pregnancy was diagnosed through gentle palpation of the abdomen. Blood samples were collected from each doe on days 0, 6, 21, 27, 34, 41 and 48 post extract administration and analysed for estradiol (E2) levels using enzyme linked immunosorbent assay (ELISA). There was nostatistical significant (P˃0.05) difference in mean (± SEM) E2 levels between groups at days 0 and 6 of extract administration. At day 21 of extract administration, there was significantly higher (P˂0.05) mean (± SEM) E2 level in group A (261.18 ± 60.98 pg/mL) than in groups B (50.33 ± 50.19 pg/mL), C (0.19 ± 0.03 pg/mL) and D (0.14 ± 0.02 pg/mL). At days 27 (does were bred), 41(14 days of gestation) and 48 (21 days of gestation) of extract administration, the mean (± SEM) E2 levels showed no significant differences (P>0.05) in all groups of does; but it was significantly higher (P<0.05) in groups A(16.75±5.11 pg/mL), B(14.42±1.68 pg/mL) and C(12.18±1.71 pg/mL) compared to group D (0.12±0.02 pg/mL) at day 34 (7 days of gestation).*

**Keywords**: Methanol leaf extract, *Newbouldia leavis,* Oestrogen, Pregnancy and Rabbit

INTRODUCTION

The use of traditional medicine cannot fade out in the treatment and management of diseases in African continent and this could be attributed to socio-cultural and socio-economic life styles; lack of basic health care and qualified personnel (Elujoba *et al*., 2005). The use of plants to facilitate birth or to protect the young embryo appears to be a common practice among traditional healers. *Newbouldia laevis* is one of such plants and its leaves are used in Southeastern Nigeria to hasten parturition and to expel the placenta after delivery (Obute, 2002).

Infertility is a major clinical problem affecting animals medically and psychologically (Akomolafe, 2012). The management options available for the treatment of infertility in males include the use of drugs and a variety of surgical procedures (Purvis *et al*., 2008). Genetic improvement of rabbits is important in order to increase their contribution to the much needed animal protein in Nigeria. A prerequisite for this improvement is the knowledge of their breeding pattern and the ability to select for high prolificacy which is lacking in Nigeria (Fayeye and Ayorinde, 2003; 2010).

The use of plant extracts as fertility enhancer in animals is now on the increase because of the shifting attention from synthetic drugs to natural plant products (Dada and Ajilore, 2009).

Rabbit meat is not only a cheap source of animal protein; it also serves as an alternative investment and source of additional income in the rural areas (Onyinyechi, 2015). In developing countries, rabbits are emerging as low-cost answer to the problems of hunger and low protein intake of poor rural dwellers (Adedeji *et al*., 2015).This work is therefore designed to investigate the effects of the methanol leaf extract of *Newbouldia laevis* on oestrogen levels during pregnancy in rabbit does with a view to improving reproductive performance.

**Hypothesis:** There is significant differences between E2 levels between the groups.

METHODOLOGY

This Study was carried out at the Department of Theriogenology and Production, Faculty of Veterinary Medicine, Ahmadu Bello University (A.B.U) Zaria. The University is located in the Northern Guinea Savannah Zone of Nigeria between latitude 11°3ʹN and 12°N and longitude 7°42ʹE and 8°E at an elevation of 650m above sea level with an average annual temperature of 18.0 ± 3.7°C to 31.8 ± 3.2°C ([www.world66.com](http://www.world66.com))

Twenty disease free female domestic rabbits (*Oryctolagus cuniculus*) of six months old and average body weight 1400-2000g were used for this study. The experiment was carried out under normal ambient temperature and each doe housed in standard rabbit cages. The does were screened against diseases, treated with Kepromec® for ectoparasite infestation and allowed to acclimatize for six weeks before the commencement of the experiment. Water and feed were provided *ad libitum*.

The leaves of *N*. *laevis* were washed to remove soil and other debris, then air-dried for 5 days from its moisture level of 85% and ground into a powder. A portion of the powder was macerated in 70% methanol for 48hours. The extract was decanted, filtered and concentrated in a vacuum evaporator at 60°C and dried in an oven set at 40°C. The extract was stored in an air tight container in the refrigerator.

The does were randomly divided into four groups; A, B, and D each comprising of five does. Groups A, B and C were administered with the methanol leaf extract of *N.laevis* at 1000 mg/kg, 500 mg/kg and 250 mg/kg respectively for 48 days, and group D was control. The does were bred at day 27 of extract administration and after conception all does were allowed to carry pregnancy to term. Water was provided to all does *ad libitum* and extract administration was continued until kindling.

Blood sample (2 mL) was collected from each doe in all groups into labeled plain tubes without anticoagulant at days 0, 6, 21, 27, 34, 41 and 48 of extract administration. Each blood sample was allowed to clot, centrifuged at 3000 × g for 15 minutes and serum was harvested into a labeled serum bottle through centrifugation method Thereafter, the serum was stored at -20°C until analysed for estradiol levels using estradiol enzyme linked immunosorbent assay (ELISA) kit (Accu-bind®) according to the manufacturer’s instructions.

Data on E2 levels were expressed as Mean±SEM (standard error of mean), subjected to Repeated- Meaures-one Way Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

Changes in mean (± sem) serum oestrogen levels

The mean (± SEM) serum oestrogen (E2) levels (pg/mL) of rabbit does administer methanol leaf extract of *Newbouldia laevis* before breeding and during pregnancy are presented in Table I. At day 0, there was no statistical significant (P˃0.05) difference in mean (± SEM) E2 level between groups A (167.15 ± 14.29 pg/mL) and B (156.78 ± 90.20 pg/mL) but these were non-significantly (P>0.05) lower compared to groups C (206.25 ± 52.78 pg/mL) and D (231.34 ± 21.92 pg/mL).

At day 6 of extract administration, mean (± SEM) E2 level was non-significantly higher (P>0.05) in group D (282.45 ± 31.46 pg/mL) than in groups A (219.68 ± 23.10 pg/mL), B (202.01 ± 111.47 pg/mL) and C (250.39 ± 55.03 pg/mL). The mean (± SEM) E2 level in group A (261.18 ± 60.98 pg/mL) was significantly higher (P˂0.05) than in groups B (50.33 ± 50.19 pg/mL), C (0.19 ± 0.03 pg/mL) and D (0.14 ± 0.02 pg/mL) at day 21 of extract administration. Also, mean (± SEM) E2 level was significantly higher (P<0.05) in group B than in groups C and D, but showed no significant difference (P>0.05) between groups C and D at day 21 of extract administration.

At days 27of extract administration (breeding), no significant differences (P>0.05) existed in mean (± SEM) E2 levels in all groups of does. The mean (± SEM) E2 level was significantly higher (P<0.05) in groups A (16.75 ± 5.11 pg/mL), B (14.42 ± 1.68 pg/mL) and C (12.18 ± 1.71 pg/mL) compared to group D (0.12 ± 0.02 pg/mL) at day 34(7 days of gestation) of extract administration.

At 41 days (14 days of gestation) of extract administration, there was significantly lower mean (± SEM) E2 level in does of group C (11.55 ± 1.45 pg/mL) than in D (16.86 ± 0.44 pg/mL) but with no significant difference compared to groups A (12.38 ± 3.22 pg/mL) and B (14.49 ± 1.70 pg/mL). At48 days (21 days of gestation) of extract administration, the mean (± SEM) E2 level showed no significant differences (P>0.05) in all groups of does but was non-significantly higher in group B (18.07 ±2.47 pg/mL).

Table I: Mean (±sem) serum oestrogen levels (pg/ml) of rabbit does administered methanol leaf extract of *Newbouldia laevis* before breeding and during pregnancy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Days of extract administration** | **A** | **B** | **C** | **D** |
|  | 1000 mg/kg | 500 mg/kg | 250 mg/kg | Control |
| **0** | 167.15 ± 14.29a | 156.78 ± 90.20a | 206.25 ± 52.78a | 231.34 ± 21.92a |
| **6** | 219.68 ± 23.10a | 202.01 ± 111.47a | 250.39 ± 55.03a | 282.45 ± 31.46a |
| **21** | 261.18 ± 60.98a | 50.33 ± 50.19b | 0.19 ± 0.03c | 0.14 ± 0.02c |
| **27** | 0.16 ± 0.05a | 0.14 ± 0.02a | 0.17 ± 0.02a | 0.14 ± 0.02a |
| **34** | 16.75 ± 5.11a | 14.42 ± 1.68a | 12.18 ± 1.71a | 0.12 ± 0.02b |
| **41** | 12.38 ± 3.22ab | 14.49 ± 1.70ab | 11.55 ± 1.45a | 16.86 ± 0.44b |
| **48** | 14.03 ± 1.98a | 18.07 ± 2.47a | 14.43 ± 2.91a | 15.88 ± 1.07a |

Mean (± SEM) values with different superscript alphabets along the same row differ significantly at P<0.05.

Oestrogen (E2) is responsible for the development of female sex organs, preparation of the reproductive tract for pregnancy and mating behaviours, and plays a critical role during pregnancy in rabbit does (Gadsby *et al*., 1983; Mustafa and Elhanbaly, 2020). In this study, there was variation in the E2 levels of does administered methanolic leaf extract of *N.laevis*before breeding and during pregnancy. At days 0 and 6 of extract administration, the E2 levels were high in all does but there was non-significantly higher levels in the does administered 250 mg/kg of extract. High E2 levels were reported to be indicative of oestrus and readiness for mating (Marcondes *et al*., 2002; Ermayanti *et al*., 2019; Ajayi and Akhigbe, 2020). The findings from this study showed fluctuations in the E2 levels and these were not unusual. This is because rabbit does are induced or reflex ovulators as ovulation majorly takes place after mating thus making them not to have a regular oestrous cycle found in other domestic animals such as cattle (Hoffman *et al*., 2010; Lone *et al*., 2017).

During pregnancy, E2 levels were significantly higher in does administered 1000, 500 and 250 mg/kg of extract compared to control at 34 days of extract administration (7 days post-breeding) but were lower than their values at days 0 and 6. The E2 levels showed non-significant fluctuations in does administered the extracts at days 41 and 48 of extract administration while that of the control increased on days 41 and 48. In the study of Klaus and Uwe (1988), lower E2 levels in nonpregnant and non-lactating does compared to during pregnancy were reported with a relatively high level recorded in the first week of pregnancy. Challis *et al*. (1973) in another study reported only a slight increase in E2 level from day 21 to 30 of pregnancy while Lau *et al*. (1982) reported a decrease in serum E2 level at the same time.

Bostanci *et al*. (2012) reported E2 level of 98.1pg/mL during the second half of gestation and Kirat *et al*. (2015) reported E2 level of 5.5 pg/mL at the 10th day of gestation in does. On day 21 of gestation, Gonzalez- Mariscal *et al*. (2009) documented E2 level of 24± 6 pg/mL while a level 10.5 pg/mL was reported by Kirat *et al*. (2012). Ashour and Abdel-Rahman (2019) recorded E2 levels of 47.31 ± 4.99 pg/mL and 56.33± 5.34 pg/mL on days 14 and 21 of gestation respectively. The extract administration may be responsible for the differences in the pattern of E2 levels observed in the present study compared to other studies. This might be linked to the alkaloids and flavonoids contained in the *N. laevis* leaf extract as these constituents were previously suggested to reduce plasma concentrations of some fertility hormones (Browning *et al*., 1998; Bianco *et al*., 2006).

In male albino rats, the aqueous leaf extract of *N. laevis* was reported to modulate some fertility hormones such as testosterone, follicle stimulating and luteinizing hormones thus suggesting that the extract could act as an adjunct that can inhibit or promote hormonal imbalances in males at certain dosages (Egba *et al*., 2014). Oladimeji and Aroyehun (2015) on other hand suggested that *N. laevis* leaf extract could provide pro-fertility effects and ameliorate the effect of hormone induced pathologies in female albino rats. This study has therefore demonstrated outcome of investigation on the effects of *N. laevis* methanol leaf extract on oestrogen levels during pregnancy in rabbit does.

CONCLUSION

From this study there were no significant difference (P>0.05) in E2 levels in all groups of does at days 27 (breeding), 41 (14 days of gestation) and 48 (21 days of gestation).The E2 level was significantly higher (P<0.05) in does administered 1000 mg/kg (16.75 ± 5.11 pg/mL), 500 mg/kg (14.42 ± 1.68 pg/mL) and 250 mg/kg (12.18 ± 1.71 pg/mL) of *N. laevis* leaf extract compared to control (0.12 ± 0.02 pg/mL) at day 34 (7 days of gestation) of extract administration. Peak E2 level was observed at day 34 (7 days of gestation) in does administered 1000 mg/kg (16.75 ± 5.11 pg/mL) *N.laevis*leaf extract, day 48 (21 days of gestation) in does administered 500 mg/kg (18.07 ± 2.47 pg/mL) and 250 mg/kg (14.43 ± 2.91 pg/mL) *N. laevis* leaf extract and day 41 (14 days of gestation) in control (16.86 ± 0.44 pg/mL).

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## ASSESSMENT OF INORGANIC FERTILIZER ON FRESHWATER FISH CULTURE IN NIGERIA

Oladele Sunday Mathew1, Abdusalam Abdulrahmad Ayodeji2

[1] Kebbi State Polytechnic, Dakingari

Phone Number: 07033702973

Email: [oladelesundaymathew@gmail.com](mailto:oladelesundaymathew@gmail.com),

[2] Kebbi State Polytechnic, Dakingari

ABSTRACT

*Inorganic fertilizers when applied to aquaculture ponds have great potentials in boosting fish production. Pond Fertilization makes available higher concentrations of nitrogen, phosphorus and other plant nutrients for inducement of phytoplankton photosynthesis which forms the base of the food web enhancing fish production. The research was carried out to assess the performance of Inorganic fertilizer on freshwater fish ponds. The N.P.K (15:15:15) fertilizer and the post–fries of Clarias gariepinus with initial mean weight of 0.045kg were used for the bi-weekly experiment which lasted six weeks. Six Aquaria (tanks) each with an area of 60cm2 X 30cm2 X 30cm2 and the depth of 12.10cm were used. Three out of six tanks were fertilized with N.P.K 15:15:15 at 0.05kg/ha and the other three remained unfertilized and served as control experiment. At the end of the experiment, one-way Anova and Duncan Multiple Range Tests showed that, the physico-chemical parameters in fertilized tanks were significantly higher (P<0.05) than the unfertilized tanks for the period of six weeks and also in terms of length-weight performances. Based on this analysis, it proved that pond fertilization with inorganic fertilizer could bring faster fish growth than unfertilized pond which would go a long way in enhancing and boosting fish culture and then recommended this good scientific and experimental ideology to fish farmers.*

**Keyword:** Fertilized/unfertilized Aquaria, Inorganic Fertilizer (NPK 15:15:15), Assessment, Catfish post-fries, Physico-chemical parameters

INTRODUCTION

Fish culture principally aims at producing high quality fish food for human consumption, and providing sufficient fingerlings to restock open waters and ponds. Fish culture also provides additional income to farmers and their families thereby alleviating poverty particularly among the rural populace (Bamidele, 2007; Oladele, 2010; Boyd, 2018). The quest to enhance protein level and supply to Nigerian people has mandated putting into use all available waters for rearing fishes of different species (Gamal *et al*. (2014). Through the use and application of fertilizer, the unfit waters for aquaculture can be made fit and suitable for fish culture (Sebastian, 2015). This is made possible because fertilizer application enhances pond primary productivity which directly or indirectly will serve as a boost to fish production. (Boyd, 2018). Planktons are good supplements to artificially formulated feed because fertilized ponds are able to turn out fishes that will reach market sizes in few months, thereby fulfilling the sole aim of aquaculture which is profit maximization in fish production (Adigun, 2005; Ovie, *et al*., 1993; Adeyemo, *et al*., 1994; Oladele, 2010).

It has been observed that the continuous utilization of fish ponds for rearing fish usually results to removal of nutrients causing low fertility. The physico – chemical parameters will also be affected beyond the range for aquaculture practice. Several studies have indicated the great performance of fish production through the abundance of plankton (Ovie, *et al*., 1993; Oladele, 2010). But the unfertilized ponds remain less productive because of the unavailability of plankton. The research was carried out to assess the influence of inorganic fertilizer on Nigerian freshwater fish culture. There is an urgent need to increase fish production through the application of inorganic fertilizer. These fertilizers contain a good combination of nitrogen and phosphorus in different proportions which increase the quantity of primary producers (Kumar *et al.,* 2014). The study compares the water quality properties of the unfertilized and fertilized aquaria and the fish Length and Weight improvement within the period of six weeks.

MATERIALS AND METHODS

The Research was carried out at the Federal University of Technology Fisheries Laboratory, at Bosso in Minna, Niger State, Nigeria. The N.P.K (15:15:15) fertilizer for the experiment was bought from Minna Central market, while the post–fries of *Clarias gariepinus* with initial mean weight of 0.045kg were sourced from the university fish farm. Six Aquaria (tanks) each with an area of 60cm2 X 30cm2 X 30cm2 and the depth of 12.10cm were used. The tanks were supplied with well water and three out of six tanks were fertilized with N.P.K 15:15:15 at 0.05kg/ha and the other three remained unfertilized and served as control experiment. The species used were *Clarias gariepinus.* Initially *Clarias* post fries were fed with supplementary diet of Artemia feed at 30% of their body weight twice daily and later changed to 0.2 – 0.5mm size of Coppen feed. The tanks subsequently received biweekly application of fertilizer after complete draining of the tanks and refilling with fresh water. The Physico–chemical parameters in all the experimental tanks were measured using the same method. Temperature, Dissolved Oxygen level, pH, conductivity, Hardness and Total Alkalinity were measured one day before and after the tanks biweekly re–fertilization. Temperature measurements were taken in the morning and evening of the same day of water analysis, while the fish growth were monitored biweekly coinciding with re–fertilization days.

RESULTS

Table 1 shows inter–relationship of the various parameters between fertilized and unfertilized water coupled with Length – weight performance. It helps to explain the summary of the mean values and significant differences of physico–chemical properties and the Length -Weight Fish performance both in the fertilized and unfertilized water. The physico – chemical parameters subjected to these analyses are pH, Conductivity, Hardness, Total Alkalinity, Dissolved Oxygen and also the Length – Weight Fish performance in the fertilized and unfertilized tanks.



**Figure 1: Mean Length (cm) of fish of the fertilized and unfertilized aquaria**



**Figure 2: Mean Weight of Fish (g) of the fertilized and unfertilized aquaria**

**Table 1: Total Summary of the Physico – Chemical Parameters and Length – Weight Fish Performance of fertilized and unfertilized Aquaria**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| TIMES(weeks)/  Properties | 0 | 2 | 4 | 6 | Average |
| **pH**  Unfertilized  Fertilized  Sig. | 7.17±0.015a  6.73±0.208b  0.023\* | 6.86±0.199a  6.85±0.050a  0.916 | 7.07±0.020a  6.60±0.010b  0.000\* | 6.90±0.021a  6.88±0.030a  0.330 | 7.00±0.155a  6.77±0.148b  0.001\* |
| **Conductivity**(µs/cm) Unfertilized  Fertilized  Sig. | 146.40±0.700b  1574.00±1.000a  0.000\* | 582.67±15.535b  4530.00±10.000a  0.000\* | 703.33±1.528b  3440.00±62.450a  0.000\* | 370.67±1.155b  3046.67±20.817a  0.000\* | 450.77±221.815b  3147.67±1106.085a  0.000\* |
| **Hardness** (mg/l) Unfertilized  Fertilized  Sig. | 86.00±2.000a  76.07±0.0306b  0.001\* | 108.33±2.082a  92.00±0.200b  0.000\* | 85.00±1.000b  150.07±0.306a  0.000\* | 85.73±0.643a  74.00±0.400b  0.000\* | 91.27±10.38  98.03±32.21  0.496 |
| **Total alkalinity** (mg/l) Unfertilized  Fertilized  Sig. | 108.00±4.000b  116.07±2.403a  0.040\* | 106.67±6.110b  151.93±0.503a  0.000\* | 86.67±6.123b  165.33±4.163a  0.000\* | 31.20±1.114b  140.33±1.528a  0.000\* | 83.13±32.79  143.42±19.03  0.000\* |
| **Dissolved oxygen** (mg/l) Unfertilized  Fertilized  Sig. | 6.93±0.503a  5.07±0.115b  0.003\* | 9.33±1.153a  8.40±0.200b  0.033\* | 7.33±1.155a  3.00±1.000b  0.002\* | 4.00±0.400b  7.67±0.200a  0.000\* | 6.90±2.130  6.01±2.27  0.218 |
| **Temperature** (0C) Unfertilized  Fertilized  Sig. | 24.90±1.054a  26.50±0.600a  0.084 | 26.04±0.055a  26.10±0.100a  0.391 | 24.23±0.058b  25.07±0.513a  0.049\* | 24.03±0.058a  24.27±0.252a  0.193 | 24.80±0.933  25.48±0.982  0.095 |
| **Length of fish** (cm) Unfertilized  Fertilized  Sig. | 3.50±0.050a  3.50±0.062a  0.000\* | 3.96±0.025b  5.49±0.045a  0.000\* | 5.53±0.025b  6.80±0.026a  0.000\* | 6.48±0.021b  8.42±0.021a  0.000\* | 4.87±1.251  6.05±1.882  0.083 |
| **Weight of fish** (g) Unfertilized  Fertilized  Sig. | 0.45±0.020a  0.45±0.020a  1.000 | 0.51±0.026b  0.70±0.026a  0.001\* | 1.02±0.010b  1.24±0.015a  0.000\* | 1.59±0.021b  2.61±0.010a  0.000\* | 0.89±0.482  1.25±0.872  0.229 |

Key\* significantly different at 95% confidence (p<0.05) values with the same letter are not significantly different from each other (p>0.05) values with different letter are significantly different from each other. R: replicate

In Table 1, one–way ANOVA showed that the average pH of the unfertilized water of neutral pH 7.0 was significantly higher than that of the fertilized water of slightly acidic pH 6.77. The average conductivity of the fertilized water (3147.67µs/cm) was significantly higher than that of the unfertilized water source (450.77µs/cm). The average total alkalinity (mg/l) of the fertilized water (7.17) was significantly higher than that of the unfertilized water (4.17). The average dissolved oxygen for the whole week was insignificantly higher in the unfertilized water than the fertilized water. At week 4, the temperature of the fertilized water was significantly higher than that of the unfertilized water. Figure 1 shows the relationship between the length of fish (cm) and the period of growth (week) of the fish of the two treated water. Duncan multiple range test showed that at weeks 2, 4 and 6 the length of fish in fertilized water (5.49 cm, 6.80 cm and 8.42 cm respectively) were significantly higher than that of the unfertilized water (3.96cm, 5.53cm and 6.48cm respectively). At week 0, the fish had same length 0.45cm. Figure 2 shows the relationship between the weight of fish and period of growth of the fish in weeks of one treated water and untreated water.Duncan multiple range test showed that at weeks 2, 4 and 6, the weight of fish in the fertilized water (0.70g, 1.24g and 2.61g respectively) were significantly higher than those in the unfertilized water (0.51g, 1.02g, and 1.59g respectively).

DISCUSSION

The average pH of 6.77 in fertilized pond was high but better than the unfertilized tanks. The higher pH value recorded in fertilized pond is in line with Boyd (2018) who reported that the application of ammonium and urea-based fertilizers can cause acidification of pond water because of nitrification, which produces two hydrogen ions from each ammonium ion. In conclusion Duncan multiple range tests showed that the weights of fish in the fertilized tanks in all the weeks of the experiment were significantly higher than the unfertilized tanks. This totally agrees with Craig and Charles (2016) that fertilized ponds can have fish yields three to four times over that of the unfertilized ponds. Duncan multiple range test also showed that at weeks 2, 4 and 6 the length of fish in fertilized water (5.49 cm, 6.80 cm and 8.42 cm respectively) were significantly higher than that of the unfertilized water (3.96cm, 5.53cm and 6.48cm respectively). This agrees with Sebastian (2015) who reported that the specific growth rate of *Clarias gariepinus* fries were observed to be better in tanks fertilized compared to unfertilized tanks under both stocking density. Sebastian (2015) also said that the addition of manures and fertilizers to the fish ponds improve the level of Phytoplankton responsible for fish growth. That goes to say that the positive impact of fertilizer on fish production cannot be over emphasized. It can be observed that fertilizer plays a very important role in inducing the production of planktons which are fish food organisms and hence promoting fish growth, thereby enhancing high productivity in production. The use of fertilizer for generating plankton for fish production is suitable for fish farmers most especially poor resources based fish farmers who have no financial capacity to purchase the artificially processed feed in adequate quantity that can sustain and enhance their fish culture. Since the purpose of aquaculture generally is to make profit, fertilizer applied to the pond obviously reduces the cost of feeding and this will help the fish farmer to make more profit in the farm business.

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## GROWTH AND BODY MOPHORMETRIC PARAMETERS OF BROILER CHICKENS ORALLY ADMINISTERED VARYING LEVELS OF LEMONGRASS EXTRACT, AT FINISHER PHASE

1Otu, B. O\*., 2Banjo, A. A., 1Kolo, P. S., 1Egena, SSA., 1Dikko, A. H & 1Audu, F.

1Department of Animal Production, Federal University of Technology, Minna, Niger State

2Department of Animal and Poultry Science, University of Kwazulu Natal, Pietermaritzburg, South Africa

Corresponding Author\*:[allisiousbisongotu@yahoo.com](mailto:allisiousbisongotu@yahoo.com),

Telephone Number**:** +2348028573305

ABSTRACT

The growth and body morphometric parameters of broiler chickens orally administered varying levels of lemongrass extract at finisher phase was evaluated. A total of 150-day old broiler chicks were used for this study in a CRD design. The birds were allotted into five treatments of 30 chicks in each treatment with three replications of 10 chicks per replicate. The control (T1) group was not administered antibiotic nor lemongrass extract and treatment group T2 was administered 0.2mls of antibiotic while T3, T4 and T5 treatment groups were administered 0.2mls, 0.4mls and 0.6mls of lemongrass extract respectively. Data on the growth and morphometric parameters were collected. There was no significant difference (P>0.05) in the growth parameters with an exception of the average initial body weight. The average final body weight (g) in T1, T2, T3, T4 and T5 were 1781.48, 1767.59, 2061.90, 1897.62 and 1898.31 respectively. The average body weight of broiler birds in T3 was higher as compared to those in T1, T2, T4 and T5. The body weight gain in T1, T2, T3, T4 and T5 were 1249.78, 1266.22, 1458.24, 1386.54, and 1420.91 respectively. The birds in treatment groups T3, T4 and T5 recorded higher weight gain than T1 (control group) and T2 (0.2mls antibiotic). The feed intake (g) were 359.87, 3152.33, 4039.16, 3777.33, 4063.40 in treatment T1, T2, T3, T4 and T5 respectively. The treatment group T5 consumed more feed (4063.40g) compared to the other treatments. Feed conversion ratio was higher in T5 (2.82) as compared to T1 (2.81), T2 (2.49), T3 (2.77) and T4 (2.73). However, there were significant (P<0.05) differences in average initial body width, final body girth, final shank length and shank length gain compare to other parameters such as initial body length, final body length, body length gain, body width gain, final body width, initial shank length, initial neck length, final neck length, which were not significantly affected. It can be concluded that the use of lemongrass extract at the levels 0.6mls and 0.2mls proved to have improved the growth performance as well as better performance of the morphometric parameters.

**Keywords:** Growth, Morphometric, Broiler chicken, oral Administration, lemongrass extract, Finisher phase

INTRODUCTION

Antibiotics have been routinely utilized as a growth promoter to improve growth and overall performance in poultry and livestock production for decades. Antibiotic use as a growth stimulant particularly at subtherapeutic dosages, has resulted in bacterial resistance, cross resistance, and multiple resistance (Gould, 2008). According to Van de Bogaard and Stobberingh (2000), resistant bacteria can be spread from chicken products to the human population by consumption or handling of contaminated poultry meat. As a result of this, strict regulations have been placed on antibiotic growth promoters, hence a lot of interests were now focussed on the search for substitute to antibiotic growth promoters.

One of the natural alternatives to antibiotic which has been observed to increase performance in poultry is lemongrass (Peter and Babu, 2012). Lemongrass is a herb that has been shown to offer medical and therapeutic advantages. Shah *et al*. (2011) noted that it contains phytochemical compounds like flavonoids, phenolic compounds, and essential oils like citral, nerolgeraniol, citronellal, terpinolene, and geranylmethyl heptenone, which may be responsible for its antibacterial, antidiarrheal, antifungal, antioxidant, and growth promoter properties. Previous researchers had considered the use of lemongrass leaf meal in broiler diets. Mmereole (2010) noted that, the addition of lemongrass in the diet of poultry as feed additive gave improved performance of broiler chickens. However, lemongrass has a high fibre content of about 9.30% (Thorat *et al.*, 2017), which is less than the 5% requirement for broilers (Olomu, 2011). This high fibre content thus will limit the utilization of lemongrass meal as a growth promoter despite its potential, thus reducing the ability of lemongrass meal to promote growth maximally due to the fact that minute quantity of the feed is being consumed by the birds because of the high fibre. It is on this thought that this research contemplated the oral administration of lemongrass extract which contain no fibre. The mode of administration as well will ensures maximum intake and hoped to maximize the already established potential of lemongrass as growth promoting alternative, as should be evident in the growth and morphometric parameters of the broiler chickens.

**MATERIALS AND METHOD**

The experiment was carried out at the poultry unit of the Extractching and Research Farm, Federal University of Technology, Minna, Gidan kwano, Minna, Niger State. Minna is located at 09° 36' 50” north latitude and 06° 33' 25” east longitude, in degrees minutes' seconds. It is 700,000 meters above sea level and is surrounded by a river that travels from the northwestern to the southwestern parts of the state. It is located in the country's Southern Guinea Savannah agro-ecological zone. The daytime temperature ranges from 38° C in the start of the wet season to 28° C in the middle. The yearly rainfall average is 1209.7 mm (Minna Niger Geography, 2004 - 2017).

Source of Experimental Materials

One hundred and Fifty (150) day old broiler chicks were purchased from Agrited hatchery Ibadan, Oyo State. Lemongrass was harvested from households in Minna, Niger State, dried at room temperature to a moisture content of 10% and grinded into powder form to make the extract. Commercial feed containing 18-20% crude protein and 2950-3210kcal/kgDM (finisher feed) was purchased from an accredited feed dealer in Minna, Niger State.

Management of Experimental Birds and Design

This research utilized a Completely Randomized Design (CRD) arrangement with five treatments, each with three replicates and ten birds per replicate. Thus, a total of 150 broiler chickens was used. The study lasted for 4 weeks of the finisher phase. A week before the birds arrived, the pen and cage were cleaned and disinfected. Before the birds arrived, the feeders and drinkers were cleaned before the arrival of the birds, charcoal stoves were used as sources of heat during the brooding period. Lamp was used as source of light. Washing drinking and feeding troughs, removing litter items, and providing feed were all done on a regular basis.

Preparation of experimental lemongrass extract

Fresh Lemongrass leaves were dried under room temperature to a moisture content of about 10% and ground. 20g of the lemongrass was boiled in water 1 litre of water at 100oC for 10 minutes and then allowed to cool for 12 hours before orally administering it to the birds. The levels of administration of the lemongrass extract is shown in table 1.

Experimental Diets

The birds were given a commercial feed and clean drinking water *ad libitum* throughout the duration of the study. Starter feed containing 22-24% crude protein and 2800-2900kcal/kgDM was given for a period of 4 weeks. Finisher feed containing 18-20% crude protein and 2950-3210kcal/kgDM was given from the fifth to eight week.

**Data collection**

Data on growth parameters collected were body weight, body weight gain, feed intake and feed conversion ratio. The body morphometric traits that were assessed were body length (BL), body girth (BG), shank length (SL), body width (BW), neck length (NL)

**Table 1. Levels of lemongrass extract administered**

|  |  |
| --- | --- |
| Treatments | Levels of lemongrass extract administered |
| T1 | 0% antibiotic & 0% lemongrass extract (negative control) |
| T2 | 0.2 mls of synthetic antibiotic (positive control) |
| T3 | 0.2 mls of lemongrass extract |
| T4 | 0.4 mls of lemongrass extract |
| T5 | 0.6 mls of lemongrass extract |

**Data analysis**

All data collected were statistically analyzed using one-way analysis of variance (ANOVA) of SPSS 16.0 program (statistical package for the social sciences). Duncan multiple range testing was used to separate mean values where they arise.

**RESULTS**

**Growth performance of Broiler chickens administered varying levels of lemongrass extract at finisher phase**

The results of the growth performance of broiler chickens orally administered varying levels of lemon grass extract at finisher phase is shown in Table 2. The results obtained showed that the initial body weight (at 5th weeks) was significantly different (p<0.05) across the treatments. The highest initial body weight was obtained in T3 (603.67g) of birds administered 0.2ml of lemon grass extract and the lowest initial body weight was recorded in T5 (477.40g) administered 0.6ml of lemon grass extract. However the feed intake, weekly feed intake, daily feed intake, feed conversion ratio, final body weight body weight gain, weekly body weight gain and daily weight gain were not significantly (P>0.05) affected. The highest feed intake (4063.40g), weekly feed intake (1015.85g), daily feed intake (145.12g) and feed conversion ratio (2.82) were observed in T5 of birds administered 0.6ml of lemongrass extract. The least feed intake was obtained in T1 (359.87g) control group. The lowest weekly feed intake, daily feed intake and feed conversation were obtained in T2 of birds administered synthetic antibiotics as 788.08g, 112.59g and 2.49 respectively. The least final body weight was observed in T2 (1767.5g) of birds administered synthetic antibiotic. The lowest body weight gain, weekly body weight gain and daily weight gain were obtained in T1 (control) as 1249.78g 312.44 and 44.63g respectively.

Morphometric performance of broiler chickens orally administered varying levels of lemongrass extract at finisher phase

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass extract is shown in Table 3. The results obtained showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly (p<0.05) different with T2 having the highest initial body width (16.99cm) while T5 recorded the least (15.58cm).T3 had the highest final body girth (42.63cm) while T5 recorded the least (40.74cm). the highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T1 (control) as 18.63cm, 6.89cm, 1.72cm and 0.25cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T5 as 17.50cm,5.47cm, 1.36cm

**Table 2. Growth performance of broiler birds administered varying levels of lemongrass extract at finisher phase**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Parameters | T1 | T2 | T3 | T4 | T5 | SEM | LS |
| AFI (g) | 359.87 | 3152.33 | 4039.16 | 3777.33 | 4063.40 | 201.52 | NS |
| AWFI (g) | 898.22 | 788.08 | 1009.79 | 944.33 | 1015.85 | 55.04 | NS |
| ADF I(g) | 128.32 | 112.59 | 144.26 | 134.91 | 145.12 | 7.86 | NS |
| FCR | 2.81 | 2.49 | 2.77 | 2.73 | 2.82 | 0.99 | NS |
| AIBW (g) | 531.70ab | 501.38ab | 603.67a | 511.08ab | 477.40b | 17.21 | \* |
| AFBW (g) | 1781.48 | 1767.59 | 2061.90 | 1897.62 | 1898.31 | 46.42 | NS |
| ABWG (g) | 1249.78 | 1266.22 | 1458.24 | 1386.54 | 1420.91 | 39.65 | NS |
| AWBWG (g) | 312.44 | 316.56 | 364.56 | 346.64 | 355.23 | 9.91 | NS |
| ADBWG (g) | 44.63 | 45.22 | 52.08 | 49.52 | 50.75 | 1.42 | NS |

Key-SEM: standard error of mean, LS: level of significance; NS: No significant difference; \*: There is significant difference; TI; control, T2 ; 0.2mls of antibiotic,T3; 0.2mls of LMGT, T4; 0.4mls of LMGT, T5; 0.6mls of LMGT, LMGT = lemongrass extract, AFI = average feed intake, ADFI = average daily feed intake, FCR = feed conversion ratio, AIBW = average initial body weight, AFBW = average final body weight, ABWG = average body weight gain, AWBWG = average weekly body weight gain, ADBWG = average daily body weight gain.

**Table 3. Morphometric parameters of broiler birds administered varying levels of lemongrass extract at finisher phase**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **PARAMETERS (cm)** |  | | | | | | |
| **T1** | **T2** | **T3** | **T4** | **T5** | **SEM** | **LS** |
| Average initial body length | 24.66 | 24.31 | 25.06 | 24.50 | 24.60 | 0.15 | NS |
| Average final body length | 39.96 | 39.45 | 40.01 | 41.50 | 39.42 | 0.53 | NS |
| Average body length gain | 15.29 | 15.14 | 14.95 | 17.00 | 14.82 | 0.55 | NS |
| Average weekly body length gain | 3.82 | 3.79 | 3.74 | 4.25 | 3.71 | 0.14 | NS |
| Average daily body length gain | 0.54 | 0.54 | 0.53 | 0.61 | 0.53 | 0.02 | NS |
| Average initial body width | 16.85a | 16.99a | 16.79a | 16.43a | 15.58b | 0.17 | \* |
| Average final body width | 27.56 | 26.97 | 27.62 | 26.15 | 26.75 | 0.27 | NS |
| Average body width gain | 10.71 | 9.97 | 10.83 | 9.72 | 11.17 | 0.27 | NS |
| Average weekly body width gain | 2.68 | 2.49 | 2.71 | 2.43 | 2.79 | 0.07 | NS |
| Average daily body width gain | 0.38 | 0.36 | 0.39 | 0.35 | 0.39 | 0.01 | NS |
| Average initial body girth | 24.51 | 24.57 | 24.48 | 24.77 | 24.01 | 0.25 | NS |
| Average final body girth | 41.95ab | 41.42ab | 42.63a | 41.11ab | 40.74b | 0.27 | \* |
| Average weekly body girth gain | 4.36 | 4.21 | 4.54 | 4.09 | 4.18 | 0.07 | NS |
| Average daily body girth gain | 0.62 | 0.60 | 0.65 | 0.58 | 0.59 | 0.01 | NS |
| Average initial shank length | 11.73 | 11.39 | 12.28 | 12.32 | 12.03 | 0.20 | NS |
| Average final shank length | 18.63a | 17.83ab | 18.29ab | 17.54b | 17.50b | 0.16 | \* |
| Average shank length gain | 6.89a | 6.45ab | 6.01ab | 5.22b | 5.47ab | 0.25 | \* |
| Average body girth gain | 17.43 | 16.85 | 18.15 | 16.34 | 16.74 | 0.27 | NS |
| Average weekly shank length gain | 1.72a | 1.61ab | 1.50ab | 1.31b | 1.36ab | 0.06 | \* |
| Average daily shank length gain | 0.25a | 0.23ab | 0.21ab | 0.18b | 0.19ab | 0.01 | \* |
| Average initial neck length | 8.19 | 7.75 | 7.60 | 8.24 | 7.63 | 0.14 | NS |
| Average final neck length | 14.94 | 15.41 | 15.96 | 15.59 | 15.31 | 0.19 | NS |
| Average neck length gain | 6.75 | 7.66 | 8.36 | 7.36 | 7.68 | 0.28 | NS |
| Average weekly neck length gain | 1.69 | 1.92 | 2.09 | 1.84 | 1.92 | 0.07 | NS |
| Average daily neck length gain | 0.24 | 0.27 | 0.29 | 0.26 | 0.28 | 0.01 | NS |

Key- SEM: standard error of mean; LS: Level of significance; NS: No significant difference; \*: there is significant difference; LGT; Lemongrass extract. TI; control, T2; 0.2mls of antibiotic, T3; 0.2mls of LMGT, T4; 0.4mls of LMGT, T5; 0.6mls of LMGT.

and 0.19cm respectively. However there were no significant differences (P>0.05) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain.

DISCUSSION

There was no significant (P>0.05) difference in the growth performance of broiler chickens administered varying levels of lemongrass extract considering growth parameters such as feed intake, weekly feed intake, daily feed intake, feed conversion ratio, final body weight, body weight gain, weekly body weight gain, and daily body weight gain with an exception of the initial body weight which was significantly (p<0.05) different and differs across the treatment groups. This result was however, at variance with Mmereole (2010), who reported that the inclusion of *Cymbopogon citratus* (lemongrass) leaf meal in poultry diet resulted in a significant difference in the performance of the growth parameters of the broiler birds. The disagreement could have been due to the mode of lemongrass administration. The author administered lemongrass as feed additive and this could have resulted in the continuous feeding and accumulated effect of the lemongrass, that could have reflected in the significant difference observed in the growth parameters as against the oral administration of lemongrass extract at weekly bases carried out in this study.

The results of the morphometric parameters of broilers birds orally administered varying levels of lemon grass extract showed that the initial body width, final body girth, final shank length, shank length gain, weekly shank length gain and daily shank length gain were significantly (p<0.05) different with T2 having the highest initial body width (16.99cm) while T5 recorded the least (15.58cm). T3 had the highest final body girth (42.63cm) while T5 recorded the least (40.74cm). the highest final, shank length gain, weekly shank length gain and daily shank length gain were recorded in T1 (control) as 18.63cm, 6.89cm, 1.72cm and 0.25cm respectively while the lowest final, shank length gain, weekly shank length gain and daily shank length were observed in T5 as 17.50cm,5.47cm, 1.36cm and 0.19cm respectively. However, there were no significant differences (P>0.05) in the initial body length, final body length, body length gain, weekly body length gain, daily length gain, final body width, body width gain, weekly body width gain, daily body width gain, initial body girth, body girth gain, weekly body girth gain, daily body girth gain, initial shank length, initial neck length, final neck length, neck length gain, weekly neck length gain and daily neck length gain. The variation in the results recorded in this study could have been due to different levels of administration of lemongrass extract.

CONCLUSION

Based on the available results, it is concluded that lemongrass extract used in this experiment gave similar and some cases better performance than the synthetic antibiotic. Antibiotic administration had no superiority over lemongrass extract on the performance of the broiler chickens. The results of this study show that 0.6ml and 0.2ml of lemongrass extract can be recommended to give better performance of birds in terms of feed intake, body weight, body weight gain, average final body girth and average shank length gain.

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## PERFORMANCE OF ARBOR ACRE BROILER CHICKENS FED DIET ENRICHED WITH VARYING LEVELS OF NANO ZINC SUPPLEMENTATION AT FINISHER PHASE

Sa’aci, Z. A., Alabi, O. J., Jiya, E. Z. and Ijaiya, A. T.

[mohammedsaaciz@gmail.com](mailto:mohammedsaaciz@gmail.com) 09133016602

Department of Animal Production, Federal University of Technology, Minna, Nigeria.

ABSTRACT

*Three weeks feeding trial was conducted to determine the effect of nano zinc supplementation on growth performance and nutrients digestibility of broiler chickens aged four weeks. Two hundred Arbor Acre broiler chicks were randomly distributed into four treatments with five replicates consisting 10 birds per replicates in a completely randomized design. Birds were reared on deep litter and fed basal diets supplemented with varying levels of nano zinc for 21 days. Data obtained were analyzed using Statistical Package for Social Science (SPSS version 16.0). Results showed that total feed intake and daily feed intake were significantly (P<0.05) influenced amongst the growth parameters and CP, CF and Ash digestibility were improved. Based on growth and nutrient digestibility performance; dietary supplementation of nano zinc at 30 mg/kg NZn supplemented diet improved feed efficiency and nutrients digestibility of broiler chickens without negative effect on their growth performance and therefore, recommending that farmers can use nano zinc as a source of feed additive to boost birds’ growth performance.*

**Keywords:** Nano Zinc, Supplementation, Growth, Nutrient digestibility and Broiler chickens

INTRODUCTION

Micro minerals are very essential in poultry nutrition for optimal productive performance (Haiam *et al*., 2020). Zinc (Zn) is required for the normal functioning of the animal body, it plays crucial role as cofactor of more than 300 enzymes, structural and regulatory functions in antioxidant and immune system, nucleic acid synthesis, cell proliferation, protein synthesis, protein and carbohydrate metabolism, and enzymatic activities in the living system (Fayiz *et al*., 2021). National Research Council (1994) recommended 30 mg of Zn/kg for broiler chickens; this might not be adequate to support maximum performance as reported by Du *et al*. (2007). Recently, with the emergence of nanotechnology, nano zinc can be incorporated in a nano form as a feed supplement to improve the efficiency of trace minerals in broiler chickens (Geetha *et al*., 2020). The nano-sized particles have higher potential than the conventional with very high surface area to volume ratio enables nanoparticles to be effective in very small amounts and absorbable more quickly than inorganic and organic minerals (Sawosz *et al*., 2009). The aim of this experiment was to evaluate the influence of dietary nano zinc oxide supplementation on growth performance and nutrients digestibility of finished Arbor acre broiler chickens.

MATERIALS AND METHODS

**Experimental site**

The experiment was carried out at the Poultry Unit of the Teaching and Research Farm of the Department of Animal Production, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger State, Nigeria.

**Source of materials**

The feed ingredients maize and soybean were purchased from Gidan Matasa and step by step Agro store, Western bypass, Minna. Zinc nitrate Zn(NO3)2, Sodium hydroxide (NaOH), were bought from Pan lac laboratory equipment and chemicals store, Keteren gwari, Minna. The Africa scent leave (*Ocimun gratissimum*) was sourced from olericulture garden FUT, Minna. All other reagents and equipment used were obtained from the Step ‘B’ Drug and Vaccine Discovery Laboratory, Bosso Campus, Federal University of Technology, Minna. The green synthesis of nano zinc was carried out at the above laboratory in line with the method described by Jay and Shafkat (2018). Experimental diet was formulated in line with nutrients requirement recommended for finisher broiler chickens (NRC, 1994), as shown in Table 1 below.

**Experimental animals, management and design**

Broiler chicks were sourced from Yammfy Farm hatchery, Ilemona, Kwara state. Two hundred (200) 28 days oldArbor Acre broiler chicks were randomly distributed into four treatments with five replicates consisting 10 birds per replicates in a completely randomized design. Birds were reared on deep litter and all management’s practices suggested for broiler production were strictly observed.

**Data collection and statistical analysis**

Data collected on growth performance and nutrients digestibility were subjected to one way analysis of varance using the Statistical Package for Social Science (SPSS version 16.0). Significant means variations were separated using Duncan multiple range test AT P<0.05.

**Table 1: Ingredients composition of the experimental diets (as fed)**

|  |  |
| --- | --- |
| Ingredients % | Finisher phase |
| Maize | 55.00 |
| Soybean cake | 26.00 |
| Fish meal | 3.00 |
| Wheat offal | 11.00 |
| Palm oil | 1.00 |
| Limestone powder | 1.00 |
| Bone meal | 2.00 |
| Salt | 0.25 |
| Lysine | 0.25 |
| Methionine | 0.25 |
| Premix | 0.25 |
| Total weight (kg) | 100.00 |
| Calculated analysis |  |
| Crude protein (%) | 20.00 |
| Crude fibre (%) | 5.53 |
| Ether extract (%) | 5.55 |
| Ca (%) | 1.11 |
| Avail P (%) | 0.58 |
| ME (kcal/kg) | 3000.00 |

Premix supplied per Kg of diet: Vit. A, 2.5iu;Vit D3, 0.5iu; Vit E, 0.0057mg; Vit. K, 0.0005mg; Vit, B1, 0.00045mg; Vit B2, 0,0013mg; pantothenic acid, 0.0018mg; Vit. B12, 0.000005mg; Folic acid, 0.00018mg; Biotin, 0.000015mg; Choline chloride, 0.075mg; Cobalt, 0.00005mg; Copper, 0.00075mg; Iodine, 0.00025mg; Iron, 0.0025mg; Manganese, 0.01mg; Selenium, 0.00005mg; Zinc, 0.0075mg; Antioxidant, 0.00031mg

RESULTS AND DISCUSSION

Table 2 revealed that all parameters measured were not significantly (P>0.05) affected by the test ingredient except total feed consumed and daily feed consumed. Results indicated that birds fed 20 mg/kg NZn supplemented diet had higher total and daily feed intake than their counterparts. This might be due to variation in the dietary levels of nano zinc supplementation. The present study agreed with the observation of Zhao *et al*. (2014) reported improvement in the feed intake of broiler chickens fed diets supplemented with zinc oxide nanoparticles. Table 3 Showed that crude protein, crude fibre and ash digestibility contents were significantly (P<0.05) influenced by nano zinc supplementation. Generally, ZN aids digestive enzymes that catalyzed the breaking down of protein in the digestive tract. Results indicated that CP and CF in birds on 30 mg/kg NZn supplemented diet had higher (P<0.05) values than those from 20 mg/kg NZn supplemented diet. This might mean 30 mg/kg impact higher protein digestibility. This could be the reason Kumar *et al*. (2021) observed low level of the CP in the faecal output of birds fed NZn when compared to other treatments.

**Table 2: Effect of dietary nano zinc oxide supplementation on growth performance of arbor acre broiler chickens (28 - 49 d)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Levels of nano zinc  (mg/kg) | Initial body weight (g/b) | Final body weight (g/b) | Total weight gain (g/b) | Daily body weight gain (g/b) | Total feed consumed (g/b) | Daily feed consumed  (g/b) | FCR |
| 20 | 970.93 | 2199.62 | 1228.72 | 58.50 | 2621.84a | 124.85a | 2.18 |
| 30 | 968.86 | 2208.18 | 1239.21 | 59.01 | 2460.91d | 117.19d | 2.01 |
| 40 | 969.56 | 2172.65 | 1203.19 | 57.28 | 2507.32c | 119.39c | 2.13 |
| 50 | 980.76 | 2188.60 | 1207.83 | 57.51 | 2518.46b | 119.92b | 2.11 |
| SEM | 11.49 | 54.42 | 55.32 | 1.86 | 5.21 | 0.17 | 0.06 |
| P-value | 0.70 | 0.92 | 0.90 | 0.90 | 0.01 | 0.01 | 0.59 |

abcd = means in the same column with vary superscript differs significantly (P<0.05).

**Table 3: Effect of dietary nano zinc oxide supplementation on nutrients digestibility of arbor acre broiler chickens (28 - 49 d)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Levels of nano zinc  (mg/kg) | CP  (%) | DM  (%) | CF  (%) | EE  (%) | ASH  (%) | NFE  (%) |
| 20 | 80.06b | 86.84 | 76.98b | 81.66 | 78.92ab | 79.68 |
| 30 | 86.23a | 85.50 | 83.79a | 83.06 | 81.20ab | 84.94 |
| 40 | 83.87ab | 89.70 | 80.68ab | 84.41 | 77.14b | 82.99 |
| 50 | 84.81ab | 88.77 | 81.34ab | 83.09 | 81.84a | 85.11 |
| SEM | 1.56 | 1.70 | 1.62 | 1.95 | 1.38 | 1.86 |
| P-value | 0.03 | 0.31 | 0.04 | 0.80 | 0.04 | 0.16 |

ab = means in the same column with vary superscript differs significantly (P<0.05).

DM = dry matter, CF = crude fibre, CP = crude protein, EE = ether extract and NFE = Nitrogen Free Extract.

SEM = standard error of mean

P –value = probability levels

mg = milligram and Kg = kilogram % = percentage

The current study concord with Saleh *et al*. (2012) WHO indicated improvement in crude fibre and crude protein digestibility of broiler chickens fed diets supplemented with zinc (0, 20, 40, 60 and 90 mg/kg). Ash demonstrated that birds on 50 mg/kg NZn supplemented diet had higher (P<0.05) ash digestibility values than those from 40 mg/kg NZn supplemented diet. This agreed with the observation of Saleh *et al*. (2012) who reported enhanced ash utilization in broiler chickens from dietary supplementation of zinc oxide.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results obtained from the present study, dietary supplementation of NZn to Arbor acre broiler chickens influenced total and daily feed intake. Crude protein and fibre digestibility were also affected by the dietary treatments. For improve performance and digestibility 30 mg/kg of NZn is recommended for Arbor acre broiler chickens.

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## THERMOREGULATORY RESPONSES IN PERIPARTURIENT SAHELIAN AND WEST AFRICAN DWARF GOATS DURING THE HOT-DRY SEASON IN THE NORTHERN GUINEA SAVANNAH ZONE OF NIGERIA

Yahaya, A.A., Yaqub, L.S., Habibu, B.,Kawu, M.U., Makun, H.J.,\* Ahmad, M.S., Ibrahim N.B.,\*\* Abubakar, U.\*\*

Department of Veterinary Physiology, Ahmadu Bello University, Zaria, Nigeria

\*National Animal Production Research Institute, (NAPRI)

\*\*National Agricultural Extension Research and Liaison Services (NAERLS)

Corresponding author: [aliyuabubakary@gmail.com](mailto:aliyuabubakary@gmail.com) Phone: +2348065752544

**ABSTRACT**

The aim of the study was to determine the thermoregulatory responses in periparturient Sahelian (SH) and West African Dwarf (WAD) goats during the hot-dry season in the Northern Guinea Savannah (NGS) zone of Nigeria. A total of twenty cycling does comprising of ten SHG (n =10) and WAD (n =10) goats were used. They were synchronised and bred in December such that the periparturient period coincided with the peak of the hot-dry season. The meteorological parameters, rectal temperature (RT) and respiratory rate (RR) were recorded once weekly; starting from three weeks prepartum until third week postpartum. The recording was done at 07:00, 14:00 and 18:00 h. The results revealed that the meteorological parameters were above the thermoneutral zone established for tropical goats. Mean RT (ºC) was significantly (P < 0.05) higher in SHG compared to WAD at 07:00 h of the prepartum week 2. While the highest mean RT was recorded in WAD at 14:00 h of the prepartum week 3. The overall diurnal fluctuation in RT was significantly (P < 0.05) higher at 14:00 h compared to 07:00 h and 18:00 h irrespective of the breed. The mean RR was significantly (P < 0.05) higher in WAD during postpartum week 1 compared to SHG, regardless of the period of the day. In conclusion, WAD had higher mean RT and RR in comparison to SHG; especially during the immediate postpartum period. Therefore, WAD was able to maintain RT within physiological range in a novel environment at expense of increased RR.

**Keywords:** Goats, Periparturient period, Heat-stress, Hot-dry season

INTRODUCTION

The periparturient period also termed the transition period (transition from gestation to lactation) is remarkably challenging in ruminants and covers the period 3 weeks pre- and 3 weeks post-parturition (Radin *et al*., 2015). In order to maximize production output, female animals, after attainment of sexual maturity spend substantial part of their life in gestation. In Nigeria, especially the Northern parts, goats are reared in small numbers predominantly under the traditional extensive management system; with little or no shelter from weather and other unfavorable environmental conditions (Timveh *et al*., 2022). Therefore, they are steadily subdued by adverse effects of meteorological stressors throughout the year. Indigenous Nigerian goats are all-year-round breeders (Omontese *et al*., 2016). As such, during pregnancy, they are subjected to concomitant effects of meteorological stressors, gestation and poor quality feed especially during the peak of hot-dry season. Animals exposed to high ambient temperatures activate compensatory mechanisms to dissipate excess thermal load from the body to maintain homeothermy. The compensatory mechanisms exert negative impact on the animals, including elevated net energy for maintenance and, consequently reduction in energy for production (Salama *et al*., 2014).

The West African Dwarf, Red Sokoto and Sahelian goats are the three main goat breeds indigenous to Nigeria. The WAD goat is predominantly found in the southern part of Nigeria; the Red Sokoto goats are indigenous to Niger Republic and the Savannah region of Nigeria; while the Sahelian goats are found in West Africa around the Sahel belt, south of the Sahara (Lawal-Adebowale, 2012). There is an observable trend of introduction of the SHG and WAD goats to the Northern Guinea Savannah (NGS) zone of Nigeria, especially by institutional and commercial farms and unregulated livestock markets (Makun *et al*., 2020). Therefore, there is the need for a detailed understanding of how these breeds are adjusting and adapting to the combined effects of meteorological stressors and pregnancy to attain optimum productivity during the peak of hot-dry season.

MATERIALS AND METHODS

**Experimental site and Animal Management**

The study was conducted at the Small Ruminant Research section of the National Animal Production Research Institute (NAPRI), Ahmadu Bello University, Shika, Zaria, Nigeria.

Experimental Design and Animals

The study was conducted during the dry season (November – May) and animals were synchronised with Cloprostenol® (at 0.263 mg/mL, IM) and bred during the last week of December, such that the periparturient period and kidding coincided with the peak of the hot-dry season (March and April). Twenty (total n = 20) pure breeds of apparently healthy, cycling does comprising of ten (n=10) each of SHG and WAD goats were used for the study. Dry-bulb and wet-bulb temperatures inside the experimental pens were taken once per week at 07:00 h, 14:00 h and 18:00 h using a hygrometer (Brannan®, UK San Diego, California, U. S. A). Relative humidity (RH) values were extrapolated from the wet and dry-bulb temperatures using conversion tables published by the Bulletin of the U.S weather Bureau No. 1071. The temperature-humidity index (THI) was calculated according to Ravagnolo *et al*. (2000):

THI = (1.8 ×T + 32) − {(0.55–0.0055·RH)·(1.8 × T − 26)}

Where: T is the ambient temperature (°C) and RH the relative humidity (%).

The parameters were determined once weekly at 07:00 h, 14:00 h and 18:00 h throughout the study period.

The RR was determined by counting the number of respiratory flank movements per minute, while the RT was recorded as an indicator of body temperature with the aid of a digital thermometer (Tro‑Digitatherm, Hamburg Germany), inserted about 3.5 cm into the rectum until alarm sound was heard, indicating stability of the reading, usually at about 1-2 minutes after insertion of the thermometer (Yaqub *et al*., 2021).

Data Analysis

The data generated from this study were expressed as mean (±SEM). The difference between groups was analysed using Two-way repeated measure analysis of variance (ANOVA) followed by Tukey’s *post hoc* test. While the difference within groups was analysed using repeated measures two-way analysis of variance test followed by Tukey’s *post hoc*. The statistical package used was GraphPad Prism version 8.0 for windows (2007) from GraphPad Software, San Diego California, USA. ([www.graphpad.com](http://www.graphpad.com)). Values of *P* < 0.05 was considered significant.

RESULTS AND DISCUSSION

Table 1 shows the meteorological parameters recorded during the study. Thermoneutral zone (TNZ) for goat ranges between 22 – 35 ºC for AT and 28 – 60 % for RH (Minka and Ayo, 2016). From this study, the AT was above the upper limit of the TNZ established for tropical goats during the afternoon hour of the study, implying that the goats were heat-stressed. Above the TNZ is the upper critical temperature at which animals must explore the services of energy dissipating mechanisms of the body in order to cool off and maintain homeothermy for optimum production (Salama *et al*., 2021). Rectal temperature was significantly higher in WAD goats during the morning hour (Table 2) regardless of the periparturient stages, except during the week before parturition (prepartum week 1). This finding is in consonance with the studies conducted in the same environment in non-pregnant goats (Habibu *et al*., 2014; Habibu *et al*., 2016). This may be a breed specific trait. It may also indicate that the breed is less adapted to temperature extremes prevailing in the Savannah region of Nigeria. However, the significantly higher RT (Table 2) in WAD during the postpartum period, especially the first week of postpartum, may have been caused by the onset of ‘milk-let down’ coupled with the climatic extremes of a novel environment that challenged the homeostatic responses of WAD in comparison to the SHG. Furthermore, the significantly higher RR in WAD during the first week of postpartum (Table 3) regardless of the hour of the day compared to SHG suggests that the first postpartum week is more thermally stressful to the WAD. Similar study in goats during heat stress demonstrated a considerable lost in milk component and milk yield (Hamzaoui *et al*., 2013). This finding in WAD could have multifaceted implications considering the challenge of adaptability of the WAD to the novel climatic environment, heat stress and onset of lactogenesis. In spite of higher mean RR in WAD, especially during the afternoon hour, this could not mitigate the rise in RT. Therefore, an increase in RR and RT obviously indicate a lesser adaptability of the WAD in comparison to SHG. While lower RR and RT recorded in SHG suggests that they are more economical in terms of diverting energy to the productive traits rather than for adaptation in the NGS zone of Nigeria.

Table 1: Fluctuations in the mean (± SEM) thermal environmental parameters during the hot-dry season in the study microenvironment, Shika, Zaria, Nigeria

|  |  |  |  |
| --- | --- | --- | --- |
| Meteorological  Parameters | Morning  (07:00 h) | Afternoon  (14:00 h) | Evening  (18:00 h) |
| Ambient temperature (oC) | 30.25 ± 0.77a | 38.33 ± 1.13b | 34.83 ± 1.68ab |
| Relative humidity (%) | 48.83 ± 4.39a | 21.33 ± 3.67b | 25.67 ± 3.41b |
| THI | 78.45 ± 1.20 | 82.17 ± 0.59 | 79.55 ± 1.58 |

a,b= Means in the same raw with different superscript are significantly (*P* < 0.05) different.

Table 2: Effect of perparturient period on rectal temperature (ºC) in SH and WAD goats during the hot-dry season in Shika, Zaria, Nigeria

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Morning  (07:00 h) | Prepartum week 3 | Prepartum week 2 | Prepartum week 1 | Postpartum week 1 | Postpartum week 2 | Postpartum week 3 |
| SHG | 39.15 ± 0.07y | 38.63 ± 0.08a,x | 38.97 ± 0.06 | 38.91 ± 0.16a | 38.84 ± 0.06 | 38.96 ± 0.09 |
| WAD | 39.08 ± 0.06y | 38.08 ± 0.08b,x | 38.82 ± 0.12y | 39.37 ± 0.11b,y | 39.21 ± 0.14y | 39.20 ± 0.07y |
| Afternoon  (14:00) |  |  |  |  |  |  |
| SHG | 39.37 ± 0.05 | 39.02 ± 0.08 | 38.96 ± 0.06 | 39.34 ± 0.11 | 39.00 ± 0.17 | 39.34 ± 0.18 |
| WAD | 39.73 ± 0.04x | 39.54 ± 0.08y | 39.27 ± 0.09y | 39.66 ± 0.07x,z | 39.31 ± 0.11y,z | 39.40 ± 0.10y |

a,b,c = Means in the same column with different superscripts are significantly different (*P* < 0.05); x,y,z = means in the same raw with different superscripts are significantly (*P* < 0.05) different

WAD = West African Dwarf goat; SHG = Sahel goat

Table 3: Effect of perparturient period on respiratory rate (breaths/min) in SH and WAD goats during the hot-dry season in Shika, Zaria, Nigeria

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Morning  (07:00 h) | Prepartum week 3 | Prepartum week 2 | Prepartum week 1 | Postpartum week 1 | Postpartum week 2 | Postpartum week 3 |
| SHG | 36.40 ± 1.83a,y | 30.40 ± 1.71y | 35.00 ± 2.22a,y | 46.20 ± 3.43a,x | 40.20 ± 3.13a | 38.00 ± 3.17a |
| WAD | 49.80 ± 2.24b,y | 40.00 ± 2.07y | 51.20 ± 5.12b,y | 77.80 ± 4.55b,x | 56.00 ± 4.13b,y | 52.00 ± 4.42b,y |
| Afternoon  (14:00 h) |  |  |  |  |  |  |
| SHG | 40.00 ± 1.89x | 41.80 ± 1.47a,y | 42.40 ± 2.25a,y | 49.60 ± 3.05a | 41.20 ± 3.38a | 38.00 ± 2.02a |
| WAD | 48.00 ± 1.52y | 78.00 ± 3.59b,x | 60.40 ± 3.12b,y | 78.40 ± 3.83b,x | 55.60 ± 3.40b,y | 61.20 ± 6.08b,y |

a,b,c = Means in the same column with different superscripts are significantly different (*P* < 0.05); x,y,z = means in the same raw with different superscripts are significantly (*P* < 0.05) different

WAD = West African Dwarf goat; SHG = Sahel goat

CONCLUSION

It was concluded that the WAD goats had higher mean RT and RR at the afternoon hour (14:00 h) in comparison to SHG during the prepartum and postpartum period. Therefore, WAD goats were able to maintain RT within the normal physiological range in a novel environment of the NGS zone of Nigeria at the expense of increased RR. Special management care should be provided to the periparturient WAD to shield them from excessive exposure to heat stress during the hot-dry season and especially, the early phase of lactation.

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**EFFECT OF BREED AND SEX ON PELT GROWTH OF NEW ZEALAND WHITE AND CHINCHILLA GIGANTA RABBITS**

1Eniwaiye, A. A\*., 1Rani, Z. T., 2Otu, B. O., 2Kolo, S. P and 2Owolabi, S. J.

1Department of Animal and Poultry Science, University of KwaZulu Natal,

Pietermaritzburg, South Africa

2Department of Animal Production, Federal University of Technology, Minna, Niger State

Corresponding Author\*:[adenikebanjo@gmail.com](mailto:adenikebanjo@gmail.com)

Telephone Number**:** +2348063249580

ABSTRACT

*New Zealand White and Chinchilla Giganta rabbits are breeds of rabbits popularly known for their meat production and pet strain and usually produce top quality pelts when slaughtered. As the rabbits increased in sizes, so also are the pelt weight and pelt area which corresponded to the body volume and the vastness of the pelt. The research aim was to study the effect of breeds and sexes on the development of pelt. A total of 216 (54 males and 54 females of NZW; 54 males and 54 females of the Chinchilla Giganta) rabbits were used in this research. Data were analysed with analysis of variance using GenStat software and the pelt area was calculated using ImageJ analysis. Variables observed were pelt weights and pelt area. The results showed that sexes had no interaction on pelt area but the breed does, and as the rabbit’s increases in age, so also the increase in pelt weight and pelt area.*

**Keywords:** Sex, Breed, Pelt, New Zealand White, Chinchilla, Rabbit

INTRODUCTION

New Zealand White (NZW) and Chinchilla Giganta rabbits are one of the most popular rabbit breeds in the world, known for their meat production and pet strain (Ozurlu *et al*., 2009; Galal *et al*., 1994). New Zealand White rabbit has a short, soft fly back and tight-set white fur in the pelt while the Chinchilla Giganta are grey in colour and produce a top quality pelt when slaughtered. However, their intensive meat rabbit production techniques are frequently incompatible with quality fur pelt production standards (Lebas *et al*., 1997). Although meat is the main goal of rabbit production, furs and pelts are by- products that are usually recovered from skins with no particular production constraints (Lebas *et al*., 1997). The New Zealand White and the Chinchilla Giganta rabbits has high-quality skins that are used in fur garments, trimming, medical and cosmetic research, and other applications (Taha *et al*., 2006). Several factors influence the characteristics of animal skins, including sex, seasonal variations, production system, and slaughtering ages (Taha *et al*., 2006; Lebas *et al*., 2007; Taha *et al*., 2017). Rabbit pelts have a low monetary value compared to other by-product of live animals (Lebas *et al*., 2007). Several studies have shown that several factors affect the properties of rabbit pelts, but there is a lack of evidence regarding the effect of breeds and sexes on the characteristics and development of New Zealand White and Chinchilla Giganta rabbit pelts. As a result, the purpose of this study was to investigate into the effect of breeds and sexes on the growth of the pelt of New Zealand White and Chinchilla Giganta rabbits.

MATERIALS AND METHODS

Two hundred and sixteen (216) rabbits of 108 (54 males and 54 females) New Zealand White (NZW) and 108 (54 males and 54 females) Chinchilla Giganta rabbits were used for this study. The two (2) strains of rabbits after slaughtering, were defured, and the weight (g) of the pelts were also recorded at various slaughtering ages (21, 28, 35, 42, 56, 70, 84, 112 and 140 days). The first cut was usually an incision at the hind feet, passing from one thigh to the other, then the skin was pulled off in one piece after which the skin will be opened up. The surface area was determined by spreading the pelt over a hard surface and the outline traced. The traced version was subjected to free draw and the surface area determined by means of image analysis (ImageJ).The area (sq.cm) of the pelts were recorded using ImageJ analytical software. The data generated were subjected to statistical analysis of variance using GenStat, 2020 version.

RESULTS AND DISCUSSION

The weight and area (cm2) of the pelt of male and female New Zealand White rabbits at their respective slaughter ages (days) were presented in Table 1 and Figure 1. More so, the weight and area (cm2) of the pelt of male and female Chinchilla Giganta rabbits at their respective slaughter ages (days) were presented in Table 2 and Figure 2. There were significant differences (P< 0.001) in the pelt area of male and female NZW rabbits, as the rabbits increased in age until day 42, when almost all the rabbits retained their mature pelt areas. Significant differences (P<0.001) were recorded in the breed against the sex and breed.sex of the chinchilla Giganta which were not significant (P>0.05). There was progressive linear increase in the pelt area of male and female Chinchilla Giganta between 21 – 140 days. The mean pelt area (995.8 cm2) of the female Chinchilla Giganta was slightly higher than that of the male (994.3 cm2), while the male (1071.6 cm2) was higher than the female (1058.8 cm2) in the New Zealand White rabbits.

As the rabbits (New Zealand White and Chinchilla Giganta) increased in sizes, so also are the pelt weight and pelt area which corresponded to the body volume and the vastness of the pelt. The vastness of the fresh pelt increased and matched with pelt weight because the rabbits’ size (or weight) translated to a higher vastness of the pelt due to the accumulation of fat under the skin.

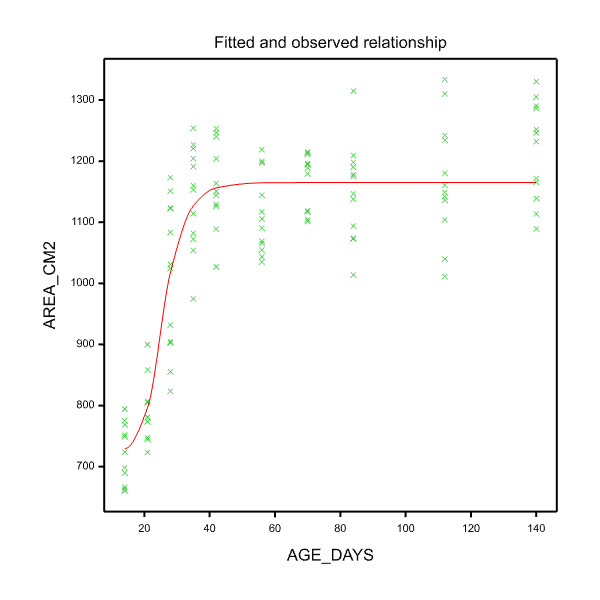
The results obtained in this study are at variance with the findings of Tao (1994), which stated that New Zealand White crossbreed rabbits weighing 3.43± 0.36 kg at day 105 had a pelt area of 1.197± 0.94cm2. The result of this research is in line with the result of Maynard and Loosely (1969) which demonstrated that an increase in the weight of rabbits would be accompanied by an increase in rabbit pelt’s area. The pelt area in this study was not affected by sex, but the pelt of male rabbits was significantly larger than the female rabbits in the New Zealand White. This could be because male rabbits are usually fed for meat and maintenance purpose only unlike the female rabbits that go through the process of reproduction and lactation. This result may explain the decrement of follicle density in the skins of male rabbits. However, previous studies showed that the fibre density was significantly higher in female rabbits than that of the male rabbits (Ozurlu *et al*., 2009; Tao, 1994), while the significant difference between the two sexes in this study were not in agreement with Yagci *et al*. (2006).

**Table 1: Weekly mean pelt weight (g) and pelt area (cm2) of female and male New Zealand White rabbits**

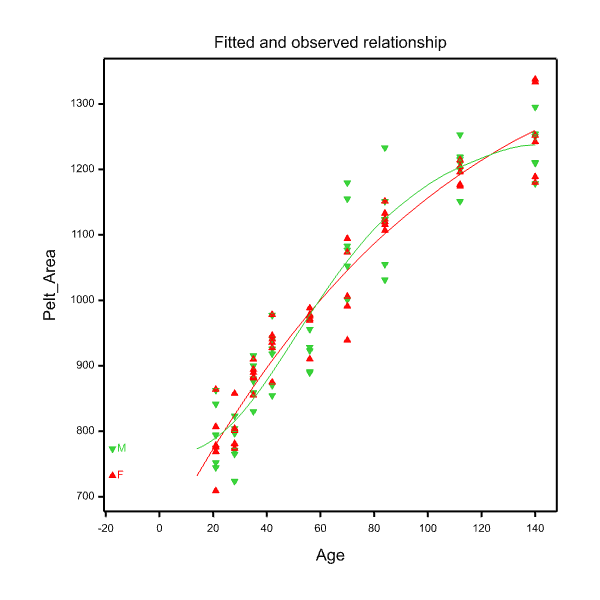
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Age (Days) | Pelt weight    F | M | Mean (g) | Pelt area    F | M | Mean (cm2) |
|  |  |  |  |  |  |  |
| 21 | 69.2 | 66.3 | 67.7b | 789.7 | 809.4 | 799.6 |
| 28 | 86.0 | 78.1 | 82.1b | 1008.3 | 1013.0 | 1010.7 |
| 35 | 126.4 | 129.9 | 128.2c | 1109.7 | 1175.0 | 1142.4 |
| 42 | 192.5 | 197.8 | 195.2d | 1161.9 | 1138.6 | 1150.3 |
| 56 | 214.0 | 192.1 | 203.1de | 1126.8 | 1097.0 | 1111.9 |
| 70 | 222.9 | 230.0 | 226.6e | 1167.3 | 1172.1 | 1169.7 |
| 84 | 315.9 | 331.1 | 323.5f | 1109. 2 | 1191.7 | 1150.5 |
| 112 | 386.7 | 372.7 | 379.7g | 1222.0 | 1118.7 | 1170.4 |
| 140 | 367.3 | 462.6 | 415.0h | 1179.1 | 1258.0 | 1218.6 |
| Mean | 220.1 | 228.9 | 224.57 | 1097.1 | 1108.2 | 1102..7 |
| LSD | Breed | Sex | Breed.sex | Breed | Sex | Breed.sex |
|  | Ns | ns | \*\*\* | \*\*\* | Ns | ns |
| SEM | 8.94 | 4.00 | 12.65 | 22.31 | 9.98 | 31.55 |
| RMS | 959.4 |  |  | 5974.0 |  |  |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Age (Days) | Pelt weight (g)  F | M | Mean (g) | Pelt area (cm2)  F | M | Mean (cm2) |
| 21 | 34.4 | 37.5 | 35.9 | 783.8 | 798.2 | 791 |
| 28 | 68.3 | 70.5 | 69.4 | 799.8 | 780.7 | 790.2 |
| 35 | 77.3 | 75 | 76.1 | 885.7 | 876.9 | 881.3 |
| 42 | 146.5 | 166.7 | 156.6 | 934 | 914.5 | 924.2 |
| 56 | 224.9 | 226 | 225.4 | 965.6 | 926.7 | 946.2 |
| 70 | 245.6 | 203.1 | 224.3 | 1015.8 | 1091.3 | 1053.6 |
| 84 | 237.8 | 230 | 237.4 | 1125.1 | 1119.4 | 1122.2 |
| 112 | 338.2 | 337 | 337.6 | 1196.7 | 1207.9 | 1202.3 |
| 140 | 384.7 | 394.8 | 389.7 | 1255.7 | 1233.1 | 1244.4 |
| Mean | 195.3 | 193.4 | 194.7 | 995.8 | 994.3 | 995 |
| LSD | Breed | Sex | Breed.sex | Breed | Sex | Breed.sex |
|  | \*\*\* | ns | \*\*\* | \*\*\* | Ns | Ns |
| SEM | 3.29 | 1.47 | 4.65 | 5.93 | 12.59 | 17.80 |
| RMS | 129.9 |  |  | 1901 |  |  |

**Table 2: Weekly mean pelt weight (g) and pelt area (cm2) of female and male Chinchilla Giganta rabbits**



**Figure 1: Fitted and observed relationship of the pelt area (cm2) of male and female New Zealand White rabbits at their respective slaughter ages (days)**



**Figure 2: Fitted and observed relationship of the pelt area (cm2) of male and female Chinchilla Giganta rabbits at their respective slaughter ages (days)**

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# CROP SCIENCE/PRODUCTION

## EFFECTS OF *Jatropha curcas* LEAF EXTRACT ON THE GROWTH CHARACTERISTICS AND NEMATODE ASSOCIATED WITH TOMATO (*Solanum lycopersicum*)

\* R.M, Olaniyi, L.Y, Bello; and A.C, Wada,

Department of Crop Production, School of Agriculture and Agricultural Technology,

Federal University of Technology, Minna, Niger state

\*Corresponding author E-mail: mojisolamusa2017@gmail.com Telephone - +2348065744456

ABSTRACT

*Tomato (Solanum lycopersicumL.) is a good source of income for many farmers in both local and export trade. The experiment was conducted at the screen house of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. The experiment was to determine the effect of Jatropha curcas leaf extract on nematode associated with tomato. The treatments were 5 concentration levels of 100 %, 50 %, 10 %, 1 % and control, arranged in a completely randomized design (CRD) with four replications. Data were collected on number of leaves, number of fruits, fresh and dry weight and root knot index. Data collected were to Analysis of variance (ANOVA) and means were separated using Duncan Multiple Range Test (DMRT) at 5% level of probability. The results indicated that significant level on number of leaf was observed at 12 WAI at Standard concentration level with 85.88 as compared to control with 50 at 12 WAI. Concentration level Standard (S) recorded the highest number of fruit, fruit weight, fresh weight, dry weight and reduced index of root knot as compared to other concentration levels. The study revealed that the effectiveness of using different concentration levels of Jatropha curcas leaf extract for the control of Meloidogyne incognita. The Standard solutions (100 %) of Jatropha curcas leaf extract was more effective in the reduction of root knot formation and also enhanced the growth parameters of the tomato thus, provides a promising option for nematode management.*

**Keywords:** *Meloidogyne incognita*, tomato, *Jatropha curcas,* concentration levels

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a major vegetable crop for most Nigerians with production estimated at 170 tonnes (FAO, 2011). Tomato has many varieties widely grown in the greenhouses and in cooler climates. It contributes most of the calorie requirements for each day and the fruits are consumed in several forms: raw in salads, soup paste, Unripe green tomatoes can also be blended and fried, used to make salsa or pickled, juice in cocktail (Rao and Balachandran, 2002). Major tomato production is in the forest and the guinea Savanna zones of Nigeria.

Tomato cultivation and storage suffer serious problems and the major constraints to its production as they have direct negative effect on its quality and yield. Therefore, there is need for the knowledge of control measure of nematode attacking tomato in major tomato growing areas. Therefore, this study was set up to facilitate the development of preventive and management measures for tomato production.

Nematodes are the most numerous animals on earth (Kimpinski and Sturz, 2003). Nematodes are obligate plant parasites with smooth, cylindrical, relatively long worms that destroy the plant tissues (Ellis *et al*., 2008). The most important plant parasitic nematodes are root knot nematodes *(Meloidogyne* spp), cysts nematodes (*Heterodera*spp and *Globodera*spp), root lesion nematodes (*Pratylenchus* spp), bulb and stem nematodes (*Ditylenchus dipsaci*), Spiral (*Helicotylenchus* spp), Reniform (*Rotylenchulus reniformis*), Dagger (*Xiphinema* spp), Bud and leaf (*Aphelenchoides* spp) and burrowing nematodes (*Radopholus similis*) (Ellis *et al*., 2008).

In Nigeria, Root Knot Nematodes (*Meloidogyne incognita*), RNK is the most prevalence in the humid forest, reaching an incidence of 73%. The nematode spread through nursery and fields and mostly through infected planting material and their accumulation paralysis tomato variety movement worldwide.

Some of the crops that may be severely damaged by *Meloidogyne incognita* are tomato, pepper, okra, watermelon, cantaloupe, onion, pumpkin, squash, sweet potato, sweet corn, carrot, eggplant, bean and peas (Trudgill and Blok, 2001). Root Knot Nematodes *(Meloidogyne incognita)* are abundant `in the soils of Nigeria, which are very susceptible to food crops causing losses in both quality and quantity. It is an important parasite which causes severe loss in tomato production (Olabiyi *et al*., 2009). Symptoms of tomato infected with root knot nematode are retardation of seedling growth, yellowing of leaves, wilting of plant.

Pollination of *Jatropha* plant is by insect and contains approximately 175 known species (Kumar, *et al*., 2008). *Jatropha curcas* production is gaining more awareness all over the world as a result of several benefits derived from the plant. The current production of *Jatropha* is estimated to 3 tons per ha to 30 tons per ha in Mali given the production rate to be 2,800 kg per ha per annum when harvested (Henning, 2002).

*Jatropha curcas* leaf extracts kill the larvae of mosquito species that vector infectious diseases such as malaria (Valencia *et al*., 2006). *Jatropha* leaf extracts reduce fungal pathogen growth like brown blotch disease, and *Colletotrichum*s pp in cowpea (Onuh *et al*., 2008). Extract from *Jatropha curcas* leaves exhibit insecticidal activity against a wide range of *Lepidopteran* species (Phowichit *et al*., 2008)*. Jatropha* seeds extract are reported to cause 97-100 % mortality against stored product pests such as *Sitophilus* weevils (Asmanizar *et al*., 2008), and *Callosobruchus* seed beetles (Adebowale and Adedire, 2006). Therefore, the objective was to study the efficacy of *Jatropha curcas* leaf extract associated with tomato in Minna, Niger State, Nigeria

MATERIALS AND METHODS

The research work was carried out in the Screen house of the Crop Production Department, Federal University of Technology, Minna. The site of the experiment is located in the Southern Guinea Savannah ecological zone of Nigeria. The experiment was located at 9 0 51 'N, 6 0 44 'E and 212 m above sea level as captured by Geographical Positioning System (GPS) equipment (GPS- 4300; Ethrex Garmin GPS, Taiwan). Niger State, Nigeria.

*Jatropha curcas* leaves were obtained from the School of Agriculture and Agricultural Technology *Jatropha curcas* plantation farm, Garatu village in Minna, Niger State. Two kilogrammes required for the experiment were collected and parked inside clean labelled polyethylene bags. These were transported to Department of Crop Production Laboratory, Federal University of Technology, Minna, Niger State.

Two kilogrammes of *Jatropha curcas* fresh leaves were washed and put inside mortar and pounded with a pestle into paste to which 200ml from 6 litres of required distilled water was added. The mixture was stirred with a clean glass rod and left on the laboratory bench for 24 hours. The pastes were covered with aluminium foil to prevent evaporation. After 24 hours, the mixture was stirred and poured into a whirling electronic tower blender for proper mixing for 1 minute. After blending, the pastes were poured into a plastic container and the remaining 5.8 litres of distlled water for each was added to the pastes. The pastes were left on the bench for 48 hour and covered with aluminium foil. After 48 hours, they were filtered into a clean container using Whatman No. 1 filter paper. The resultant solutions were labelled as standard concentration ‘S for *Jatropha curcas* leaf (SJCL). Ten drops of Streptomycin sulphate were added to prevent bacterial formation and growth.

Treatments were different concentration levels which were prepared as undiluted standard solution ‘S’, half concentration of the standard solution S/2, one – tenth of the standard solution S/10, and one – hundredth of the standard solution S/100 using the method of (Bello *et al.,* 2006);

100 % (S) represented the standard stock concentration (undiluted), 50 % (S/2) represented 1ml of the standard concentration 1ml of distillled water added, 10 % (S/10) represented every volume of the standard concentration measured ten times of the distilled water was added, 1 % (S/100) represented every volume of the standard concentration measured hundred times its equivalent added and 0 % was the control (distilled water). The experiment was arranged in Completely Randomized Design (CRD). Each concentration with the control were replicated 4 times for the extracts of *Jatropha curcas* leaves thereby making a total of 20 pots of 15 kg of sterilized soil. For each concentration of the extract, 15 ml of the extract was poured into each of the tomato pots using a measuring cup. Equal volume of distilled water was poured into similar sized pot and inoculated similarly to serve as control.

Data were collected on number of leaves, number of fruits, fresh and dry weight and root knot index. The number of leaves were counted from 1 week after Inoculation (WAI) to 12 Weeks After Inoculation (WAI), the number of fruits were counted from the first day seed germinated till when the experiment was terminated, the fresh and dry weights were taken using the Metlar Balance and root knot index was done by counting the number of galls in the laboratory after harvesting the method of Bridge and Page (1980) after the experiment was terminated. All data were taken and recorded for each concentration for each hour.

Data collected were subjected to analysis of variance (ANOVA) using Statistical System Analysis (SAS) guide (SAS, 2008). Means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION

The result in Table 1 shows that there was no significant difference in leaf number of tomato plants treated with the different concentration levels of leaf extract of *Jatropha curcas* at 1WAI, but significant leaf reduction was observed in the control with 15.25 as compared to S, S/2 and S/10. Similar increase in leaf number was observed in all the concentration levels between 2 and 5 WAI.

However, at 6 WAI, significant effect of the concentration levels were observed in the leaf number differences between S with 52.63 and other concentration levels and the lowest decrease in leaf number was in the control with 30.75. Similarly, there were no significant differences in the number of leaves from plants treated with S/10 and S/100 at 6 WAI. The highest significant increase in leaf number of the tomato plants was observed in S as from 7 to 12 WAI where S attained the leaf number of 85.88 which was significantly difference from the other concentration levels S/2, S/10, S/100 and control with the leaf numbers 71.3, 66.13, 58.38 and 50 respectively**.** Gutlierrez *et al*., (2014) suggested that *Jatropha* leaf have a wide range of pesticidal and antimicrobial properties at standard solution. *Jatropha* leaf extracts at half standard solution kill the larvae of mosquito species that vector infectious diseases such as malaria (Valencia *et al*., 2006).

**Table 1 Effect of different concentration levels of *Jatropha curcas* leaf extract on leaf number of tomato (*Solanum lycopersicum* L).**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **TRT** | **1WAI** | **2WAI** | **3WAI** | **4WAI** | **5WAI** | **6WAI** | **7WAI** | **8WAI** | **9WAI** | **10WAI** | **11WAI** | **12WAI** |
| S | 17.25a | 29.13a | 36.63a | 40.25a | 46.38a | 52.63a | 58.38a | 64.75a | 69.88a | 74.95a | 80.90a | 85.88a |
| S/2 | 19.40a | 25.2ab | 30.63b | 34.63b | 38.88b | 43.25b | 46.91b | 51.13b | 55.88b | 60.63b | 65.50b | 71.13b |
| S/10 | 17.13a | 23.50b | 28.8bc | 32.3bc | 36.3bc | 40.6bc | 44.7bc | 48.8bc | 52.7bc | 57.25bc | 61.00bc | 66.13bc |
| S/100 | 16.63a | 20.3bc | 24.6cd | 28.5cd | 32.0cd | 35.7cd | 39.5cd | 43.2cd | 47.0cd | 50.75cd | 55.13cd | 58.38cd |
| C | 15.25a | 18.50c | 21.87d | 24.38d | 27.63d | 30.75d | 33.88d | 36.50d | 39.50d | 43.00d | 46.38d | 50.00d |
| MEAN | 17.13 | 23.35 | 28.52 | 32.13 | 36.25 | 40.6 | 41.68 | 48.9 | 53 | 57.32 | 61.78 | 66.3 |
| ±SE | 1.58 | 1.65 | 1.75 | 1.49 | 1.55 | 1.63 | 1.93 | 2.38 | 2.58 | 2.77 | 3.06 | 3.32 |

Means with the same letters along the same column are not significantly difference (*p* ≤ 0.05) from each other by DMRT

WAI= Week(s) after inoculation, TRT= Treatment, S = Standard solution, S/2 = Half Concentration of the standard solution

S/10 **=** One-tenth of the standard solution, S/100 = One – hundredth of the standard solution, C = Distilled water,

DMRT = Duncan Multiple Range Test

**Effect of different concentration levels of *Jatropha curcas* leaf extract on number of fruits, fruit weight, Root knot, plant fresh weight, plant dry weight of tomato against *Meloidogyne incognita*.**

The result in Table 2 shows the number of fruits, fruit weight, root knot, fresh weight, dry weight of tomato inoculated with egg masses of *Meloidogyne incognita* under screen house conditions. The result shows that there was no significant difference in the number of fruits among concentrations S/2, S/10, S/100 and control with 1.25, 1.00, 0.50 and 0.25 respectively. The undiluted concentration level S recorded higher significant number difference of 3.50. Also, on fruit weight, there was no significant difference in the weight of the fruits among the concentration levels S/2, S/10, S/100 and control with 23.63g, 17.73g, 7.64 g and 2.46g respectively. The undiluted concentration recorded significantly higher fruit weight of 51.22 g. There was significant difference in the number of root knots from all the concentration levels. The control recorded the highest value for root knot of 7, followed by S/100 with 6, S/10 with 4, and S/2 with 2 the lowest value was recorded in the undiluted concentration S with 1.

There was no significant difference in fresh weights of S/100 and control with 18.19 g and 15.96 g respectively. However, concentrations S/2 and S/100 did not differ significantly with weights of 27.20 and 23 respectively. Whereas undiluted concentration S recorded the highest fresh weight of 35.68 g which differed significantly from the weights recorded from the remaining concentration levels. Results for the dry weights were similar as there was no significant difference between the weights from S/100 and control which recorded the lowest dry matter weight of 9.68 g and 8.98 g respectively. Also, there was no significant difference between the weights from S/2 and S/10 with 17.05 g and 15.57 g respectively. Whereas, S with dry weight of 24.73 g differed significantly from the weights of the other concentration levels S/2, S/10, S/100 and control. This is in line with the report made by Onuh *et al*., (2008) that Jatropha leaf extracts at control level reduce fungal pathogen growth like brown blotch disease, and *Colletotrichum* spp in cowpea.

Table 2 Effect of different concentration levels of *Jatropha curcas* leaf extract on Number of Fruit, Fruit Weight, Root knot, Plant Fresh Weight and Plant Dry Weight of tomato (*Solanum lycopersicum* L)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **TRT** | **N.FR** | **FRWT (g)** | **RKN** | **PFWT (g)** | **DPWT (g)** |
| S | 3.50a | 51.22a | 1e | 35.68a | 24.73a |
| S/2 | 1.25b | 23.63b | 2d | 27.20b | 17.05b |
| S/10 | 1.00b | 17.73b | 4c | 23.00bc | 15.57b |
| S/100 | 0.50b | 7.64b | 6b | 18.19cd | 9.68c |
| C | 0.25b | 2.46b | 7a | 15.96d | 8.96c |
| MEAN | 1.3 | 20.54 | 4 | 24.01 | 15.2 |
| ±SE | 0.57 | 7.21 | 0.27 | 1.82 | 1.06 |

Means with same letters along the same column are not significantly difference (*p* ≤ 0.05) from each other by DMRT. TRT= Treatment, N.FR= Number of Fruit, FRWT (g) = Fruit Weight, RKN= Root knot, PFWT (g) = Fresh Weight, DPWT (g) = Dry Weight, S = Standard solution, S/2 = Half Concentration of the standard solution, S/10 **=** One-tenth of the standard solution, S/100 = One – hundredth of the standard solution, C = Distilled water, DMRT = Duncan Multiple Range Test

CONCLUSION AND RECOMMENDATION

The study revealed that the effectiveness of using different concentration levels of *Jatropha curcas* leaf extract for the control of *Meloidogyne incognita*. The Standard solutions (100 %) of *Jatropha curcas* leaf extract was more effective in the reduction of root knot formation and also enhanced the growth parameters of the tomato. Thus, *Jatropha curcas* leaf extract may be a source of cheap and effective nematicide for the management of *Meloidogyne incognita* without any threat to the health of man, animals and environment.

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Soil

## EFFECT OF FOLIAR FERTILIZER APPLICATION ON PHYSIOLOGICAL CHARACTERISTICS AND HERBAGE YIELD OF AMARANTHUS AND CORCHORUS

Ameh, B.K.\* Saidu, A. and Tolorunse, K. D.

1Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria

2Department of Crop Production, Federal University of Technology, Minna Niger State, Nigeria

\*Corresponding author email: kizitobarthlome@gmail.com: +2348165045418

ABSTRACT

*One-third of children deaths in Africa are attributable largely to protein energy malnutrition and micronutrient deficiencies which can be solved by exploring underutilized nutritious crop. Experiment was conducted at the Crop Production Screen House and Albishiri Irrigation Farm both in Minna, during the dry Season of 2021. The objective was to determine the effect of application of organic foliar fertilizers rates on physiology and yield response of leafy vegetables in Minna. The experiment consisted of five rates of foliar fertilizer (0 L ha-1, 0.5 L ha-1, 1.0 L ha-1, 1.5 L ha-1 and 2.0 L ha-1) arranged in completely randomized design. Data were collected on plant height, The results indicated that plants that received organic foliar fertilizer rates at 2.0 L ha-1 produced significantly tallest plant at 4,5 and 6 WAS similar results were obtained for number of leaves, dry shoot weight. There was significant variation in the performance of the vegetables planted. Seeds had significant effects on fresh weight and dry weight of Amaranthus and Corchorus. It is therefore recommended that farmer should adopt the application of organic foliar fertilizer (Super Agro) at the rate of 2.0 L ha 1.*

**Keyword:** Foliar Fertilizer, Amaranthus, Corchorus, Irrigation, Herbage yield

INTRODUCTION

Vegetable can be classified as fruit vegetables such as tomato, cucumber, okra; root and tuber/root vegetables such as potato, sweet potato, radish; green leafy vegetables such as amaranthus, celery, cabbage and bulb vegetables such as onion, garlic and shallot (Abewoy, 2018). Vegetable are important for nutrition in terms of bioactive nutrient molecules such as dietary fiber, vitamins, and minerals (Keatinge *et al.*, 2011). They are best resources for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs (Abewoy, 2018). Vegetable are produced all over the world but in a varied extent. Asia is the largest vegetable producer. China and India is the two largest vegetable producer of Asia cover 62 % of world’s total production with an individual contribution of 554 and 127 million metric tons respectively (Shahbandeh, 2020). Bangladesh has also gained remarkable improvement in vegetable production in the last few years (Zaman, 2019). Therefore, the objectives are to determine the effect of foliar application of organic fertilizer rates on Physiology and yield responses of Amaranthus and Corchorus.

MATERIAL AND METHODS

The experiment was conducted in the dry season of 2021 at the Crop Production Screen House, Federal University of Technology and Albishiri Irrigation Farm, Minna (9O 37’N, 6O 28’E) in the Southern Guinea Savanna of Nigeria. Soil samples were collected at random across the experimental site at the depth of 0 – 15cm along a transect and then bulked together to form the composite sample. Amaranthus and Corchorus varieties were obtained from the irrigation farmers in Minna, Niger State. Foliar fertilizer was obtained from an Agro-chemical shop in Minna. The Super gro fertilizer contained Nitrogen 72 g, Phosphorus 45 g, Potassium 30 g, Sulphur 15 g, Calcium 9 g, Magnesium 7 g, Iron 5 mg, Iodine 3 mg, Marine 1 mg and Zinc 1 mg per litre.The screen house experiment was a factorial combination of two vegetable varieties (Amaranthus and Corchorus) and five rates of folia fertilizer (Super Gro) (0 L ha-1, 0.5 L ha-1, 1.0 L ha-1, 1.5 L ha-1 and 2.0 L ha-1) resulting into ten treatment combinations. The experiment was laid out in a completely randomised design (CRD) with four replications resulting into 40 pots. The pots were watered (3liter) before planting and watered as when required to ensure the pots are kept moist. Watering will be done every other day until harvest. The field experiment was also a factorial combination of two vegetable (Amaranthus and Corchorus) varieties and five rates of folia fertilizer (Super Gro) laid out in a randomized complete block design (RCBD) with three replications resulting into 30 plots. The land was ploughed and levelled. The check basins of 3 m x 3 m were constructed. The gross plot size was 3m x 3m (9 m2) and a net plot was 1.5 m x 3 m (4.5 m2). An alley of 0.5 m was left within the replicates. In the field, the plots were irrigated a day to planting and immediately after planting. Irrigation was done twice a week. The field was irrigated to field capacity at each time of irrigation. Data were collected on plant height, number of leaves per plant, stem girth, number of branches, leaf area, number of days to 50 % flowering, fresh wet weight, dry weight, root length, fresh root weight and dry root weight. Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) package version 9.0 (2013). Means were separated using Duncan Multiple Range Test (DMRT) at P≤ 0.05.

RESULTS

The effect of foliar fertilizer rates on plant height of Amaranthus and Corhorus vegetables at 4, 5 and 6 WAS grown under screen house is shown in Table 1 Plant height was significantly different among the foliar fertilizer rates throughout the sampling periods of the study. At 4 WAS, the application of foliar fertilizer at the rate of 2.0 L ha-1 produced significantly taller plants than the other application rates compared with the control (0 L ha-1) which produced the shortest plants. But that was not the case at 6 WAS were the application of foliar fertilizer at the rates of 0.5, 1.0 and 2.0 L ha-1 produced statistically similar tallest plants than the other rate compared with the control (0 L ha-1) which had the shortest plants. At 6 WAS, the application of foliar fertilizer at the rates of 1.5 and 2.0 L ha-1 produced similar tallest plants than the other rates compared with the control (0 L ha-1) which produced the shortest plants.

Table 1: Effect of foliar application of foliar fertilizer rates on plant height of Amaranthus and Corchorus vegetables at 4, 5 and 6 WAS grown under screen house

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Plant height (cm) | | |
|  |  | Weeks after sowing | | |
| Treatment |  | 4 | 5 | 6 |
| **Fertilizer (F) (L ha-1)** |  |  |  |  |
| 0 |  | 28.85c | 39.23c | 46.95c |
| 0.5 |  | 40.81b | 60.18a | 66.60b |
| 1.0 |  | 50.85a | 59.60a | 67.60b |
| 1.5 |  | 41.39b | 52.43b | 72.37a |
| 2.0 |  | 51.83a | 63.97a | 73.60a |
| SE± |  | 1.82 | 2.24 | 1.24 |
| **Vegetables (V)** |  |  |  |  |
| Amaranthus |  | 58.62a | 77.06a | 89.92a |
| Corchorus |  | 26.87b | 33.11b | 40.92b |
| SE± |  | 1.15 | 1.42 | 0.78 |
| **Interaction** |  |  |  |  |
| F × V |  | \*\* | \*\* | \*\* |

Table 2: Interaction between foliar fertilizer application rates of Amaranthus and corhorus on plant height at 4, 5 and 6 WAS grown under screen house

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | **Vegetable** | | |
|  |  | Amaranthus | | Corchorus |
| **Fertilizer (F) (L ha-1)** |  | **4 WAS** | |  |
| 0 |  | 34.77c | | 22.93e |
| 0.5 |  | 54.79b | | 26.83de |
| 1.0 |  | 74.69a | | 27.00de |
| 1.5 |  | 57.01b | | 25.77de |
| 2.0 |  | 71.83a | | 31.83cd |
| SE± |  | 2.57 | |  |
|  |  | **5 WAS** | |  |
| 0 |  | 52.66c | | 25.80e |
| 0.5 |  | 87.56a | | 32.80de |
| 1.0 |  | 84.57a | | 34.63d |
| 1.5 |  | 70.69b | | 34.17d |
| 2.0 |  | 89.81a | | 38.13d |
| SE± |  | 3.17 | |  |
|  |  | **6 WAS** | |  |
| 0 |  | 62.13d |  | 31.77h |
| 0.5 |  | 94.99bc |  | 38.20g |
| 1.0 |  | 93.36c |  | 41.83fg |
| 1.5 |  | 99.97a |  | 44.77ef |
| 2.0 |  | 99.15ab |  | 48.04e |
| SE± |  | 1.75 | |  |

DISCUSSIONS

The tallest plants, highest number of leaves per plant, widest leaves, bigger stems, heavier fresh shoots and roots, heavier dry shoots and roots obtained with the application of foliar fertilizer (Super gro) at the rate of 2.0 L ha-1 could be attributed to the availability of sufficiently high content of macro and micro nutrients in the foliar fertilizer which in turn provided the plants with required nutrient that may be insufficiently supplied through the root system in the soil. This finding is in conformity with the results of Shafeeq *et al*. (2013) who reported that the superiority of highest levels of Stimufol foliar nutritional compound fertilizer at the highest levels of 200 g/fed in enhancing plant growth may be attributed to its high contents of macro and micro nutrients which provides the plants with required nutrients which one or more of them were insufficiently supplied through the root system in such low fertile soil. The authors also stated that foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. Abou-El-Nour (2002) reported that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amounts of fertilizer added to soil.

CONCLUSIONS

From the results obtained from this study, it is concluded that the application of foliar fertilizer at the rate of 2.0 L ha-1 generally recorded significantly taller plants, higher number of leaves, wider stems and leaves, heavier fresh and dry fruits, higher ash content, crude protein content, fat content and crude fibre content under both screen house and irrigation conditions though statistically similar with application rates of 1.0 and 1.5 L ha-1 than the control (0 L ha-1) which had the shortest plants, lowest number of leaves per ant, smallest stems and leaves, lighter fresh and dry shoots and roots and lowest nutritional parameters measured in this study. Based on the context of this study, it is recommended that farmers in this agro-ecological zone of Nigeria should adopt the foliar application of folair fertilizer (Super gro) at the rate of 2.0 L ha-1 for higher growth, yield and nutritional qualities of Amaranthus and Corchorus.

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## YIELD AND POD SHATTERING BEHAVIOUR OF SOME SOYBEAN GENOTYPES ACROSS LOCATIONS IN NIGERIA

C. H. Ngwu\*, A. S. Gana, K. D. Tolorunse, and A. Y. Mamudu

Department of Crop Production, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria

\*Corresponding Author’s E-mail: [hilarychukwudi@gmail.com](mailto:hilarychukwudi@gmail.com)

Contact number: +2348035337753

ABSTRACT

*Soybean producers in Nigeria are always interested in soybean varieties that can yield high with minimal seed loss through pod shattering. In view of the above, this study was conducted to evaluate the seed yield and pod shattering resistance of twenty-six (26) soybean genotypes. This was conducted in three locations across Nigeria during 2020 cropping seasons. In each location, the experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. After harvest, pod shattering evaluation was done using the sun-dry method. Data on seed yield and pod shattering were collected and analyzed using Analysis of Variance (ANOVA). Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while Chinka having an average yield of 1.41 ton/ha, was the best among the locations. Out of outstanding genotypes, only NCRI SOYAC61 was not resistant to pod shattering. Therefore, farmers or researchers interested in a soybean genotype that can yield high and resist pod shattering could consider the other four genotypes.*

**Keywords**: Genotype, Location; Shattering; Soybean; Yield

INTRODUCTION

Soybean (*Glycine max* (L) Merril) is a grain 1egume that grows in tropica1 and sub tropica1, as well as temperate climatic conditions. It has the genetic potential to yield up to 4 ton ha-1, if improved varieties are used (Hailu and Kelemu, 2014). However, according to United States Department of Agriculture (USDA, 2021), soybean production in Nigeria in 2019/2020 farming season was on an average of 0.88 ton/ha, in farmers’ field. This achievement is not satisfactory considering soybean genetic potential. In Nigeria, Soybean is largely produced in the middle belt. However, its production in recent years has extended beyond these traditional areas to cover other Northern and Southern regions of the country (Ikeogu and Nwofia, 2013). The cultivation of this crop in Nigeria has been faced with some challenges including pod shattering and poor yield.

Pod shattering, which is the opening of mature pods along the dorsal or ventral sutures of the soybean pod and subsequent seed dispersal as the crop reaches maturity may result to a yield loss, which may be up to 100 %. It could be caused by the time of harvesting after maturity, environmental conditions, chemical composition of the pod wall; anatomical structure of the pod, and genetic factor of the variety (Krisnawati and Adie, 2017). In the major soybean production areas of Nigeria, the crop due to the time of planting, reaches maturity at the end of October or early November. Coincidentally, this is the period of rainfall cessation and the beginning of dry harmattan wind, with low relative humidity and rising temperatures, creating a suitable condition for pod shattering. Krisnawati and Adie (2017) ranked soybean genotypes with no pod shattering as very resistant; less than 25 % pod shattering as resistant, 25-50 % as moderately resistant; 21-75 % as highly susceptible; and greater than 75 % as very highly susceptible. The objective of this study is to identify and select some soybean genotypes with high yield and pod shattering resistance across locations in Nigeria.

MATERIALS AND METHODS

The study was conducted using 26 soybean genotypes (Table 1), in three locations in Nigeria during 2020 cropping season. The first location was in Minna, Niger State (Latitude 9.6737oN, Longitude 6.5109oE); the second was in Chinka, Kaduna State (Latitude 9.0535oN, Longitude 7.3026oE); while the third location was in Awka, Anambra State (Latitude 6.3437oN, Longitude 7.0938oE). The GPS coordinates were taken at the middle of each experimental site.

The field experiment was laid out in Randomized Complete Block Design (RCBD) with three (3) replications in each of the environments. The gross plot size was 6 m2. The net plot size was 3 m2. Gross plots within a replication were separated by a distance of 0.5 m, while an alley of 1 m separated one replication from the other. The total experimental area was 715 m2. Two (2) soybean seeds were sown per hill. The planting distance used was 75cm × 20cm between and within rows, respectively. Single super phosphate (SSP) was applied at the rate of 40kg/ha at 2 weeks after planting. Manual weeding was done at 2 and 6 weeks after planting. Data were collected on seed yield and pod shattering percentage.

Pod shattering identification was done using sun-dry method (Krisnawati and Adie, 2016). Twenty pods were placed inside brown envelops and sun-dried for seven days. On the 7th day the number of shattered pods were counted and expressed in percentage. Data collected were subjected to Analysis of Variance (ANOVA) using General Linear Model (GLM) procedure of SAS. Levels of significance were determined at 5%. Means were separated using Duncan Multiple Range Test at P<0.05.

RESULTS

Weather

The peak of rainfall in each location was within the period of field experiment. The rainfall pattern was more fairly distributed in Minna and Chinka than in Awka. The highest annual rainfall was recorded in Awka (2777 mm), followed by Minna (1763.57 mm); while the lowest annual rainfall was recorded in Chinka (1031.4 mm). The maximum monthly temperature during the field experiment ranged from 28.9-35.7 oC in Minna; 28.7-35.3 oC in Chinka; and 29.8-34.6 oC in Awka. Interestingly, temperature was rising as the crop approached maturity and the hottest temperature in each environment during the field experiment was recorded in November, which was the month of harvest and pod shattering identification. The relative humidity ranged from 43-86 % in Minna; 43-85 % in Chinka; and 69-84 % in Awka. The relative humidity across the environments was fairly uniform, but there was an apparent decline as the crop was approaching harvest (October-November).

Yield

In Minna, NCRI SOYAC78 had the highest yield (1.53 tons/ha), which differed significantly from only NCRI SOYAC73, NCRI SOYAC26, NCRI SOYAC25, NCRI SOYAC28, NCRI SOYAC64, NCRI SOYAC9, NCRI SOYAC68, and NCRI SOYAC67. NCRI SOYAC25 on the other hand, was the lowest in yield (0.67 ton/ha). However, it differed significantly from only four genotypes namely; NCRI SOYAC78, NCRI SOYAC18, NCRI SOYAC17, and NCRI SOYAC29. In Chinka, NCRI SOYAC9 had the highest average seed yield (1.97 tons/ha), which differed significantly from only NCRI SOYAC18, NCRI SOYAC77, NCRI SOYAC73, NCRI SOYAC29, NCRI SOYAC64, NCRI SOYAC3, NCRI SOYAC7, NCRI SOYAC68, NCRI SOYAC20, NCRI SOYAC10, and NCRI SOYAC22. Conversely, NCRI SOYAC18 was the least in average seed yield (0.9 ton/ha) and it differed significantly from NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC26, NCRI SOYAC25, NCRI SOYAC65, NCRI SOYAC24, NCRI SOYAC9, NCRI SOYAC62, NCRI SOYAC75, and NCRI SOYAC76. The mean seed yields of NCRI SOYAC61 (1.4 tons/ha) and NCRI SOYAC25 (1.37 ton/ha) in Awka were the highest in this location, and they differed significantly from only NCRI SOYAC26, NCRI SOYAC29, NCRI SOYAC65, NCRI SOYAC24, NCRI SOYAC62, NCRI SOYAC63, NCRI SOYAC75, NCRI SOYAC10 and NCRI SOYAC67. The poorest in yield among the genotypes was NCRI SOYAC63 (0.7 ton/ha). However, it differed significantly from only five genotypes namely; NCRI SOYAC78, NCRI SOYAC18, NCRI SOYAC25, NCRI SOYAC9, and NCRI SOYAC61. Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while the genotypes performed better in Chinka than in other locations (Table 1).

Pod Shattering

In all the locations, the highest pod shattering percentage was recorded in NCRI SOYAC63 (98.33 % in Minna, 80 % in Chinka and 90 % in Awka), and was significantly different from other genotypes. For low shattering genotypes in different locations, genotypes NCRI SOYAC78 and NCRI SOYAC7 that had the lowest pod shattering percentage in Minna (5 %), NCRI SOYAC28 that had the lowest pod shattering percentage (3.33 %) in Chinka, while NCRI SOYAC22 that had the lowest in Awka (1.67 %). Based on mean pod shattering percentage across the three locations and using the ranking of Krisnawati and Adie (2017), none of the genotypes was very resistant to pod shattering, twenty-one were resistant; four were moderately resistant, while only one was very highly susceptible.

Table 1 Mean yield (ton/ha) and pod shattering (%) of the genotypes across the three locations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Genotype | Yield (ton/ha) | | | | Pod shattering (%) | | | |
| Minna | Chinka | Awka | Mean | Minna | Chinka | Awka | Mean |
| NCRI SOYAC78 | 1.53a | 1.47abcdef | 1.33ab | 1.44 | 5.00g | 6.67fg | 21.67bcde | 11.11 |
| NCRI SOYAC18 | 1.37abcd | 0.90f | 1.17abc | 1.15 | 31.67b | 48.33b | 36.67bc | 38.89 |
| NCRI SOYAC17 | 1.47ab | 1.67abc | 1.07abcd | 1.40 | 6.67fg | 6.67fg | 18.33bcde | 10.56 |
| NCRI SOYAC69 | 1.20abcde | 1.70abc | 1.13abcd | 1.34 | 13.33defg | 31.67bcd | 25.00bcd | 23.33 |
| NCRI SOYAC77 | 1.23abcde | 1.33bcdef | 0.97abcd | 1.18 | 10.00defg | 8.33efg | 3.33e | 7.22 |
| NCRI SOYAC73 | 0.73de | 1.20cdef | 1.03abcd | 0.99 | 6.67fg | 6.67fg | 16.67cde | 10.00 |
| NCRI SOYAC26 | 0.83bcde | 1.83ab | 0.87cd | 1.18 | 25.00bcd | 6.67fg | 18.33bcde | 16.67 |
| NCRI SOYAC29 | 1.40abc | 0.97ef | 0.87cd | 1.08 | 8.33efg | 13.33defg | 10.00de | 10.55 |
| NCRI SOYAC25 | 0.67e | 1.53abcde | 1.37a | 1.19 | 21.67bcdef | 11.67defg | 18.33bcde | 17.22 |
| NCRI SOYAC28 | 0.80cde | 1.40abcdef | 0.90bcd | 1.03 | 11.67defg | 3.33g | 25.00bcd | 13.33 |
| NCRI SOYAC64 | 0.87cde | 1.03def | 1.03abcd | 0.98 | 30.00bc | 20.00cdefg | 25.00bcd | 25.00 |
| NCRI SOYAC65 | 1.00abcde | 1.57abcd | 0.80cd | 1.12 | 20.00bcdefg | 30.00bcd | 38.33b | 29.44 |
| NCRI SOYAC24 | 1.00abcde | 1.87ab | 0.83cd | 1.23 | 11.67defg | 16.67cdefg | 26.67bcd | 18.34 |
| NCRI SOYAC3 | 1.10abcde | 0.97ef | 1.00abcd | 1.02 | 18.33bcdefg | 35.00bc | 11.67de | 21.67 |
| NCRI SOYAC9 | 0.77cde | 1.97a | 1.20abc | 1.31 | 11.67defg | 18.33cdefg | 21.67bcde | 17.22 |
| NCRI SOYAC7 | 0.97abcde | 1.17cdef | 1.00abcd | 1.05 | 5.00g | 18.33cdefg | 8.33de | 10.55 |
| NCRI SOYAC68 | 0.87bcde | 1.20cdef | 1.13abcd | 1.07 | 10.00defg | 11.67defg | 28.33bcd | 16.67 |
| NCRI SOYAC20 | 1.20abcde | 1.30bcdef | 1.13abcd | 1.21 | 10.00defg | 13.33defg | 20.00bcde | 14.44 |
| NCRI SOYAC62 | 0.93abcde | 1.57abcd | 0.87cd | 1.12 | 23.33bcde | 15.00cdefg | 25.00bcd | 21.11 |
| NCRI SOYAC63 | 1.27abcde | 1.47abcdef | 0.70d | 1.15 | 98.33a | 80.00a | 90.00a | 89.44 |
| NCRI SOYAC75 | 1.10abcde | 1.63abc | 0.77cd | 1.17 | 13.33defg | 26.67cdef | 25.00bcd | 21.67 |
| NCRI SOYAC10 | 0.93abcde | 1.20cdef | 0.90bcd | 1.01 | 18.33bcdefg | 8.33efg | 25.00bcd | 17.22 |
| NCRI SOYAC67 | 0.83bcde | 1.40abcdef | 0.90bcd | 1.04 | 16.67bcdefg | 28.33bcde | 26.67bcd | 23.89 |
| NCRI SOYAC76 | 1.00abcde | 1.60abcd | 1.13abcd | 1.24 | 11.67defg | 6.67fg | 10.00de | 9.45 |
| NCRI SOYAC61 | 1.03abcde | 1.47abcdef | 1.40a | 1.30 | 31.67b | 21.67cdefg | 26.67bcd | 26.67 |
| NCRI SOYAC22 | 0.97abcde | 1.33bcdef | 1.13abcd | 1.14 | 15.00cdefg | 50.00g | 1.67e | 7.22 |
| Mean | 1.04 | 1.41 | 1.02 | 1.16 | 18.65 | 19.17 | 23.21 | 20.34 |
| ±SE | 0.23 | 0.21 | 0.15 |  | 5.57 | 7.06 | 7.16 |  |
| CV | 38.47 | 25.25 | 26.02 |  | 51.68 | 63.84 | 53.45 |  |

Means followed by the same letter(s) within a column are not significantly different at P≤0.05 using DMRT; ±SE = Standard error of the mean; CV = Coefficient of Variation.

DISCUSSION

The mean yield of all the genotypes across the three locations, which was best in Chinka, could be a reflection of adequate rainfall pattern in this location. Similarly, the high annual rainfall observed in Awka, which was higher than the recommended range of 700-1200 mm (Mondine *et al.*, 2001) could be responsible for the comparatively poor yield obtained in the location. The similar behaviours of the genotypes in pod shattering across locations, which was evident in NCRI SOYAC63 (highest across the locations) shows location had little or no influence on the pod shattering pattern of genotypes. This could be as a result of similar temperature and relative humidity levels observed across the locations since pod shattering behaviour of a soybean genotype is greatly influenced by these two climatic parameters (Zhang *et al*., 2018). This means that irrespective of location; some soybean genotypes can still exhibit the same level of resistance or susceptibility to pod shattering. This is in agreement with the findings of Bhor *et al*. (2014), which stated that the genotypic characteristics of any genotype play a key role in the overall expression of pod shattering of that genotype irrespective of climatic factors.

CONCLUSION AND RECOMMENDATION

The genotypes differed in their yield and pod shattering across the three locations. Five genotypes (NCRI SOYAC78, NCRI SOYAC17, NCRI SOYAC69, NCRI SOYAC76, and NCRI SOYAC61) were outstanding in yield across the three locations, while Chinka was the best location in terms of yield. Out of these five outstanding genotypes, only NCRI SOYAC61 was not resistant to pod shattering. Therefore, farmers or researchers could select the other four for optimum productivity.

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## EFFECTS OF ROOT KNOT NEMATODE (*Meloidogyne incognita*) ON THE GROWTH PERFORMANCE OF OKRA (*Abelmoschus esculentus*) CULTIVARS IN MINNA, NIGERIA

Umar, K.,1\* Ibrahim. H 2, Bello. L.Y,.1 and Tolorunse K.D.1

1Department of Crop Production, Federal University of Technology, Minna, Nigeria

2Department of Horticulture, Federal University of Technology, Minna, Nigeria

\*Corresponding author: [umarsoma@gmail.com](mailto:umarsoma@gmail.com) (08063109798)

ABSTRACT

*Seeds of two okra varieties were tested against Root Knot Nematode (Meloidogyne incognita) in the screen house of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger state, Nigeria. The root-knot nematode (Meloidogyne incognita) has been referred to as one of the most widespread nematodes severely injuring vegetables, it causes high losses to okra production. The experiment was a factorial combination of five inoculum by two variety resulting into ten treatments combinations replicated four times and arranged in Completely Randomized Design (CRD). Data were collected on plant height, number of leaves, stem girth and leaf area. Data collected were subjected to statistical analysis and means were separated using Least Significant Difference (LSD). The results indicated that there were significant (P < 0.05) differences among the levels of inoculation. However, okra plants inoculated with* 2,*4, 6 and 8) eggmasses produced plants with statistically similar lower height (27.7, 27.6 and 25.6cm) compared to other inoculum levels. Statistically similar lower number of leaves (1.8 and 1.0) were produced by the two varieties of plants inoculated with 6 and 8 eggmasses respectively. However, plants inoculated with4,6 and 8 eggmasses was significantly lower in plant stem girth (2.7cm) compared to other treatments. Statistically similar lower leaf areas were produced by plants inoculated with (6 and 8) eggmasses (38.9 and 37.3cm) respectively than other treatments. The findings indicated that inoculum of nematode (Meloidogyne incognita) had effect on okra at different stages of growth. The cultivation of moderately resistant cultivars in fields moderately infested with M. incognita would help reduce nematode reproduction enough to affect the residual nematode population*

**Key words:** *Meloidogyne,* eggmasses, inoculation, sowing, soil sterilization.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) originated from Ethiopia and was cultivated by the ancient Egyptians in the 12th century B.C.). It was domesticated in West and Central Africa but is now widely cultivated throughout the tropics primarily for local consumption. In Nigeria, it ranks third in terms of vegetable production and consumption, following tomato and pepper (Ijoyah *et al*., 2009). Okra is one of the most widely known and utilized species of the family Malvaceae (Naveed *et al*., 2009). Okra has great potential as foreign exchange earner and accounts for about 60 % of the export of fresh vegetables from India to the Middle East and European countries (Singh *et al*., 2014). Production of okra constitutes about 4.6 percent of the total staple food production in Nigeria. The crop contributes immensely to the economic status of farmers especially those engaged in large scale production of the crop in dry season and can be regarded as one of the crops which sufficiently contributes to food security since many families’ plant okra as a garden crop (Roy *et al*., 2014). It is a multipurpose crop due to the various uses of its edible parts like the fresh leaves, buds, flowers, pods, stems and seeds (Yonas *et al*., 2014). Okra is a popular health food due to its high fibre vitamin C, and folate contents, it is also known for being high in antioxidants (Maramag *et al.,* 2013). The crop is also a good source of calcium and potassium,parts usedarefruits, leaves and seeds. The juice of the roots is used externally in Nepal to treat cuts, wounds and boils (Sathish *et al.,*2013). The optimum production of vegetables throughout the world is threatened by large number of biotic factors including plant-parasitic, nematodes (Hussain *et al.,*2016c). The root-knot nematode (*Meloidogyne incognita*)has been referred to as one of the most widespread nematodes severely injuring vegetables, it causes high losses to crop production particularly in infested fields of sandy soils (Ibrahim *et al*., 2010). Like all plant-parasitic nematodes, root-knot nematodes possess a stylet for injecting secretions as well as ingesting nutrients from host plant cells (Kayani *et al.,* 2017). Nematodes have no internal skeletal framework, and their "skin" or cuticle acts against internal turgor pressure to maintain body shape and aid locomotion. *Meloidogyne* extensively disrupt xylem tissues and greatly retard absorption and upward movement of water and nutrients (Silva *et al.,* 2015).  Inadequate supply of water, nutrients, photosynthates and energy, growth and developments of leaf tissue and its constituents especially chlorophyll pigments are adversely affected (Hussain *et al.,* 2016b). Poor growth of foliage subsequently leads to decreased production (Dhaliwal *et al*., 2012). The most reliable control of root-knot nematodes can be achieved by integrating two or more methods including an effective rotational scheme, resistant varieties, and selected cultural practices gives excellent control with little added cost (Collange *et al.*, 2014). Many vegetable farmers today have suffered lots of losses as a result of nematode infections, the root-knot nematode (RKN), *Meloidogyne incognita* has been referred to as one of the most widespread nematodes severely injuring vegetables (Hussain *et al.,* 2016a). During infection, dry matter accumulation in seeds is interrupted, hence maximum dry weight (Physiological Maturity) will not be reached resulting into poor seed viability Franca *et al*. (2012). Various methods have been used either singly or in combination of two or more methods which has resulted in varying degrees of effectiveness in the management of nematodes (Collange *et al.*, 2014).Root-knot nematodes are considered among the top five major plant pathogens and the first among the ten most important genera of plant parasitic nematodes in the world (Mukhtar *et al*., 2013b). Keeping in view the economic importance of *M*. *incognita* in reducing the quantity and quality of crop production, the present study is designed to determine the effects of different inoculum levels of *M*. *incognita* on the growth, fruit pod, yield and seed quality of two okra varieties which will help in the determination of economic threshold level in the control and management of the root knot nematode in the production of these two varieties of okra in Minna soils. Therefore, the objectives of the study were to help farmers identified nematode infections and consequences in other to reduce and manage the occurrences for optimum yield.

MATERIALS AND METHODS

The study was carried out in 2019 growing season at the Screen House of School of Agriculture and Agricultural Technology, Federal University of Technology at Gidan Kwano Campus, Minna. Minna is located between Latitude 90 31’ N and Longitude 60 29’ E, (Lawal *et al*., 2012). Seeds of two Okra varieties (NHAe-47 and LD88) were sourced from National Horticulture Research Institute (NIHORT) Ibadan, Nigeria. Topsoil of (0-15 cm) depth was collected from the Teaching and Research and Farm of Federal University of Technology, Minna. The collected soil was sterilized using a metal tray for one hour at 98.5 0 C with fire wood as the source of heat Salaudeen and Aguguom (2014) The sterilized soil was spread on a large metal sheet after heating and left over night to cool off before it was used. Sterilized soil was thoroughly mixed and fill into forty (40) polythene pots each of 10.6kg. The experiment was a factorial combination of two okra varieties (NHAe-47 and LD88) by five inoculums (control, 2 eggmasses, 4 eggmasses, 6 eggmasses, 8 eggmasses) resulting into ten treatment combinations and arranged in Completely Randomized Design (CRD) with four replications. Five seeds of each cultivar were sown into 10 kg sterilized soil in a hole at the depth of 3 centimetres Two weeks after emergence, seedlings were thinned to two plants per stand in each pot. The inoculum used for the experiment was the eggmasses of root knot nematode (*Meloidogyne incognita)* which was obtained from the roots of heavily infested okra plant (*Abelmoschus esculentus*), cultured in the Screen House of School of Agriculture and Agricultural Technology, Federal University of Technology, Minna. Eggmasses, okra plant roots infected with *M incognita* were uplifted from pots, washed under a running tap water, cut into approximately 1-2 cm pieces and was vigorously shaken in a bottle containing 0.5 % Nacl for 5 minutes to remove adhering soil (Hussey and Barker, 1973). The eggmasses were collected on a 38 m sieve and washed in a beaker and the eggmasses collected into plastic Petri dishes labeled according to different levels of treatment for inoculation. Three weeks after planting grooves were created around the base (2.0 cm) from the plant, eggmasses of *M. incognita* were inoculated and gently covered for all the replicates. Water was applied to each pot every 24 hours to field capacity. Pots were kept constantly moist; water application was done early in the mornings and to field capacity, daily. Weeds were controlled by hand pulling in each polythene pot as found necessary throughout the period of the research work. Plant height was taken from the base of the plant to tip of apical leaf (cm) using meter rule, number of leaves were counted and recorded,Vernier calliper was used to determine stem girth for all replicates. Leaf area was determined by taking length and breadth multiplied by constant K, (Musa *et al.,* 2016). Data were collected based on plant height, number of leaves, stem girth and leaf area per plant. Data collected were subjected to general linear model analysis of variance (ANOVA) using Statistical Analysis System (SAS) package version (2017). Means were separated using Least Significant Different (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

The results of the experiment on effects of inoculum (*M. incognita)* and variety on growth performance of two okra varieties inoculated at different levels as showed in (Table 1) indicated that okra plants inoculated with (2, 4, 6 8) eggmasses produced significantly lower heights respectively which were statistically similar compared to control plants with significantly higher (53.3cm) height. However significant differences in height was not recorded amongst the two okra varieties. The results in (Table1) indicated that two varieties of okra plants inoculated with 6 and 8 eggmasses produced statistically similar lower number of leaves (1.8 and 1.0) respectively compared to control plants with significantly more leaves (7.4). However significant differences was recorded amongst the two varieties: NHAe47-4 recorded more number of leaves (3.30) than LD88 which recorded (2.55) number of leaves. Results showed in (Table1) indicated that plants inoculated with (4, 6 and 8) eggmasses were significantly lower in plant stem girths (2.8,2.8 and 2.7cm) which were statistically similar vaues compared to control plants with significantly larger stem girth, however no significant differences was recorded amongst the two varieties in stem girth. While the results showed in (Table1) indicated that two varieties of okra plants inoculated with 6 and 8 eggmasses produced leaf area which were statistically similar (38.9 and 37.3cm) respectively compared to other treatments. Significant differences in leaf area was recorded amongst two varieties: LD88 produced larger (53.17cm) leaf area than NHAe47-4 which recorded (49.47cm) leaf area. Therefore, significant reduction in growth observed on aerial parts of all the treated plants during the study such as plant height, fewer number of leaves, reduction in leaf area and stem girth per plant compared to control plants, may be attributed to damages caused by nematode when they became sedentary and established feeding sites on the roots of treated plants which consequently resulted to poor growth as observed on growth parameter during this study, this agrees with the report of (Silva *et al.,* 2015)who stated that *Meloidogyne* extensively disrupt xylem tissues and greatly retard absorption and upward movement of water and nutrients. (Hussain *et al.,*2016b) in his report stated that due to the inadequate supply of water, nutrients, photosynthates and energy, growth and developments of leaf tissue and its constituents especially chlorophyll pigments are adversely affected, this is supported by (Kayani *et al*. 2017) who in his report opined that poor growth of foliage subsequently leads to decreased production. (Dhaliwal *et al*., 2012) also in his report stated that plants with infected roots are more susceptible to other diseases caused by fungi and bacteria and tend to stop producing early. The findings on the effects of inoculum (*Meloidogyne inconita)* which caused reduction in plant height, number of leaves, stem girth and leaf area in this study showed significant differences among okra cultivars in their responses to *M. incognita*. Two okra varieties investigated indicated that inoculum of nematode (*Meloidogyne incognita*) also had significant effects on all levels of inoculation. Therefore, effects of inoculum of (*M .incognita*) caused significant reduction on plant height, number of leaves, stem girth and leaf areas on two okra varieties investigated. Similarly, significant differences were recorded amongst the two varieties on number of leaves and leaf areas throughout the study. Cultivation of moderately resistant cultivars in fields moderately infested with *M. incognita* would help reduce nematode reproduction enough to affect the residual nematode population densities, as uninterrupted cultivation of susceptible cultivars is aggravating the root-knot problem. The approach will also help to minimize environmental pollution, preserve the agro-ecosystems and biodiversity and keep management processes more economical. Furthermore, these cultivars could be used in breeding programs to introduce new resistant cultivars to these nematodes in the area of study.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 1 Effects of inoculum (*M. incognita*) and variety on the growth performance of okra** | | | | |
| Treatments | Plant height (cm) | Number of leaves | Stem girth(cm) | Leaf area(cm) |
| Inoculum (I)  Two (2) eggmasses 30,0b 2.5b | | |  |  |
| 2.9b | 52.4 b |
| Four (4) eggmasses 27.7bc | | 2.0b | 2.8 bc | 46.1 c |
| Six (6) eggmasses | 27.6bc 1.8bc | | 2.8 bc | 38.9 d |
| Eight (8) eggmasses | 25.6 bc | 1.0 c  7.4a | 2.7 c | 37.3 d |
| Control | 53.6a | 3.7 a | 81.8 a |
| SE ± | 1.50 | 0.49 | 0.07 | 2.73 |
| LSD | 3.07 | 0.99 | 10.12 | 5.56 |
| Variety (V) |  |  |  |  |
| NHAe47-4 | 33.12a | 3.30a | 3.01 a | 49.47 b |
| LD88 | 32.95a | 2.55b | 3.01 a | 53.17 a |
| SE ± | 0.95 | 0.30 | 0.05 | 3.52 |
| LSD | 1.94 | 0.63 | 0.10 | 0.10 |
| Interaction |  |  |  |  |
| I x V | NS | NS | NS | NS |

Means with the same super script within column are not significantly different at (P< 0.05) level of probability

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## SOYBEAN (*Glycine max (L) Meriil*) GENOTYPE STUDY IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA

Olaleye. T.B.2, Tolorunse.K.D.1 and Gana.A1

1Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria

2Department of Crop Production, Federal University of Technology, Minna Niger State, Nigeria

\*Corresponding author: [abosede600@gmail.com:](mailto:abosede600@gmail.com) +2349039363393

ABSTRACT

*Effective identification of superior genotypes is generally complicated by the presence of Genotype (G) Environment interactions, whereby cultivar relative yields vary across different environments. The study was conducted to ascertain genotype x environment on soybean genotype in Southern Guinea Savanna of Nigeria the established cultivars in terms of yield component adaptability to an ecology field experiment were conducted from developed genotypes in Southern Guinea Savanna Ecology of Nigeria. Ilorin, Ibadan and Niger State during the 2020-2021 Cropping Session application of Pha-1 resulted in significantly higher genotypes in NCRI- SOY AC73 than other genotypes were significantly different between the two Cropping session while there was no significant variation for grain yield in other genotypes and hence good adaptability while the former ones shows unstable productivity under adverse condition resulting from rainfall pattern in 2020 and 2021 thus were deemed unsuitable for the Southern Guinea Savanna Ecology which is highly prone to drought conditions. Data collected were subjected, Correction Analysis Number of Leaves, Plant Height, and number of branches in conclusion, NCRI-SOY AC73 was best adapted to the Southern Guinea Savanna.*

**Keywords:** Adaptability, Southern Guinea Savanna, soybean genotype, Environmental

INTRODUCTION

Soybean (*Glycine max (L.) Merrill*) is one of the most important oil seed crops in the world. The crop has gained popularity in Nigeria, outranking cowpea (Vigna unguiculata (L) Walp), because of its potential to supply high quality protein (Akande et al., 2007). Soybean production constitutes 6 % of all arable land in the world and has the highest percentage increase in area under production among crops annually. The global demand for the crop is expected to increase due to the crop’s potential to improve the dietary quality of the vast majority of people and livestock (Hartman et al., 2011). Stability analysis is performed to estimate the performance of genotypes as linear function of the level of productivity in each environment (Bernardo, 2010).

MATERIALS AND METHODS

Study Location

The experiment was conducted in three different locations across the Southern Guinea Savanna of Nigeria; namely: Ilorin in Kwara state Nigeria, NCRI Apata, Ibadan, Oyo state, Nigeria and Minna, Niger state, Nigeria. The study was conducted during the raining season of 2021.

The use of multiplicative models which include the additive main effect and multiplicative interaction (AMMI) model has also been used to assess the stability of other crops (Adjebeng-Danquah, *et al*., 2017). The AMMI model allows fitting of the sum of several multiplicative terms rather than only one multiplicative term in dissecting the performance of genotypes in different environments (Bernardo, 2010). Also suggested the use of the genotype and genotype × environment interaction (GGE) biplot to graphically visualize genotypic performance across several environments. The use of these strategies will enable the breeder to make informed decisions in where to place which variety based on their adaptability for optimum performance.

Source of Seeds

The Ten genotypes t used were obtained from Niger State River Basin Development Authority.

Treatments and Experimental Design

The treatments were NCRI SOY AC78, NCRI SOY AC18, NCRI SOY AC17, NCRI SOY AC69, NCRI SOY AC77, NCRI SOY AC73, NCRI SOY AC26, NCRI SOY AC29, NCRI SOY AC25, NCRI SOY AC28. These were arranged in randomized complete block design, with three replications in all the locations

1. Agronomic Practices Land preparation

This was done manually by clearing the bushes and preparing the ridges.

1. Sowing of seeds

Each genotype of soybean entry will be planted in three 4-mrows, with spacing of 60cm between rows and 5cm between plants.

1. Weed control

Weed control was achieved by pre-emergence application of stomp (Pendimenthalin 500) immediately after planting and supplemented with one hand weeding at five weeks after planting (WAP).

1. Harvesting

Plots were harvested by hand in October 2021 and then threshed by plot harvester for seed yield and other seed traits determinations.

1. Data Collection

Environmental Data Collected in Each Location

1. Mean monthly rainfall (mm)
2. Mean monthly temperature (oC)
3. Mean monthly relative humidity (%)
4. Branches per plant: was done by counting 5 plant each from each plot number of branches of the plants in the middle rows, their average computed and recorded.
5. Leaf area: the leaf area of the 5 plants each in the middle rows was measured, using a leaf area meter at constant of 6.
6. Days to 50 % flowering: was recorded when half of the 5 plants each in a net plot flowered. This will be done through visual observation.

Growth Data

The following growth data were collected:

Emergence (%): was calculated using the formula below, according to Baset Mia and Shamsuddin (2009):

Emergence (%) = number of emerged sedling x 100

Expected number of plants

Plant height: This were measured on plants in the middle rows at 4, 8 and 12 weeks after planting (WAP) using meter rule and/tape. It was measured from ground to the last leaf of the main shoot. The average height of the

5 selected plants were computed and recorded.

Number of leaves: was done by counting the visible leaves on the 5 plants each in the middle rows and average number was taken and recorded.

vii. Days to maturity: was calculated from the sowing date to the date where 95 % of the 5 plants each in the net plot reached maturity.

Yield Data

Pods per plant: was counted manually from the 5 plants each in the middle rows during harvest and were recorded.

Seeds per pod: Twenty (20) pods were randomly selected from each genotype, the number of seeds they contain was counted and their average taken and recorded.

Above ground biomass (kg/plot): This was taken by weighing the above ground part of all the plants in net plot during harvest, using a weighing balance.

i. Seed yield (kg/plot): The weight of seeds harvested per net plot was measured using a weighing balance

ii. Harvest index: was determined by using the formula described by Kemanian et al. (2007). This is given below: Harvest index = Seed yield above ground biomass

Statistical Analysis: Data collected were subjected to the using Statistical Analysis Software (SAS)

**Table 1: Performance of 10 soybean accessions for 15 agro-morphological traits across three locations**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sources** | **Germ %** | **NL at 1Month** | **NL at 2Month** | **NL at 3Month** | **NB at 1Month** | **NB at 2Month** | **NB at 3Month** | **PH at 1Month** |
| Locations (L) | 5064.02\*\* | 97.07\*\* | 1242.53\*\* | 2837.053\*\* | 14.01\*\* | 63.95\*\* | 3214.28\*\* | 75.81\*\* |
| Genotypes (G) | 104.79\*\* | 57.39\*\* | 168.54\*\* | 568.27\*\* | 1.62\*\* | 8.49\*\* | 18.41\*\* | 24.93\*\* |
| G x L | 126.11\*\* | 12.73\*\* | 87.33\*\* | 635.52\*\* | 2.55\*\* | 9.06\*\* | 23.64\*\* | 11.53\*\* |
|  | **PH at 2Month** | **PH at 3Month** | **Biomass (kg)** | **100seed weight (g)** | **No of pods** | **Seed yield (kg/plot)** | **Harvest index** |  |
| Locations (L) | 90.88\*\* | 1249.37\*\* | 0.09\*\* | 1.34ns | 1951.30\*\* | 0.078\*\* | 0.01ns |  |
| Genotypes (G) | 23.00\*\* | 100.96\*\* | 0.07\*\* | 2.67\*\* | 8170.04\*\* | 0.12\*\* | 0.02\*\* |  |
| G x L | 40.83\*\* | 107.31\*\* | 0.03\*\* | 1.39ns | 7830.52\*\* | 0.07\*\* | 0.01\*\* |  |

DISCUSSION

Mean performance for germination and Number of Leaves Per Plant among 10 Soybean Accession three locations was not significant difference among Number of pods per plant and grain yield the soybean genotype varied significantly for Number of leaves per plant among 10 Plant Height, Number of Branches per plant among 10 accessions at three locations 2021 genotype x interactions effects were significantly different for both number leaves, plant height and number of branches .across the year of study number of leaves per plant recorded the highest with NCRI SOY AC73 Mean Performance of 10 soybean accessions for 15 agro morphological tracts across three location shows that NCRI-SOY-AC13 has the highest Number of Leaves Number of Branches which was significantly difference from other genotypes. Genotypes NCRI-SOY-AC69 Produce the highest Number of pod which was similar to other genotype genotypes NCRI-SOY-AC77 produces the highest number of seed weight.

CONCLUSION

The results of study revealed substantial genetic variability in the genotypes evaluated for most of the traits high genotypic coefficient of variations were observed for NCRI SOY AC75, Number leaves, Plant height and Number of branches and plant biomass of the soybean genotypes.

RECOMMENDATION

NCRI SOY AC75 produce Number leaves, Plant height and Number of branches and plant biomass these strategies will enable the breeder to make informed decisions variety based on their adaptability for optimum performance in southern Guinea Savanna.

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## EFFICACY OF SOME BOTANICAL EXTRACTS ON THE MANAGEMENT OF FALL ARMYWORM *(Spodoptera frugiperda* J.E. Smith*)* ON MAIZE *(Zea mays* L.*)*

\*1R. O. Oyewale, 1H.Chijioke, 2M.O. Akinyele, 1H.M. Ibrahim and 1R.O.Ibrahim

1Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria

2Department of Agricultural Biotechnology, National Biotechnology Development Agency Lugbe, Abuja, Nigeria

\*Corresponding Author: [r.oyewale@futminna.edu.ng](mailto:r.oyewale@futminna.edu.ng); 08069532552

ABSTRACT

*A field experiment was conducted during 2021 rainy season at the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus to evaluate the efficacy of some botanical extracts for the management of Fall Armyworm on Maize. The treatments were arranged in Randomized Complete Block Design (RCBD) with three replicates. Growth and yield parameters were recorded. The data were subjected to Analysis of Variance and means were separated using Duncan multiple rang test. The results revealed that botanical extracts had varie effects among the six (6) plant botanicals with Neem leaves extracts having the lowest infestation, also had the highest number of plant height, stem diameter, fresh yield weight, dry yield weight and grain yield weight. Therefore, the use of Neem leaves extract was recommended for the management of fall armyworm of maize.*

**Keywords:** Maize; botanical extracts; *Sporodeptera frugiperpa;* variety; pests

INTRODUCTION

The management of insect pests largely depends on the use of synthetic insecticides in the field and store. However, indiscriminate use of many synthetic insecticides, human technical’s, environmental non target organisms, resistance of insect pest, food and product contamination with toxic residue, biodiversity, erosion and other side effects (Sallam and Allsopp, 2002). In addition, non-availability of insecticides to country side farmers and ventilation restriction in stored grain are the negative effects of synthetic chemicals. As a result, organochlorine has been reportedly banned in developed countries. These resurcitated the idea of botanical insecticides as a promising alternative to pest control. Botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soiland are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides (Ebenezer, 2010). Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insect developing resistance to botanical insecticide is less likely (Isman, 2013). Laboratory and field tests have shown the effectiveness of this plant extracts against armyworm, leaf-cutting caterpillars, ants, whiteflies and the three stages of mosquitoes (Zhen and Zhang, 2000).

Fall army worm (FAW) can be one of the most difficult insect pests to control in field corn ((Pogue 2002). Late planted field and late maturing hybrids are more likely to become infested. Fall army worm causes serious leaf feeding damage as well as direct injury to the ear. Fall army worm can damage corn plant in nearly all stages of development, it will concentrate on later plantings that have not yet silked (FAO, 2018). Therefore, this research work was to test for the efficacy of some botanical extracts such as Neem leaf extract, Red stem fig leaf extract, Flamboyant leaf extract, Billy goat weed leaf extract, Moringa leaf extract and Masquerade leaf extract as bio pesticides to control the infestation of fall armyworm of maize crop and boost yield of maize crop in Nigeria. Therefore, the objective was to determine the most effective botanical in the management of fall armyworm of maize.

MATERIALS AND METHODS

Experimental Site

The field experiment was conducted during 2021 rainy season at the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus (latitude 6 ° 33'E and Longitude 9 ° 37'N, with altitude 1475 m above sea level) located in the Southern Guinea Savannah agro-ecological zone of Nigeria. It has a peak temperature of 40 °C from March to April. The mean annual rainfall ranges from 120-130mm. (Ojanuga, 2006). The soil type varies from loamy or silty loam soil or silty clay loam.

Source of Experimental Materials

A maize variety OBA 98 was obtained from the Department of Crop Production, Federal University of Technology Minna, Niger state, Nigeria.

Preparation and Application of Botanical Leaf Extract

The botanical leaves were plucked around the school Premises, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger state.The leaves of six different botanicals were collected and washed with clean water. 1 kg of the leaves was weighed using weighing balance scale (sensitive weighing balance manufactured by Metler instruments LTD) in the Laboratory. After weighing, the leaves were then choped with the use of knife into smaller pieces and blended (electric blender) with 1 litre (L) of Distilled water and mixed properly. Aluminium foil was used to cover the concentration to prevent evaporation, dirt and dust, after which the samples were kept for 24 hours on the laboratory bench to undergo fermentation, after 24 hours, the solution was stirred and sieved using muslin cloth and was labeled. Half litter of the botanical extract was added to 2 liters of water for the spraying of maize plant using knapsack sprayer.

Experimental Design and Field Layout

The experiment was arranged in Randomized Completely Block Design (RCBD) with three replicates. The net plot size was 14 x 24 m2. Each replicate consisted of 7 plots, replicate measuring 4 x 24 m2 and each plot measuring 4 x 3m2. Each plot consists of five ridges with 1 m as alley between the replicate and 0.5 m between plots. Plant spacing is 75 cm between rows and 25 cm within row.

Cultivation Practices

The first fallow was cleared with hand implements such as hoes and machete in order to keep the soil loose for good seedbed and subsequent effective germination and seedling emergence. Land was prepared manually in form of ridge of 3 m long, sowing was done at the full establishment of rainfall. Maize seeds were sown two per hole with inter-row and intra-row spacing of 75 cm and 25 cm respectively. Plant was thinned to one per stand at 2WAS, weeding was done at 3 and 6 WAS. At three weeks after sowing, (WAS) NPK 20:10:10 fertilizer was applied by side placement at the rate of 9.6 g per plant (5 cm away from the plant stand) at 3 WAS using a bottle cover of NPK 20:10:10 as source. At six weeks after sowing and three weeks after application of N. P. K 20:10:10 fertilizer, urea fertilizer was applied at the rate of 9.6 g per plant (5 cm away from the plant stand) at 6 WAS using a bottle cover of urea as source, this is to complete the N requirement of the crop

Data Collection

Ten plant samples were randomly selected and measured from the ground level to the tip of the tallest leaf using a meter rule at 10WAS.The stem diameter of ten plants were measured by using Vernier Calliper at 10WAS. Ear rot was rated on a scale of 1-5, where 1= little or no visible ear rot and 5 = extensive visible ear. The number of days from planting to the time when 50 % of the plants have tasseled shading polar were counted and recorded. The number of ear per plant was counted, Fresh weight was taken after harvesting of the plant using electronic weighing balance. Dry weight was taken after sun drying the maize using electronic weighing balance. Grain weight was done after threshing from the cob using electronic weighing balance. Plant stand was physically checked for the appearance of Fall Armyworm infestation.

Fall Armyworm severity was determined by scoring Armyworm damage to maize plant, using the following scale;

Visual rating damage Numerical score Resistant reaction

No damage 0 likely escape

Few pin hole 1 highly resistance

Few short holes on few leaves 2 Resistance

Several short holes (<50%) 3 Resistance

Several leaves with short holes (>50%) 4 moderately resistance

Elongated lesion on a few leaves 5 moderately resistance

Elongated lesion on several leaves 6 Susceptible

Several leaves with long lesions or tattering 7 Susceptible

Sever tattering 8 Highly Susceptible

Plant drying as a result of foliar damage 9 extremely sensitive to damage.

Source: CIMMYT, (2011)

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) procedure version 9, 2002 model. The treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % probability level.

RESULT AND DISCUSSION

Before the application of the botanical extracts, all of the treatments plots have been infected by Fall Armyworm Table 1, but there was no significant difference in the infestation rate among the treatments plots with Masquerade leaf extract recording the highest infestation rate followed by Red stem fig leaf extract, Neem leaves, while control and Flamboyant leaves recorded similar infestation rate, Billy goat weed and then Moringa recorded the lowest infestation rate.

After the first, second and third applications, there were no significant difference among the botanicals except in the case of control which differs significantly (P≤ 0.05) from the botanicals.

Table 2 showed the plant height and number of days to 50 % tasseling of maize. There was no significant difference among the treatments to attain 50 % tassseling. Similarly, there was no significant different among the botanical extracts on plant height. Neem leaf extracts recorded the highest plant height followed by Control, Masquerade leaves extracts, Red stem fig leaf extracts, Moringa leaves extracts, Billy goat weed leaves extracts, respectively and shortest plant height was recorded on Flamboyant leaves extracts, but were not significantly different from one another. This result disagree with the earlier model of Thornley (1998) that increase in stem diameter of infected plant will lead to decrease in the plant height while increase in plant height will result to decrease in stem diameter of the plant.

Table 3 showed the number of ear per plant and number of rotten ear of maize.Numbers of ear per plant was not significantly differed among the botanical extracts. Red stem fig leaves had the highest number of ear per plant followed by neem leaf extract flamboyant leaves, billy goat weed leaves, while moringa leaves and masquerade leaves had similar number of ear per plant and then control having the lowest. There was significant difference between control and the botanical extracts, but there no significant difference among the botanical extracts with control recording the highest number of rotten ear and significantly (P≤ 0.05) different from botanical extracts.

Table 4 showed the stem diameter and fresh cob weight of maize.There was no significant difference among the botanical extracts with respect to stem diameter despite that Neem leaves recording the highest stem diameter followed by Moringa leaves and Red stem fig leaves, while Masquerade leaves recorded the thinnest stem diameter. Similarly, no significant difference among the botanical extracts on fresh yield weight. Neem leaves recorded the highest fresh yield weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy goat weed leaves and least was recorded in Masquerade leaves.

Table 5 showed cob weight and grain yield weight.There was no significant difference among the botanical extracts on the cob weight. Neem leaves recorded the highest cob weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy Goat weed leaves and the lowest was recorded at Masquerade leaves. Similarly, there was no significant difference among the botanical extracts on the grain yield weight. The highest was recorded from Neem leaves followed by Red stem fig leaves, Moringa leaves, Flamboyant leaves, Billy goat weed leaves, control and the lowest was recorded in Masquerade leaves. According to Nailul *et al*., (2018), research conducted in Andalas University Padang, Indonesia, that botanical extract of *Gentiana linearis* recorded the highest plant height, leaf area, fresh cob weight and grain yield which was in conformity to this study The study also confirm the study (effect of moringa leaf extract on growth and yield of maize) conducted by Biswasn *et al.,* 2016,which showed that there was positive effects of moringa leaf extract on the number of leaf, root length, fresh weight and grain yield of maize. Similarly it also confirm another study on the (Yield performance of maize treated with neem seed extracts against stem borers) by Wahed I *et al.,* 2016 which shows that neem seed extracts were effective in protecting the maize plants from maize stem borers infestation.

CONCLUSION

From the result obtained above, it was concluded that Neem leaves extracts had the lowest infestation in most of the parameters taken. Neem leaf had the highest number of plant height, stem diameter, fresh yield weight, dry yield weight and grain yield weight. This showed that, the use of Neem leaves botanical extracts on the management of fall armyworm of maize had low fall armyworm infestation.

Table1: Effect of botanical extracts on the incidence of fall armyworm

|  |  |
| --- | --- |
| Treatment | Before After first After second After third application application application application |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 5.10 2.43b 1.23b 0.63c  5.90 3.73b 2.60b 1.80bc  5.00 4.90a 5.30a 5.47a  5.00 3.37ab 2.70b 2.00b  4.93 3.20ab 2.53b 1.63bc  4.53 3.70ab 2.47b 1.73bc  6.07 3.70ab 2.33b 1.47bc  0.24 0.24 0.30 0.34 |

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 2: Effect of botanical extracts on the plant height and number of days to 50 %

tasseling

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Plant height(cm) Number of days to 50%  tasselling |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 210.40 52  204.23 52  207.53 52 191.43 52 198.97 52  199.20 52  204.77 52  3.98 0.00 |

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 3: Effect of botanical extracts on the number of ear per plant and number of rotten ear

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Number of Number of rotten ear  ear per plant |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 1.23 1.80b  1.27 1.93b  1.00 3.80a  1.17 1.80b  1.10 1.67b  1.07 1.80b  1.07 1.80b  0.04 0.19 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 4: Effect of botanical extracts on stem diameter and fresh cob weight of maize

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Stem diameter Fresh cob weight |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 5.63 193.41  5.33 179.18  5.11 154.42  4.79 165.75  5.08 150.27  5.52 164.72  4.66 140.59  0.16 6.63 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

**Table 5: Effect of botanical extracts on cob weight and grain yield weight of maize**

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Cob weight Grain yield weight |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 116.78 100.05  98.86 83.36  89.12 75.21  95.63 78.62  88.80 75.93  92.96 79.10  82.93 71.19  3.91 3.40 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

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## RESPONSE OF *Corchorus olitorius* (JUTE MALLOW) CULTIVARS INFECTED WITH ROOT-KNOT NEMATODE (*Meloidogyne incognita*) TO PRE-SOWING TREATMENT

M. O. Ahmed\*, L. Y. Bello and M. T. Salaudeen

Department of Crop production, School of Agriculture and Agricultural Technology Federal University of Technology, Minna, Niger state, Nigeria.

\*Corresponding author’s email: ahmedmariam852@gmail.com

ABSTRACT

*The study was conducted to evaluate the Response of Corchorus olitorius cultivars infected with Root-knot nematode to pre-sowing treatment with Candle bush extract. Four cultivars of Corchorus olitorius, NGB00229 (A), NGB00209 (B), NGB00277 (C) and NGB00215 (D) were evaluated for physiological and morphological parameters. Number of leaves, plant height, leaf area, biomass weight (fresh and dry) and root gall index were used as agronomic indices. Seeds were treated using the recommended heat treatment method in order to break seed dormancy. Seeds were sown using the Completely Randomized design (CRD), with four replications and the C. olitorius cultivars as the treatment. Data collected were analyzed using the analysis of variance (ANOVA) and the means were separated using Student-Newman Keul’s Test (SNK) at 5% level of probability. Results showed significant differences in most of the traits evaluated for the four cultivars except for the number of pods and their relative weights which was not significantly different. Cultivars NGB00215 showed the least resistance to root knot nematode while other cultivars were highly resistant. Also, cultivars A performed best in most of the parameters taken such as the number of leaves, with (127) leaves while cultivars B (102), C (86) and D (84). The present study indicated enough variation among the extract concentrations with the 100, 75 and 50 (%) concentrations having higher indices than the 25 and 0 (%) levels, which can in turn help to broaden the genetic bases of new cultivars to reduce nematode insurgence.*

**Keywords**: cultivars; traits; root knot nematode; concentrations and physiological parameters.

INTRODUCTION

Nematodes or roundworms as described by Hodda, (2011) and Zhang, (2013), are a diverse animal phylum inhabiting a broad range of environments. Nematodes are very small, slender worms, typically about 5 to 100 µm thick, and 0.1 to 2.5 mm long, Weischer and Brown, (2000). The body is often ornamented with ridges, rings, bristles, or other distinctive structures (Lalosevic *et al*., 2013). Chitwood, (2016), reported that global losses associated to root-knot nematodes (RKNs) alone from 75 countries as at 2000 was valued at $121 billion. Phytoparasitic [nematodes](https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/nematode) are considered as hidden enemies, which can cause yield losses up to 80% in vegetables and have been associated with the severely infested fields (Tariq-Khan *et al* .,2017).

*Corchorus olitorius* L., commonly known as wild okra, belongs to the family Tiliaceae. It is widely consumed as a vegetable among rural communities in most parts of Africa (Velempini *et al*., 2003). In West Africa it is commonly cultivated and very popular among people of all classes especially in Nigeria (Oyedele *et al*., 2006). According to Zakaria *et al*. (2006), wild okra is used in folklore medicine in the treatment of gonorrhea, chronic cystisis, pain, fever and tumors. *Corchorus olitorius* is known to contain high levels of iron and folate which are useful for the prevention of anemia (Oyedele *et al*., 2006).

*Senna alata* is an important [medicinal tree](https://en.wikipedia.org/wiki/Medicinal_tree), as well as an ornamental [flowering plant](https://en.wikipedia.org/wiki/Flowering_plant) in the [subfamily](https://en.wikipedia.org/wiki/Subfamily) [*Caesalpinioideae*](https://en.wikipedia.org/wiki/Caesalpinioideae), which grows well in forest areas of West Africa (Owoyale *et al*., 2005). The result of the qualitative analysis of the leaf carried out by Sun *et al.,* (2009), indicated that alkaloids, quinones, saponins, phenolic compounds, flavonoids, tannins, and anthraquinone were present.

According to Islam, (2013), the most serious pests of *C. olitorius* are nematodes from the genus [*Meloidogyne*](https://en.wikipedia.org/wiki/Meloidogyne), leaf-eating beetles and caterpillars. Application of insecticides is also possible, but agent and application time should be chosen carefully since the leaves are harvested for consumption. The mineral composition of the leaves of *C. olitorius* revealed high concentrations of Mg, Fe and Ca. It should be noted that the fruit is rich in total lipid while the stem has good fiber content; this makes the entire aerial parts of this plant important and explains the use of the plants as a fiber crop (Roy *et al*., 2006). Therefore, the objectives were to:

(i) to determine the most effective concentration(s) of *Senna alata* extract for pre sowing treatment on the growth of *Corchorus olitorius* infected with *Meloidogyne incognita*. (ii) to determine the best cultivar(s) of *Corchorus olitorius* that can tolerate the inoculum level of *Meloidogyne incognita.*

MATERIALS AND METHODS

Source of plant accessions

Four cultivars of jute mallow which includes *corchorus* NGB00229; NGB00209; NGB00277 and NGB00215 were obtained from the National Center for Genetic Resources and Biotechnology (NACGRAB), Ibadan, Oyo State, Nigeria. While the leaves of *Senna alata* were collected from a fully grown and mature tree in Gurara, Minna, Niger State.

Laboratory experiment

Conical flasks of 250 ml in volume and Polyethylene bags were used for this research work. The conical flasks were arranged on the laboratory bench in a Completely Randomized Design (CRD). For each of the extract, 200 ml of each of the concentration levels was poured into the conical flasks after steeping (pre soaking in hot water) using a pipette. At the beginning of the experiment, four hundred (400) seeds of the four cultivars of *Corchorus olitorius* was transferred into hot water with a temperature of 93 ºC and allowed to soak for 10 seconds to overcome dormancy using four different conical flasks labeled NGB00229 (A), NGB00209(B), NGB00277 (C) and NGB00215 (D). After 10 seconds, these seeds were sieved out using a filter paper and transferred into the various solutions labeled S (100 %), S (75 %), S (50 %), S (25 %) and the control (distilled water). This was done to allow the seeds further absorb each of the extract in order to increase their viability and germination capacity while increasing their anti-nematicidal properties prior to inoculation. The seeds were allowed to soak further for 10 minutes and later air dried which took place 24 hours before sowing in the nursery. The treatments were replicated four times and a control which was kept at an ambient temperature ranging from 30°C-34°C in the laboratory during the course of the research. The experiment was a 4×5 treatment combination making a total of 20 treatments combinations.

Pot Experiment

The pot experiment was conducted under screen house conditions. Poly pots (16 cm by 25 cm) were filled with 2 Kg sterilized soil in the ratio 3: 1 (sandy loam: farmyard manure). Each pot was inoculated with 10 egg masses of *M. incognita* containing about an average of 200 larvae by making grooves around the roots at the same distance from the base. Data collection began two weeks after inoculation and continued on a weekly basis for a period of eight weeks. The data was analyzed for parameters such as: number of leaves/plant, leaf area, plant height, number of pod/plant, biomass fresh/dry weight and root gall index. Most of the cultivars were found immune according to the rating scale. Data was analyzed using the analysis of variance (ANOVA) and the means were separated using Student-Newman Keul’s Test (SNK) at 5% level of probability.

RESULTS

Table 1 revealed the resistance rating of the cultivars, NGB00229, NGB00209, NGB00277 (highly resistant), and NGB00215 (moderately resistant). However, as the plants grew older, significant differences were observed. In the third week after inoculation (WAI), the number of leaves produced by cultivars A (82ᵃ), was observed to be the highest but was not significantly different at p ≤ 0.05 from cultivars B (74ᵃᵇ) and D (65ᵇ), however it differed statistically from cultivars C (48ᶜ), having the lowest number of leaves due to *Meloidogyne incognita* infection. Furthermore, it was evident from the analysis carried out that cultivar NGB00229, performed best in the number of leaves produced as it was significantly different at p ≤ 0.05 from the other cultivars as it was not affected by *Meloidogyne incognita* infection. The least number of leaves was observed in cultivar NGB00215 which behaved similarly for other parameters. There were slight differences in the root gall index with cultivar NGB00215 showing the highest susceptibility to root-knot nematode infestation as indicated in table 1.

Table 1: Reproduction of Root knot nematode on the five cultivars and resistance rating of the nematode

Cultivars Root Gall Index Reaction

NGB 00229 0.900ᵇ highly resistant

NGB 00209 1.700ᵇ highly resistant

NGB 00277 1.850ᵇ highly resistant

NGB 00215 4.450ᵅ moderately resistant

SE ±0.399

Values in each column followed by the same letters are not significantly different according to Duncan’s Multiple Range Test (P ≤ 0.05).

**Table 2: Effect of *Meloidogyne incognita* on the number of leaves of different cultivars of *Corchorus olitorius* across five concentration levels.**

Cultivars Concentrations Week 1 Week 3 Week 5 Week 7

NGB00229 (A) 32ᵅ 82ᵅ 120ᵅ 127ᵅ

100 (%) 30ᵅ (± 2.1) 75ᵅ (±4.7) 131ᵅ (±7.6) 117ᵅ (±8.6)

NGB00209 (B) 33ᵅ 73ᵅᵇ 101ᵅᵇ 102ᵇ

75 (%) 27ᵅ 73ᵅ 116ᵅᵇ 97ᵅ

NGB00277(C) 17ᵇ 48ᶜ 92ᵇ 86ᵇ

50 (%) 26ᵅ 61ᵅ 98ᵇᵅ 100ᵅ

NGB00215 (D) 28ᵅ 62ᵇ 98ᵇ 84ᵇ

25 (%) 25ᵅ 63ᵅ 81ᶜ 90ᵅ

0 (%) 28ᵅ 63ᵅ 92ᵅ 94ᵅ

SE± 1.90 4.20 6.76 7.73

Values in each column followed by the same letters are not significantly different according to Duncan’s Multiple Range Test (P ≤ 0.05).

DISCUSSION

Most of the plant growth characters of the jute mallow cultivars were significantly negative correlated with the number of galls of *M. incognita.* Moreover, it can be suggested that egg masses also had an indirect effect on the reduction of plant growth. *Meloidogyne* spp. induces galling in the roots and giant cells formation in the stellar region, which destroys the xylem tissues and ultimately reduces the absorption and movement of water and nutrients (Abad *et al*., 2003). The limitation of nutrient elements in the plant is one of the initial effects that the nematode infestation has on the physiology and metabolism of its host (Lu *et al*., 2014). These effects increase with the duration of infestation (Malakeberhan *et al.,* 1987). In conclusion, the current study demonstrated that the four cultivated *C.olitorius* cultivars are highly resistant to *M. incognita* with the exception of the cultivar NGB00215, which was found moderately resistant after pre-sowing the seeds with *Senna alata* extract. Also, the highest concentration (100%) of *Senna alata* performed the best when compared to other concentration levels in reducing the effect of root-knot nematode infestation.

CONCLUSION AND RECOMMENDATION

It can be concluded from the study that there was a low incidence of *Meloidogyne incognita* in this study area. Furthermore, Adopting proper management techniques such as sourcing of highly resistant cultivars seeds from reliable agricultural institutes, regular weeding, as well as effective seed treatment with the adequate plant extract is capable of reducing disease incidence of *Meloidogyne incognita* (root-knot nematode) in *Corchorus olitorius* (jute mallow). This is required in screening for nematode-resistant varieties for increased yield in jute mallow production at a reduced cost.

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## EFFECT OF FRUIT AGES ON MOTHER- PLANT SEED QUALITY OF “EGUSI” MELON (*Cucumeropsis manni Naudin*) CULTIVARS

`Akpede-Baro, B. N.\*1, Ibrahim, H.2, Gana, A. S.1 and Tolorunse, K. D.1

1Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria

2Department of Horticulture, Federal University of Technology, Minna Niger State, Nigeria

\*Corresponding author: [barobenedicta@gmail.com](mailto:barobenedicta@gmail.com); +2347065610738

ABSTRACT

*Melon fruits produced at the base of the stem are older. Age reduces as they get closer to the apex of the stem. Melon farmers however, conduct harvest operation on the same day and do not grade fruits according to their ages and position on the mother- plant before extraction of seeds. The experiment was conducted in 2019 at the laboratory of Crop Production Department, Federal University of Technology, Minna to evaluate the qualities of two “egusi” melon cultivars harvested at different ages on their mother-plant. The treatments were three harvesting stages, 23, 33. 43* days after anthesis *(DAA****)*** *and two “egusi” melon cultivars (“paragi” and “ofe”)*. *The* *seeds were placed on filter paper moistened with distilled water in plastic dishes and laid out in Completely randomized design (CRD) in four replications. Data were collected on seed length, dry seed weight, seed diameter, 100-seed weight and germination percentage. Data collected were subjected to analysis of variance (ANOVA) and means were separated using Tukey’s test. The results indicated that, the “Paragi” variety recorded significantly higher values for all the observed seed parameters except seed length and seed diameter. The results also revealed 23 days after anthesis had significantly lower values compared to 33 and 43 days after anthesis for 100-seed weight, number of seeds per fruit and weight of seed. For seed length and seed diameter, 43 days after anthesis was significantly higher. The germination percentage between the two varieties were generally similar throughout the duration of storage. Though significant germination percentage differences were recorded among the seeds harvested at different days after anthesis at 0, 6, 8, 10, 12 and 14 storage periods, the trend was not consistent. Seed of cultivar “Paragi” retained higher quality traits. For optimum storability and good seed quality, “egusi” melon should be harvested at 43 days after anthesis.*

**Key words**: “Egusi” Melon, Seed Quality, Germination percentage

INTRODUCTION

“Egusi” melon (*Cucumeropsis manni*) is the biological ancestor of the watermelon now found all over the world. It is a member of the cucurbitaceae family and the genus *Citrullus* (Ogbonna and Obi, 2010). Melon consisted of 4 to 5 species of the genus, viz: *Cucumeropsis manni* (thumb), *Citrulus colocynthis* (L) Sachred, *Citrullus ecirrhorous* (Cogn) and *Citrullus naudrnianus* (Sord Hook), with the basic chromosome number of 2n =22, n=11 (Ogbonna, 2013). The word "Egusi" is derived from Yoruba language, (Vossen *et al.,* 2004). Bello (2011), stated that “egusi” melon is a native of African where it was cultivated for many centuries. It has been referred to *Citrullus vulgaris* in some texts (Ogbonna and Obi, 2007) and *Cucumeropsis manni (*Ogbonna, 2013). “Egusi” melon is now wide spread in all tropical, sub-tropical and warm temperate (hot summers) regions of the world, including Africa. The kernels of its seed can be eaten as snacks when roasted and used for the purpose of cooking oil source (Bande *et al*., 2012). According to Demir and Smith (2001); Oladiran and Kortse (2002) and Demir *et al.* (2004) seed age is a major determinant of seed quality. Most small-holder farmers obtain fruits that have been left to weather on the field; which are most likely to be seeds from fruits of different position and ages, such seeds are known to be of poor quality. Such seeds are known to germinate poorly when planted. This has over the years resulted in low productivity among peasant vegetable growers as they are usually unable to access improve and high-quality seed due to high cost. Therefore, the objective of the study was to evaluate the variabilities in the qualities of two “egusi” melon cultivars harvested at different ages.

MATERIALS AND METHODS

The experiment was conducted in 2019 at the laboratory of Crop Production Department, Federal University of Technology, Minna, Niger State (latitude 90 51 N and longitude 60 44 E). The treatment was a factorial combination of “egusi” melon cultivars (“paragi” and “ofe”) and three harvesting stages (23, 33, 43 days after anthesis (DAA)). Twenty-five seeds from each treatment were placed on filter paper moistened with distilled water in a petri dish and arranged in a completely randomized design (CRD) with four replicates. Data were collected on 100-seeds weight, number of seeds per fruit, dry seed weight, seed length, seed diameter and germination percentage. The seed moisture content was determined as follows:

Germination test were done by counting four replicates of 25 seeds each of the treatment combinations which were placed on filter paper. The Petri-dishes were carefully arranged in seed germination chamber at a constant temperature of 30 oC. Germination counts were taken every-other-day and results were expressed in percentages. Data collected were subjected to analysis of variance (ANOVA) using Minitab and means were separated using Tukey test at 5 % level of probability where significant differences exists among the treatments**.**

RESULTS

Table 1 shows the effects of harvesting at different days after anthesis on seed parameters of two “egusi” melon cultivars. The “Paragi” cultivar recorded significantly higher values for all the observed seed parameters except seed length and seed diameter. Also, 23 days after anthesis had significantly lower values compared to 33 and 43 days after anthesis for 100-seed weight, number of seeds per fruit and weight of seed. For seed length and seed diameter, 43 days after anthesis was significantly higher. The interaction effect of “egusi” melon cultivars and harvesting at different days after anthesis was significant at 100-seed weight, highly significant for both number of seeds per fruit and dry seed weight, but not significant for both seed length and seed diameter. The interaction effect of cultivars and harvesting at different days after anthesis were revealed in Table 2. There was a significantly low values of harvesting at 23 days after anthesis compared to 33 and 43 days after anthesis at all the seed parameters irrespective of the cultivar. At each seed parameter, the trend in the values of harvesting at different days after anthesis protocol varied with cultivar. At 100-seed weight, whereas the values for “Paragi” cultivar were not significant in harvesting at 33 and 43 days after anthesis, significant variations were recorded for values with “Ofe” cultivar. At this latter cultivar, the best value was recorded at harvesting at 43 days after anthesis (10.20g). The poorest value was obtained at 23 days after anthesis in “Paragi” cultivar. Variations in responses and trends of values among harvesting at different days after anthesis was recorded at the other seed quality parameters as well. Table 3 shows the effects of harvesting at different days after anthesis on germination percentage on “egusi” melon cultivars at different storage periods. The germination percentage between the two cultivars were generally similar throughout the duration of storage. Though significant germination percentage differences were recorded among the seeds harvested at different harvesting days after anthesis at 0, 6, 8, 10, 12 and 14 storage periods, the trend was not consistent. Furthermore, the interaction between cultivars and harvesting at different days after anthesis was not significant throughout the duration of storage (Table 3

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| --- | --- | --- | --- | --- | --- |
| Table 1. Effects of harvesting at different days after anthesis on seed parameters of two “Egusi” melon cultivars | | | | | |
| Treatments | 100-seed weight (g) | Number of seeds per fruit | Dry seed weight (g) | Seed length (cm) | Seed diameter (cm) |
| **Cultivars (C)** |  |  |  |  |  |
| “Paragi” | 10.24a | 191a | 16.21a | 1.06a | 0.44a |
| “Ofe” | 9.46b | 112b | 12.41b | 1.03a | 0.43a |
| LSD | 0.17 | 10.85 | 1.31 | 0.09 | 0.05 |
| **Days after anthesis (D)** |  |  |  |  |  |
| 23 | 8.93b | 108b | 13.91b | 0.91c | 0.29b |
| 33 | 10.18a | 172a | 19.11a | 1.04b | 0.49b |
| 43 | 10.43a | 175a | 19.90a | 1.20a | 0.53a |
| LSD | 0.21 | 13.29 | 1.61 | 6.10 | 0.06 |
| **Interaction** |  |  |  |  |  |
| C x D | \* | \*\* | \*\* | NS | NS |
| LSD = Least Significant Different at 5% level of probability; \* = significant; \*\* = highly significant; NS = not significant | | | | | |
|  |  |  |  |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Table 2. Interaction effects of harvesting at different days after anthesis and “Egusi” melon cultivars on 100-seed weight, number of seeds per fruit and weight of seed** | | | | |
| Cultivars | Days after anthesis | 100-seed weight (g) | Number of seeds per fruit | Dry seed weight (g) |
| “Paragi” | 23 | 9.46c | 112b | 13.91b |
|  | 33 | 10.60a | 232a | 23.34a |
|  | 43 | 10.67a | 229a | 24.38a |
| “Ofe” | 23 | 8.44d | 103b | 6.91c |
|  | 33 | 9.76bc | 112b | 14.90b |
|  | 43 | 10.20ab | 121.b | 9.64c |
| LSD |  | 0.49 | 30.97 | 3.75 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | |
| **Table 3. Effects of harvesting at different days after anthesis on germination percentage of two “egusi” melon cultivars at different storage periods** | | | | | | | | |
| Storage period (weeks) | | | | | | | | |
| Treatment | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| **Cultivars (C)** |  |  |  |  |  |  |  |  |
| “Paragi” | 88.33a | 93.00a | 95.33a | 83.33a | 78.00a | 64.00a | 68.00a | 65.33a |
| “Ofe” | 86.50a | 94.67a | 94.00a | 82.00a | 78.67a | 71.08a | 67.75a | 61.33a |
| LSD | 7.49 | 4.87 | 2.80 | 7.96 | 10.08 | 11.44 | ` 9.20 | 13.47 |
| **Days after anthesis (D)** |  |  |  |  |  |  |  |  |
| 23 | 79.00b | 91.50a | 90.00a | 73.00b | 70.50b | 62.50b | 59.00b | 49.00b |
| 33 | 92.00a | 95.50a | 97.00a | 90.50a | 81.00a | 63.50ab | 70.13ab | 49.00ab |
| 43 | 91.25a | 94.50a | 97.00a | 84.50a | 83.50ab | 76.63a | 74.50a | 73.50a |
| LSD | 9.17 | 5.92 | 3.43 | 9.75 | 12.35 | 14.01 | 11.27 | 16.50 |
| **Interaction** |  |  |  |  |  |  |  |  |
| C x D | NS | NS | NS | NS | NS | NS | NS | NS |
| LSD = Least Significant Different at 5% level of probability; NS = not significant | | | | | | | | |

DISCUSSION

The “egusi” melon, when harvested at 23 days after anthesis, revealed that the seed still had the high moisture content which greatly impact on the storability but progress in maturity and storability were found in harvesting at 43 days after anthesis. This was similar to the results reported by Demir and Ernis (2005) who had hypothesized that the reduction in the storability might be due to maturity associated issues with development of seeds such as accumulation of dry matters, desiccation development cessation of mobilization. In addition, the higher the moisture content at harvest, the lower the germination percentage was alluded to by Owolade *et al*. (2003) who also observed that the higher the moisture content the higher the loss of seed at storage. It is important to note that the superiority of seeds harvested at 43 days after anthesis was particularly more obvious in age and at the seed quality.

CONCLUSION

It is concluded that seeds of the two cultivars used in this study possessed seed quality potentials but “Paragi” cultivar germinated and stored better than “Ofe” cultivar in few cases. The study also revealed that it may be necessary to immediately record the day of anthesis in “egusi” melon production. Seeds of “egusi” melon harvested at 43 days after anthesis retained higher germination for longer period and exhibited good seed quality. It is therefore recommended that “Paragi’ cultivar be nominated for evaluation trials for subsequent release as “egusi” melon variety in Nigeria. Also, that harvesting of “egusi” melon at 43 days after anthesis be adopted in order to enhance good seed quality.

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## GRAIN YIELD OF EARLY MATURING PRO-VITAMIN A (PVA) MAIZE INBRED LINES UNDER STRIGA INFESTATION AND OPTIMAL CONDITIONS

B. R. Aleji1\*, A. S. Gana1, K. D. Tolorunse1 and B. Badu-Apraku2

1Department of Crop Production, Federal University of Technology, Minna, Niger State, 920101, Nigeria;

2International Institute of Tropical Agriculture (IITA), PMB 5320, Ibadan 200001, Nigeria

\*Corresponding author: alejiracheal@yahoo.com

ABSTRACT

*A total of two hundred and ten single-cross hybrids generated by crossing the panel of 50 selected early maturing pro vitamin A (PVA) inbred lines from the International Institute of Tropical Agriculture – Maize Improvement Program (IITA-MIP) to four early maturing PVA inbred testers using the line x tester mating design, six single crosses were obtained by intermating the four testers, plus four commercial checks served as the entries. The research was conducted at Mokwa, Niger State for two years under artificial Striga infested and optimal growing conditions. The results revealed that General (GCA) and Specific (SCA) combining ability means were significant (p<0.01) for grain yield and other agronomic traits across environments, this indicated additive and nonadditive gene actions were important in the inheritance of most traits of the inbred lines. The GCA effects of multiple traits (HGCAMT) method classified the inbred lines into four heterotic groups under Striga infestation and five groups under optimal growing condition. TZEIOR 172 x TZEIOR 108 and TZEIOR 202 x TZEI 25 were identified as the highest-yielding and most stable hybrids across the contrasting environments. TZEIOR 21 x TZEI 25 was identified as the preferred hybrid for Striga infested environments. The inbred lines such as TZEIOR 201 and TZEIOR 202 recorded significant and positive GCA effects for grain yield across the contrasting environments and could be useful for developing Striga tolerant and/or combined drought and heat stress tolerant hybrids and synthetics*.

**Keywords:** Maize; General combining ability, Specific combining ability, *Striga hermonthica*; inbred lines

INTRODUCTION

Maize (Zea mays L.) is the most extensively grown crop species in the world next to wheat and rice (Maria *et al*., 2017). However, its production and productivity are mostly constrained by *Striga hermonthica* (Del.) Benth., commonly known as *Striga*. *Striga* infestation causes yield losses up to 100 %, which amounts to estimated annual losses of$40.8 million (Kanampiu *et al.,* 2002). *Striga* germination is close to its host in response to specific chemical signals from the root of the host or certain non-host plants (Hooper *et al.,* 2009). The parasitic weed *Striga hermonthica* Benth, is an important constraint to cereal production in sub-Saharan Africa (SSA), often results in yield loss as high as 100 % in maize production and productivity depending on, soil degradation, the severity of the infestation, genotype type, soil fertility, the climatic condition causing farmers to abandon their farmlands. Therefore, there is a need to identify, characterize and commercialize new maize plant varieties possessing the required ecological chemistry to protect crops against this biotic stress of *Striga* under such conditions. *Striga* control complication results in its abundant seed production, a complicated parasitism mode and longevity of the seed bank*.* One of the effective ways to manage *Striga* is the use of forage legumes as an intercrop. However, the most effective way is development improvement and commercialization of improved crop varieties with resistance to *Striga* for the resource-poor farmers. *Striga* resistance means the capability of the maize plant to suppress the germination and attachment of the *Striga* plants resulting in few numbers of emerged *Striga* plants while *Striga* tolerance is the capacity of the maize plant to survive and produce a reasonable yield in the presence of the attached *Striga* plants (Kim, 1994). Therefore, the objectives of the study were to develop early maturing provitamin A (PVA) single cross hybrids with resistance to *Striga* infestation and identify high yielding and yield stability of the hybrids across environments.

MATERIALS AND METHODS

A total of two hundred and fifty-six early maturing PVA, PVA-QPM inbred lines comprising normal yellow and orange endosperms, extracted from *Striga* resistant and drought tolerant, broad-based population, 2009 TZEOR1 DT STR S7, 2009 TZEOR2 DT STR QPM S7, (TZEI 17×TZEI 11) S6, TZE Comp5-Y C6 ­­­S7, (TZEI 11×TZEI 8) S7, (ENT 8×TZEI 158), TZE-Y-Pop-DT-STR-QPM and 2009-TZE - OR2 DT-STR QPM developed by the IITA-MIP. The 256 inbred lines and 210 single cross hybrids were evaluated at Mokwa (9o18’N and 5o04’E, 457 m asl, 1,100 mm annual rainfall and ferrisol plinthustalf soil type), Niger State Nigeria, under *Striga* infested and *Striga* free conditions. Fertilizer was applied at the rate of 60 kg N ha-1, 60 kg P2O5 ha-1 and 60 kg K2O ha-1 at 2 weeks after planting (WAP) and an additional 60 kg N ha-1 at 4 WAP under *Striga* free condition. Under *Striga* infested condition, about 2WAP, ethylene gas was injected into the soil to stimulate suicidal germination of existing *Striga* seeds in the soil. Fertilizer application of *Striga* plots were delayed until about 21 days after planting when 30 kg ha-1 N, 30 kg ha-1 P, and 30 kg ha-1 K was applied as 15-15-15 NPK. The delay in fertilization was to stimulate the production of strigalactones, which stimulate *Striga* emergence and attachment to the roots of the maize plants. Weeds other than *Striga* in the trials were controlled manually (hand weeding). The hybrid trials were laid out using a 14 x 15 randomized incomplete block design with two replicates and a 16 × 16 randomized incomplete block design with two replicates was used for the inbred line evaluations. Single-row plots, 3 m long, with a spacing of 0.75 m between two adjacent rows and 0.40 m between plants within rows were used for both the inbred line and hybrid evaluations. Three seeds were sown per planting hole and the emerged seedlings thinned to two per stand at 2 weeks after emergence, resulting in a final plant population density of about 66,667 plants ha-1.

Data Collection

Observations were made on days to 50 % silking (DS) as the number of days when 50 % of the plants had emerged silks, while days to 50 % anthesis (DA) represented the number of days when 50 % of plants had shed pollen. The anthesis–silking interval (ASI) was determined as the difference between DA and DS. Other measured traits were plant height (PLHT) and ear height (EHT), measured as the distance in centimeters between the base of the plant and the first tassel branch and the top ear, respectively. Ears per plant (EPP) was obtained by dividing the number of ears harvested by the number of plants at harvest. Plant aspect (PASP) was rated on a scale of 1–9, where 1 = excellent and 9 = poor; and ear aspect (EASP) was recorded on a scale of 1–9, where 1 = clean, uniform, large, and well‐filled ears and 9 = ears with undesirable features, such as diseased, small ears, and ears with poorly filled grains. Data on the number of emerged *Striga* plants and host plant damage (*Striga* damage rating) were collected at 8 and 10 weeks after planting. *Striga* emergence count: the number of emerged *Striga* plants per plot at 8 and 10 WAP; *Striga* damage symptoms rated on a scale of 1 to 9 as described by (Kim, 1994), 1= Normal plant growth, no visible symptoms, 9= Complete scorching of all leaves, causing premature death or collapse of host plant and no ear formation. Grain yield (kgha−1) of the rainfed experiment was computed on the basis of the field weight, assuming a shelling percentage of 80 at 15 % moisture content.Grain yield under *Striga*-infested environment was calculated as follows:



Where: 10,000= land area per hectare (m2), 4x0.75= land area per plot (0.75 m x 0.4 m), and 0.80 = 80 % shelling percentage.

Statistical Analysis

Log transformation as performed on data related to counts, scales and scores using the formula [log (counts + 1)], while square root transformation was carried out on data in percentages before subjecting them to analysis of variance (ANOVA). Data on grain yield and other agronomic traits were subjected to combined ANOVA for each environment using PROC GLM in Statistical Analysis System (SAS) version 9.3 (SAS Inc. 2011). Analysis of variance were performed on the adjusted means of the individual traits *Striga* infested and optimal growing conditions and thereafter combined across environments.

RESULTS

The combined analysis of variance (ANOVA) across the two *Striga* environments showed highly significant (P< 0.05 or P< 0.01) differences among environments (E) and entries (inbred lines) for measured traits (Table1). The genotype x environment interactions (GEI) were significant (P < 0.05) for measured traits except for anthesis-silking interval (ASI) while significant differences were detected in the environments for all the measured traits. Broad sense heritability (H2) estimates based on plot mean basis ranged from 42 % for ear height (EHT) to 64 % for ears per plant (EPP), while the estimate for grain yield was 68 %. The H2 for ASI could not be determined because of the negative genotypic variance. The results also revealed moderately high to high heritability estimates for traits measured under *Striga* infestation. The combined ANOVA across three optimal environments showed significant (P< 0.05 or P< 0.01) variations among environment, entry (genotype) and genotype x environment mean squares for all measured traits except GEI effects for ears per plant (EPP). Heritability (H2) estimates ranged from 58 % for ears per plant (EPP) to 80 % for ear aspect (EASP), grain yield had very high estimates of 85 % and EPP 80 % under optimal environments (Table 2).

Table 1: Mean squares and heritability estimates of 256 early maturing PVA, PVA-QPM maize inbred lines evaluated under *Striga* infested condition at Mokwa during the 2019 and 2020 growing seasons

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Source** | **DF** | **GY (t ha−1)** | **DA** | **DS** | **ASI** | **PLHT** | **EHT** | ***Striga* damagerating** | | ***Striga* emergencecount** |  | **EASP** | **EPP** |
|  |  |  |  |  |  |  |  | **8WAP** | **10WAP** | **8WAP** | **10WAP** |  |  |
| ENV | 1 | 600443359.30\*\* | 8841.87\*\* | 831.96\*\* | 868.41\*\* | 362441.60\*\* | 6015.94\*\* | 1681.00\*\* | 83.27\* | 0.19\*\* | 1.01\*\* | 243.91\*\* | 40.14\*\* |
| Entry | 255 | 1067995.40\*\* | 483.41\*\* | 533.29\*\* | 3.32\* | 1684.91\*\* | 599.67\*\* | 3.51\*\* | 6.44\*\* | 0.24\*\* | 0.25\*\* | 6.67\*\* | 0.12 |
| Rep(ENV) | 2 | 76139849.20\*\* | 54.24\*\* | 58.23\*\* | 10.34\*\* | 2580.10\*\* | 1223.76\* | 12.10\*\* | 12.10\*\* | 0.10\*\* | 0.31\*\* | 49.93\*\* | 1.37\* |
| BLK(ENV\*Rep) | 60 | 798245.20\*\* | 11.95\*\* | 14.09\*\* | 3.12\*\* | 677.04\*\* | 264.83\*\* | 1.30\*\* | 2.12\*\* | 0.12\* | 0.10\*\* | 5.60\*\* | 0.13\* |
| Entry\*ENV | 255 | 726600.50\*\* | 457.45\*\* | 501.42\*\* | 3.54 | 1577.01\*\* | 586.37\*\* | 3.22\*\* | 5.39\* | 0.20\*\* | 0.21\*\* | 6.53\*\* | 0.09\*\* |
| Error | 450 | 427852.00 | 3.30 | 4.79 | 1.55 | 264.30 | 130.41 | 0.33 | 0.97 | 0.06 | 0.04 | 1.25 | 0.05 |
| **Heritability** | **-** | **68** | **50** | **58** | **-** | **56** | **42** | **51** | **48** | **51** | **48** | **69** | **64** |

\*, \*\* = Significant. at 0.05 and 0.01 probability. levels, respectively; Env = environment; Rep=replication; GY = Grain yield; DA.= days to 50 % anthesis; DS. = days to 50 % silking; ASI. = anthesis-silking interval; PLHT = plant height; EHT = ear height; EASP. = ear plant aspect; EPP. =ears per plant.

**Table 2: Mean squares and heritability of grain yield and other agronomic traits of 256 PVA, PVA-QPM maize inbred lines evaluated under optimal growing environments at Mokwa 2019 and 2020 growing seasons**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **SOURCE** | | **DF** | **YIELD** | **DA** | **DS** | **ASI** | **PASP** | **EASP** | **EPP** | **PLHT** | **EHT** |
| Env | | 1 | 396743.70\*\* | 11.04\*\* | 32.19\*\* | 638.80\*\* | 194.84\*\* | 98.79\*\* | 0.03\*\* | 42147.27\*\* | 7538.62\* |
| Entry | | 255 | 1620201.60\*\* | 10.31\*\* | 13.13\*\* | 0.72\*\* | 2.31\*\* | 3.10\*\* | 0.11\*\* | 367.28\*\* | 135.14\*\* |
| Rep(Env) | | 2 | 2799843.50\*\* | 860.59\*\* | 1148.64\*\* | 0.77\*\* | 19.65\*\* | 10.85\*\* | 0.64\*\* | 4168.83\*\* | 2431.98\*\* |
| BLK(Env\*Rep) | | 60 | 846949.30\*\* | 11.52\*\* | 15.81\*\* | 0.50\* | 1.27\*\* | 2.11\*\* | 0.10\*\* | 328.77\* | 202.51\*\* |
| Entry\*Env | | 244 | 771149.20\* | 4.86\*\* | 6.13\*\* | 0.93\*\* | 1.56\*\* | 2.17\*\* | 0.12 | 260.30\*\* | 100.87\*\* |
| Error | 437 | 481999.80 | 4.01 | 4.94 | 0.59 | 0.85 | 1.80 | 0.09 | 91.81 | 67.63 |
| **Heritability** | | **-** | **85** | **67** | **72** | **74** | **74** | **80** | **58** | **65** | **74** |

\*, \*\* = Significant at 0.05 and 0.01 probability levels, respectively; Env = environment; Rep = replication; DA = days to 50 % anthesis; DS = days to 50 % silking; ASI = anthesis-silking interval; PLHT = plant height; EHT = ear height; PASP = plant aspect; EASP = ear plant aspect; EPP = ears per plant.

DISCUSSION

The significant differences observed among measured traits under *Striga* infestation and optimal environments indicated that the germplasm evaluated in this study is genetically diverse whichshould allow good progress from the selection under contrasting environments. The significant environmental variation for all traits under *Striga* infestation and optimum environments indicated that each environment was unique and highly variable emphasizing the need for testing in more environments over years. The significant genotype x environment interactions for grain yield, *Striga* damage ratings and emerged *Striga* plants under *Striga* infestation is an indication that the hybrids responded differently to *Striga* infestation at the different sites suggesting that the strains of *Striga hermonthic*a at the different sites were different. The significant genotype x environment interactions for grain yield, *Striga* damage ratings and emerged *Striga* plants under *Striga* infestation is an indication that the hybrids responded differently to *Striga* infestation at the different sites suggesting that the strains of *S. hermonthic*a at the different sites were different. Similar findings were reported by several researchers in West and Central Africa (Yallou *et al.*, 2009; Menkir *et al.*, 2010; Badu-Apraku and Lum, 2010; Badu-Apraku *et al.*, 2019).

CONCLUSION

The Savanna agro-ecologies of West and Central Africa (WCA) have the highest potential for maize grain yield production and productivity due to low night temperatures, low incidence of pests and diseases and high solar radiation, all of which favour maize production and productivity. However, *Striga hermonthica* parasitism, declining soil fertility and drought stress are the major limiting factors to maize production in the subregion. Genetic enhancement of maize under *Striga hermonthica* could improve grain yield for farmers.

RECOMMENDATION

The two highest yielding and most stable hybrids (TZEIOR 172 x TZEIOR 108) and (TZEIOR 202 x TZEI 25) should be tested in multi-location trials to confirm the consistency of performance and promoted for adoption and commercialization in the sub-region.

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## EFFECTS OF LOCATION OF SEED IN FRUIT ON SEED QUALITY OF OKRA (*Abelmoschus esculentus (L.) Moench*)

Jibril, A. O.1\*, Ibrahim, H.2, Mamudu, A. Y.1 and Tolorunse, K.D.1

1Department of Crop Production, Federal University of Technology, Minna, Niger State

2Department of Horticulture, Federal University of Technology, Minna, Niger State

\*Corresponding author: [jibrilabdulkarim5@gmail.com](mailto:jibrilabdulkarim5@gmail.com) (08032902489/ 07057444677)

ABSTRACT

*The experiment was carried out at the Crop Production Department Laboratory, Federal University of Technology, Minna, Niger State, Nigeria. Field work for seed multiplication was done at the research farm of Crop Production Department during the raining season of 2019. Two plots of land (plot 1 and 2) measuring 15m by 26m each were prepared for the mass production of seeds of LD88 okra varieties Treatments were locations (base, middle and top) replicated four times and fitted into a Completely Randomized Design (CRD). Sample of seeds of each of the different treatments was placed in an open plastic plate measuring 300 mL. The containers were placed in the incubator at a temperature of 37 0C. Data were collected on number of seed per fruit, seed yield, seed moisture content, 100-seed weight, germination percentage, germination speed and electrical conductivity of the seeds. Data collected were subjected to analysis of variance (ANOVA) and means were separated using Duncan Multiple Rang Test (DMRT). The results showed that significantly higher (p<0.05) number of seeds and seed yield were recorded at middle and top over the base. The base had a significantly heaviest (p<0.05)100-seed weight, followed by the middle while the top had the least value.. Germination percentage was generally best at the base and middle locations. The top seeds had the highest leachate. Germination speed was insignificantly similar in the three locations*

**Keywords:** Anthesis, viability, leachates**.**

INTRODUCTION

One of the most popular vegetables consumed across Nigeria is okra (Johnson, 2017). Okra (*Abelmoschus esculentus (L) Moench*), belongs to the family “Malvaceae”. The crop originated from Ethiopia (Sathish and Eswar., 2013) but spread to other countries through the Portuguese. Okra is one of the most widely known and utilized species of the family “Malvaceae” (Naveed *et al*., 2009). It is grown as a fruit vegetable on almost all West African farms and high values are attached to its edible green pods, leaves and seeds. The tender leaves of okra are chopped together with the fruits for making soup. The fruits are used either in the green or dried form. It may be chopped green and cooked as soup to accompany dish or sliced, dried and ground into powder for future use (Ibrahim and Oladiran, 2011). The matured stem contains fibre of good strength and is used for domestic purposes which include making of fish line, traps and hammocks. The edible parts are the cheapest source of essential minerals like iron, phosphorus, and calcium. They are also sources of iodine which prevent the development of goitre in people whose drinking water is deficient of the mineral. Numerous small-holder farmers (who produce the bulk of the crops in circulation) still hold on to the practices of leaving okra fruits at various positions on mother-plant until all the fruits are mature and completely dried before they are harvested at the end of the season; seeds from such fruits are extracted and bulked irrespective of the position of the seeds within the fruit/pod. It therefore means that farmers take no account of the differences in quality that may exist among seeds in the various locations within the fruit It is believed that the bulked seed lot might have varied qualities brought about by the differences in the positions/location of seeds within the fruits.It is clear that population at present increases in geometrical progression while the accessible land to produce food for the exploded human population is limited in supply. Although, there are various ways of carrying out soil improvement to increase crop productivity, wrong choice of seeds will definitely make no meaning out of the planned programme. Hence, good quality seeds (in terms of higher germination /emergence rate and increase in vigour) will definitely complete the race towards achieving food sufficiency. Therefore, the objective of the study was to examine the effects of differences in locations of seeds in fruits on seed quality.

MATERIALS AND METHODS

This study was carried out at the Teaching and Research Farm of Federal University of Technology, Minna (Latitude 9o 311 N and Longitude 6o 29IE) during the raining season of 2019. Seed quality studies were carried out in the laboratory of Crop Production Department, Federal University of Technology, Minna.

LD88 variety of okra was obtained from the National Horticultural Research Institute (NIHORT), Ibadan Nigeria.Mass planting technique was adopted to produce adequate seeds for seed parameters studies. A plots of land which measured 15m by 26 m was prepared for the mass production of seeds of LDD88 varieties of okra. The plots of land was cleared, ploughed and narrow ridges (0.40m wide) of 15m in length were constructed manually (using hoes) at a spacing of 0.75m apart. Seeds of the variety LD88 were sown at a spacing of 50 cm along the ridges. Two seeds were sown per hole and seedlings were later thinned to one per stand after two weeks of sowing. Weeding was done manually using hoes at interval of two weeks from the day of crops emergence from the soil to keep the field weed free. Flowers were date-tagged at various positions as they opened to index anthesis; ensuring easy identification of fruit age. Fruits that developed from tagged flowers were harvested at 42 Days After Anthesis (DAA) when the initial green colour of the fruits had turned straw brown and the fruits completely split along the ridges. The treatments comprised of location (base, middle and top) replicated four times and fitted into a Completely Randomized Design (CRD).Freshly harvested fruits were immediately taken to the laboratory of Crop Production for further studies. Each fruit from each replicate was divided into three equal parts (Base, Middle and Top). Each part of the fruit was then opened and seeds extracted were counted (to determine seed number) and weighed fresh (to determine seed yield) before shade-drying for two weeks on top of paper placed on the table in the laboratory. Data were collected based on number of seeds, seed yield, seed moisture content, 100-seed weight, germination percentage (GP), germination speed (GS) and electrical conductivity (EC) test. All data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS) package; version: 2017 7.0. Means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION

Location of seeds in fruit significantly *(p<0.05)* affected all seed parameters measured as shown in Table 1. The number of seeds were significantly higher at middle (45.41) than the top (43.09); but lowest at the base (22.41). Similarly, seed yield was significantly lowest at the base (1.12), higher *(p<0.05)* at the middle but highest *(p<0.05)* at top (2.14). The significantly high number of seeds recorded at middle and top over the base is as a result of more flesh (nutrient transporting tissues) which normally accumulate at the base of the fruit leaving less space for seeds while the ‘middle’ and ‘top’ have more space for the formation of more seeds due to lesser flesh. This was clearly noticed in the study during the process of seed extraction. This is also connected to the higher seed yields observed at the ‘middle’ and ‘top’. Carol *et al.* (2011) revealed that numerous nutrient transporters occupy the base of the pod and they control the importation of nutrient elements into the seed.

100-seed weight was significantly highest *(p<0.05)* at the base (4.54), followed by those at the middle (4.30) but significantly lowest *(p<0.05)* at the top (4.11). The highest value observed at the base is traced to the fact that more nutrients get to the basal seeds since they are closest to the environment of higher concentration of macronutrients than the top; hence, bigger and heavier seeds due to more dry matter (assimilates) deposited in the basal seeds than the middle and lesser at the top. (Kolodziejek, 2017) observed in *Peucedanum oreoselinum* (Apiaceae), that high quantity of macronutrient in surrounding of the fruit often lead to the production of seeds that are heavier. So, the abundant nutrient transporters that fill the base of the pod (Carol *et al.,* 2011) will likely increase the amount of assimilates available to the basal seeds; but, least at the top.

Table 1: Effects of location of seed in fruit on seed parameters of LD88 variety of okra

|  |
| --- |
| Treatments Number of seeds Seed yield (g) Seed moisture content (%)100-seed weight (g)  Base 22.00c 1.12c 18.46a 4.54a  Middle 45.00a 2.12b 18.43a 4.30b  Top 43.00b 2.14a 17.24a 4.11c  SE± 0.32 0.014 3.25 0.01  LSD 0.63 0.01 86.21 0.01  Means with the same letter in the same column are not significantly different at (P<0.05)level of probability |

Location of seed in fruit significantly (P<0.05) affected the germination percentage as indicated in Table 2. The base had a significantly highest (P<0.05) germination percentage after the followed by the middle but lowest at the top. The best and better germination percentage values associated with the base and middle respectively are traced to greater dry matter accumulation which can likely give the seeds upper hand over the top seeds.Location of seeds in fruit insignificantly affected germination speed among the ‘base’, ‘middle’ and ‘top’ seeds. Germination speed were statistically similar as evident in table 2.

Location of seed in fruit significantly (P<0.05) affected the electrical conductivity of seed as it is observed on table 2.The ‘top’ seeds had a significantly highest (P<0.05) leachate than those from the ‘base’ and ‘middle’. This suggests that the top seeds were of lesser quality than the basal and middle seeds right from the time of harvest. .Kennya, *et al.* (2012) explained that electrical conductivity is based on the principle that low conductivity (lower output seed leachate) means a high-quality seed while high-conductivity references greater output seed leachate, suggesting lesser quality

**Table 2: Effects of location of seed in fruit on the germination percentage, germination speed and electrical conductivity of seeds of LD88 variety of okra**

Treatments Germination percentage Germination speed (days) E C Test (ms/cm

Base 69.63a 3.87a 247.26b

Middle 67.70b 4.00a 234.36c

top 64.70c 4.00a 269.57a

SE± 0.33 0.35 3.18

LSD 0.67 0.69 6.33

Means with the same letters in the same column are not significantly different at (P<0.05) level of probability

CONCLUSION

Considering the results of this research work carried out using the LD88 varieties of okra, the conclusion can be drawn based on the fact that seed-filling was greater in seeds extracted from the base and middle part of the fruit than those from top locations of the fruit. This was clearly observed from the 100-seed weight where the basal and middle seeds had significantly higher values than those from the top. In addition, germination percentage significantly favoured the basal and middle seeds than those from the top location of the fruit. Electrical conductivity values of the seeds also indicated lesser quality of the top seeds than those from the base and middle. It is therefore recommended that the extraction of okra seeds to be sown as the next season cropping should be restricted to the base and middle location of the pod for better viability and vigour.

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## MORPHOLOGICAL AND SEEDS DIVERSITY IN DRUMSTICK PLANT (*Moringa oleifera Lam.)* GERMPLASM FROM NORTHERN NIGERIA

N.M. Ndayankpa\*, A.O. Falusi, O.A.Y. Daudu, M.O. Adebola & A. Abubakar

Department of Plant Biology, Federal University of Technology, Minna, Nigeria.

\*Corresponding author: [nafisatndayankpa@gmail.com](mailto:nafisatndayankpa@gmail.com), +2349062216117

ABSTRACT

Genetic diversity within and among accessions of Moringa oleifera in Northern Nigeria was evaluated to determine the level of variability its exploiting in breeding and genetic improvement programs of plant. Collection and characterisation of the crop germplasm from the major cultivated states in Nigeria was carried. Evaluted for morphological was done using a Randomised Complete Block Design (RCBD) with replicate three each. A total of 34 accessions were collected with high significant (P < 0.05) variability observed in seed length, days to emergence, plant height and number of branches per plant. The seed length ranged from 1.02 cm to 1.44 cm while days to emergence varied from 5.00 to 10.00 days. The highest plant height and number of branches per plant were recorded in NGR-ZFR-16 at 2 month after emergence with the value of 94.87cm and 18.00 branches per plant. These highest values recorded in the accession was maintained in subsequent months signifying the superiority of the accession. Cluster analysis grouped the accessions into three major clusters based on their morphological similarity; three major groups, with cluster I consist 55.88% of the genotypes, 38.23% in cluster II, 5.88% in cluster III. The high variability recorded in the germplasm, indicate that the accessions and traits could be explored in the crop improvement.

**Keywords:** Crop improvement, Germplasm,Genetic variability, *Moringa oleifera*, Landraces,

INTRODUCTION

*Moringa oleifera*, also known as Drumstick tree, is a perennial flowering plant of the family Moringaceae, (Abdellatef and Khalafalla, 2010). It is cultivated in tropical regions and all over the world due to high protein, vitamins, mineral and carbohydrate content of entire edible parts of the plant; leaves, pod, stem and root (Ojuederie *et al*., 2013; Amao *et al*., 2017). *M. oleifera* play animportant role in dietary diversification and contribute to relief of hidden hunger in lessdeveloped and developing countries like Nigeria (Popoola and Obembe, 2013). In the northern parts of Nigeria where it is locally called Zogale among the Hausa speaking people, it is one of the vegetable which is fast gaining wide acceptance and cultivated. However, the plant is considered as is neglected and underutilized vegetable probably due to loss of local knowledge and lack of established varietiess with little or no research attention from agronomic researchers (Padulosi *et al*., 2013).

Understanding knowledge of genetic diversity has been reported to be one of the prerequisites for development of plant species conservation strategies (Rao and Hodgkin, 2002). Exploitation of the variability through germplasm evaluation and characterisation studies for key traits are essential not only for understanding the breeding value of the indigenous clandraces but also for isolating promising germplasm lines which could be used for the crop improvement (Abubakar *et al*., 2019). Thus, study on the nature and magnitude of the diversity in existing germplasm of drumstick *(M. oleif*era) in Northern Nigeria would enable the identification of accessions with superior characteristics for selection which could be used in further breeding program.

MATERIALS AND METHODS

Source of experimental materials

Seeds of *Moringa oleifera* were collected from 10 cultivated states in Northern Nigeria. Farmers’ fields and the local markets were visited for the collection of the germplasm. These accessions covered the accessible growing state (Bauchi, Benue, Jigawa, Kaduna, Kano, Nasarawa, Niger, Sokoto, Zamfara and FCT) in the Northern Nigeria. Mode of collections and geographical distribution were carried out as described by Popoola and Obembe (2013).

The accessions were evaluated for quantitative parameters using a Randomised Complete Block Design (RCBD) with each accession replicated three times. A total of 3 seeds per poly pot were sown for each accession at a spacing of 100 cm for both inter and intra rows. The seedlings were thinned to one plants per stand and transplanted on the field at four weeks after emergence. Weeding was done manually using hoe when necessary.

Data collection and analysis

Data were collected on quantitative traits base on standard procedures. Quantitative data such as seed length (SDD), day to emergence (DTA), plant height (PLH) and number of branches per plant (NBPP). Data collected on quantitative characters were subjected to analysis of variance (ANOVA) using the statistical package for social sciences, version 2020. Also, the quantitative characters were used for construction of dendrogram.

RESULTS

Morphological characterisation of the accessions showed that there were significant differences among the accessions at different time of the study period with different traits favouring different accessions. Seed length varied from 1.02 cm in NGR-YOB-31 to 1.44 cm in both NGR-ZFR-14 and NGR-KAD-17. These values were differed significantly from one another and from the value of all other accession. Significant earlies day to seedling emergence was 5.00 days obtained in NGR-BCH-11, NGR-ZFR-15 and NGR-ZFR-16, while the latest was 10.00 days in NGR-BEN-28 and NGR-SOK-33. These values were differed significantly from the value of all other accession. At two and six months after emergence (MAE), the highest plant were obtained from NGR-ZFR-16 (94.87 and 277.27) cm and followed by NGR-ZFR-15 (91.50 and 273.23) cm. These plants heights two MAE were not significantly different (p˃0.05) from one another but differed significantly from the height of all other accessions (Table 1.). The least plant height was recorded in NGR-SOK-33 during the study with the values of 57.00, 105.77 and 167.40cm at 2, 4 and 6 MAE, respectively. This value at 6 MAE was not significantly different (p>0.05) from all other accessions value.

The highest number of branches per plant at 2 MAE was recorded in NGR-ZFR-16 (18.00) and the least was obtained in NGR-FCT-07 an NGR-BEN-27 with the average value of 11.67. This highest value was not significantly different from 17.67 branch per plant obtained in both NGR-ZFR-15 and NGR-BCH-12. At 4 and 6 MAE accession NGr-BEN-12 had the highest number of branches per plant with the value of 41.67 and 60.33, respectively (Figure 1). Cluster analysis of the 34 collected accessions based on their similarity distance revealed that there was high diversity among the moringa accessions in terms of the morphological traits, with accessions from different states been clustered in the same group (Figure 2). On the basis of morphological similarity, the accessions were clustered into three major groups, with cluster I consist 55.88% of the genotypes, 38.23% in cluster II, 5.88% in cluster III and 28.57%. Cluster I was further sub-divided into two subgroups (Ia and Ib) with Sub-cluster Ia having accession 11 accessions Ib had 8 accessions. Accession NGR-SOK-33and NGR-BEN-28 were group together as a distinct accessions in cluster III (Figure 1).

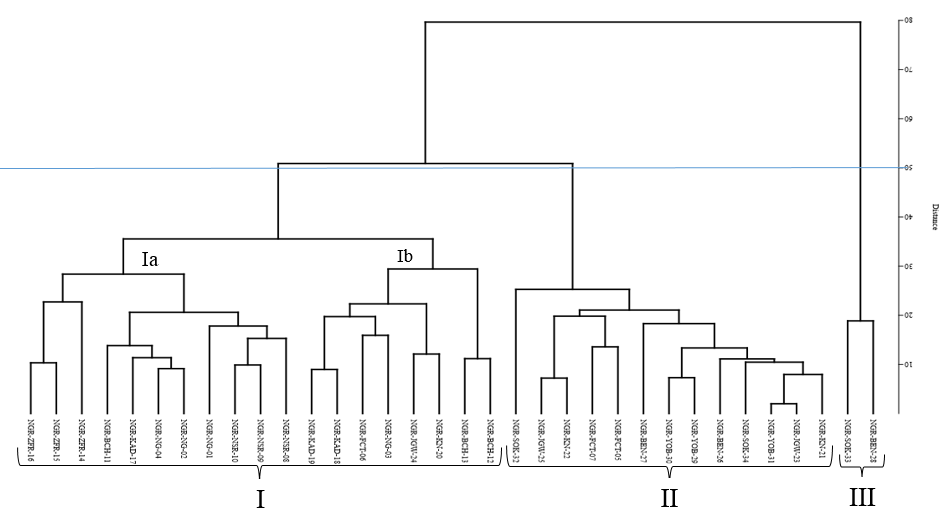
Table 1: seed length, seed emergence and Plant heights of *Moringa oleifera* germplasm from Northern Nigeria

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Parameters | State | Seed Length | Day to  Emergence | PLH2 | PLH4 | PLH6 |
| NGR-NG-01 | Niger | 1.36±0.02cde | 8.00±0.00def | 94.47±0.90i | 176.4±70.69jkl | 254.40±2.08a |
| NGR-NG-02 | Niger | 1.34±0.05bcde | 6.67±0.33abcd | 83.13±0.49ij | 170.17±1.30jk | 247.40±1.01a |
| NGR-NG-03 | Niger | 1.22±0.04abcde | 8.67±0.67def | 75.43±0.72efg | 154.20±1.04fgh | 227.70±0.80a |
| NGR-NG-04 | Niger | 1.36±0.04cde | 6.33±0.23abcd | 84.67±0.38ij | 165.43±0.38hij | 240.97±0.12a |
| NGR-FCT-05 | FCT | 1.20±0.05abcde | 8.00±0.00def | 68.17±0.12d | 143.60±0.83def | 214.23±1.10a |
| NGR-FCT-06 | FCT | 1.20±0.03abcde | 7.00±0.00bcd | 76.77±0.19gh | 168.77±0.28ijk | 232.97±0.63a |
| NGR-FCT-07 | FCT | 1.18±0.06abcde | 7.67±0.33cde | 77.33±0.24gh | 147.57±0.38efg | 221.70±0.87a |
| NGR-NSR-08 | Nasarawa | 1.44±0.05cde | 8.33±0.33def | 75.97±0.61efg | 166.70±1.44hij | 257.23±1.33a |
| NGR-NSR-09 | Nasarawa | 1.38±0.06cde | 7.00±0.00bcd | 87.47±1.42ij | 178.40±1.19kl | 267.07±1.61a |
| NGR-NSR-10 | Nasarawa | 1.40±0.04cde | 7.33±0.19bcde | 83.27±1.47ij | 171.77±0.90jk | 262.77±1.40a |
| NGR-BCH-11 | Bauchi | 1.32±0.11bcde | 5.00±0.00a | 79.60±1.06hi | 163.17±0.67hi | 251.270.52a |
| NGR-BCH-12 | Bauchi | 1.40±0.04cde | 5.33±0.33ab | 70.27±1.29efg | 148.00±1.57efg | 253.77±1.33a |
| NGR-BCH-13 | Bauchi | 1.38±0.04cde | 6.33±0.67abd | 60.43±3.20abc | 149.40±4.73efg | 249.56±5.07a |
| NGR-ZFR-14 | Zamfara | 1.44±0.05e | 5.67±0.33abc | 76.53±1.68gh | 168.67±2.34hij | 271.87±3.96a |
| NGR-ZFR-15 | Zamfara | 1.42±0.04de | 5.00±0.00a | 91.50±0.96j | 186.73±1.41L | 273.23±1.79a |
| NGR-ZFR-16 | Zamfara | 1.40±0.04cde | 5.00±0.00a | 94.87±0.18j | 177.87±0.62jkl | 277.27±1.16a |
| NGR-KAD-17 | Kaduna | 1.44±0.06e | 8.00±0.00def | 79.83±0.63gh | 161.50±0.55hi | 245.80±0.72a |
| NGR-KAD-18 | Kaduna | 1.40±0.07cde | 7.33±0.33bcde | 77.57±1.84gh | 164.53±2.22hi | 233.20±1.59a |
| NGR-KAD-19 | Kaduna | 1.38±0.04cde | 7.67±0.30cde | 72.47±0.77def | 166.83±1.52hij | 227.37±1.43a |
| NGR-KN-20 | Kano | 1.06±0.07ab | 8.33±0.67def | 61.40±1.30abc | 152.37±1.84fgh | 243.93±2.32a |
| NGR-KN-21 | Kano | 1.10±0.05abc | 7.33±0.33bcde | 74.93±0.59def | 142.50±0.93cde | 209.53±1.13a |
| NGR-KN-22 | Kano | 1.24±0.02abcde | 7.33±0.33bcde | 61.33±1.88abc | 140.37±1.43cd | 217.40±2.03a |
| NGR-JGW-23 | Jigawa | 1.14±0.06abcde | 8.00±0.00def | 75.67±0.33efg | 140.87±0.07cd | 208.67±0.88a |
| NGR-JGW-24 | Jigawa | 1.26±0.02abcde | 9.33±0.67ef | 64.33±2.91c | 155.50±2.64gh | 233.03±1.70a |
| NGR-JGW-25 | Jigawa | 1.22±0.07abcde | 9.33±1.33ef | 57.77±0.77ab | 139.33±0.35cd | 221.30±1.01a |
| NGR-BEN-26 | Benue | 1.14±0.07abcde | 7.33±0.67bcde | 72.33±1.29de | 136.93±0.61cd | 200.47±0.47a |
| NGR-BEN-27 | Benue | 1.20±0.04abcde | 7.67±0.33cde | 62.73±1.50bc | 129.13±2.01c | 205.47±0.80a |
| NGR-BEN-28 | Benue | 1.22±0.02abcde | 10.00±0.00f | 56.73±2.01a | 114.20±3.28b | 184.07±3.96a |
| NGR-YOB-29 | Yobe | 1.22±0.08abcde | 8.33±0.33def | 75.20±0.15efg | 135.73±0.37c | 213.20±0.31a |
| NGR-YOB-30 | Yobe | 1.12±0.10abcd | 7.67±0.29cde | 73.13±0.64def | 138.60±0.30cd | 217.00±1.00a |
| NGR-YOB-31 | Yobe | 1.02±0.06a | 8.67±0.33def | 76.07±1.21efg | 139.40±0.70cd | 208.67±1.34a |
| NGR-SOK-32 | Sokoto | 1.34±0.05bc | 7.67±0.31cde | 82.80±0.53ij | 154.27±1.83efg | 221.60±0.93a |
| NGR-SOK-33 | Sokoto | 1.34±0.08bc | 10.00±0.00f | 57.00±1.35a | 105.77±2.51a | 167.40±2.19a |
| NGR-SOK-34 | Sokoto | 1.24±0.07ac | 8.67±0.67def | 80.63±0.35hi | 140.30±0.21cd | 202.90±0.84a |

Means followed by similar alphabet letters are not significantly different by Student-Newman-Keuls (SNK)

Note: PLH2: plant height at 2 months after emergence; PLH4: plant height at 4 months after emergence; PLH6: plant height at 6 months after emergence

**Figure 1: Number of branches per plant of thirty four (34) *Moringa oleifera* accessions from Northern Nigeria.**



**Figure 2: UPGMA dendrogram on morphological traits of 34 *Moringa oleifera* (Lam.) accessions from northern Nigeria.**

DISCUSSION

Genetic diversity has been described as the amount of variability among individuals of a variety or population of species resulting from many genetic differences between individuals and may manifest in differences in DNA sequence, in biochemical characteristics like protein structure, in physiological properties like abiotic stress resistance or growth rate, orin morphological characters (Amao *et al*., 2017). The ranged of seed length recorded in this study falled within the ranged of 0.98 and 1.54 cm obtained by Ruiz-Hernández *et al*. (2021), and the average value 1.5 cm reported by Zhigila *et al*. (2015) and 1.16 of López *et al*. (2018). In agreement with 6 to 12 days to emergence reported by Onyekwelu and Olabiwonnu (2010) 5 to 10 days was recorded in the study.

The high significant differences recorded in plant height and number of branches among the accessions studied with different accessions been identified as sources for specific traits of interest, demonstrate that adequate variability exist in the germplasm. Similarly, Saini *et al*. (2013) has attributed the diversity in Indian *M. oleifera* cultivars to the spread of the planting material and gene flow in high rates through cross pollination. These variabilities observed could be attributed to the cross-pollination nature of the plant. In line with this results several works have reported high variability in morphology of the plant (Hassanein and Al‑Soqee, 2018).

Grouping of the accessions into four clusters with each cluster group containing accessions from different state and source, indicate that there was no association between pattern of clusters and geographical distribution of accessions. Similar to the findings obtained in this study Shahzad *et al.* (2013) suggest that that the grouping of the accessions is an indication of multiple ancestral populations of *M. oleifera* within close geographical regions must have been introduced to other parts of the world.

CONCLUSION

The study confirmed that considerable high variability exists among the landraces of *M. oleifera* in the country. Clustering of the genotypes independent of the state or source of collection suggested that, hybridizing the genetically diverse parents of the crop belonging to different clusters of could provide an opportunity for bringing genes of diverse nature together for it improvement.

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## EFFECT OF VARIETY AND INTRA-ROW SPACING ON GROWTH AND YIELD CHARACTERS OF HYBRID MAIZE (*Zea mays*) IN FCT

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| U. A. Ekwere; M. O. Akinyele; O.C. Ogunremi; R. I. Joseph; D.A. Adeshina and S.E. Adeboye  Agricultural Biotechnology Department, National Biotechnology Development Agency, (NABDA) Umaru Musa Yar’dua Express way, Lugbe - Abuja, Nigeria.  \*Corresponding author email: uwemakpan016@gmail.com  Mobile: +2348035618117 |

ABSTRACT

*This study was carried out at the Research Farm of the Faculty of Agriculture, University of Abuja in the Southern Guinea Savanna Zone of Nigeria, during the cropping season of 2019 to evaluate the effect of variety and intra-row spacing on growth and yield characters of hybrid maize in Federal Capital Territory (FCT). Two hybrid maize varieties Dekalb920 and Dekalb 818 sourced from National Seed Council of Nigeria were evaluated under five different intra-row spacing’s of 14, 18,21,25and 30cm, with gross plot of 15m and net plot 0f 9m and Parameter such as plant height, leaf area index, stem diameter and yield were evaluated. It was a factorial combination experiment laid out in a Randomized Complete Block Design (RCBD) with three replicates. Data collected were subjected to Analysis of Variance (ANOVA) and means were separated using Duncan multiple range test. The results obtained from the experiment 12th weeks after sowing indicated that hybrid variety Dekalb 920 had mean plant height of 273.06cm, leaf area index of 14.03cm2 and yield of 8.0t/ha among other parameters was superior to Dekalb818 variety investigated. With respect to intra-row spacing, plants sown on 14 cm had higher plant height and leaves area index of 287.7 cm and 14.03cm, respectively while plants sown on intra-row spacing of 30 cm had plant height of 268.0 cm2 and leaves area index of 11.57 respectively. The result showed that Variety and Intra-row spacing had significant influences on the growth parameters, yield and yield components of maize. The result also indicated that variety Dekalb 920 was the more suitable of the two maize varieties tested, and 14cm and 25cm intra-row spacing was better to achieve optimum yield in Federal Capital Territory (FCT)*

**Keywords:**Maize; varieties; spacing; growth; yield;

INTRODUCTION

Maize (*Zea mays* L.) is the world's largest cultivated cereal crop with over 872 million metric tons (MT) produced in 2012 (FAO, 2016), and one of the most important cereals used for food and feed production (IITA, 2006). The use of maize as staple food is as follows: 78% for human consumption, 17% for feed and residual uses, and about 5% for re-planting (United States Department of Agriculture USDA). Maize is produced in all the agro-ecological Zones of Nigeria except in the Sahel Savannah. The largest area of production is the Northern Guinea Savannah (Manyong *et al*., 1996). Twenty-two states in Nigeria including the Federal Capital Territory (FCT) have high production rate of maize in which 17 out of the 22 states are in the Northern part of the Country and their high production of maize are rated in three categories as in medium to high potential in production (Olaniyan, 2002).

Spacing is one of the important factors that affect corn yield and due to its genetic potential; corn yield is different under various plant populations (Abuzar *et al*., 2011). According to the Sangoi (2001) there is no specific optimum population density for all the weather conditions since it differs based on environmental and controlled conditions Low plant density causes minimum corn yield due to the leaf area’s little plasticity in each plant (Lashkari *et al*., 2011). Therefore, the objective of the experiment is to compare the performance of the varieties of maize used in this trial as influenced by the different intra- row spacing.

MATERIALS AND METHODS

The experiment was conducted at the Research Farm of the Faculty of Agriculture, University of Abuja, in the Southern Guinea Savanna Zone of Nigeria, during the cropping season of 2019.

The Experimental land was mechanically ploughed using a tractor mounted disc plough, and then harrowed twice to break the soil clods. Most of the debris was ploughed back into the soil then the experimental plots were laid out using measuring tape and pegs. The Planting materials used for the trial were two varieties of maize Dekalb 920 and 818. The maize varieties were obtained from National seed council of Nigeria. Abuja.

The experimental treatments were 5 different intra-rows spacing of 14cm (B1), 18cm (B2), 21cm (B3), 25cm (B4), and 30cm(B5) by 75cm inter row spacing and two maize varieties. Dekalb920 (A1) and Dekalb 818(A2) Thus, a 2 x 5 factorial combination trial was used for the treatments and making a total of 10 treatment combinations. Randomized Complete Block Design (RCBD) with 3replications was adopted. Factorial arrangement was used in organizing the treatments which were fitted into the Design Each replicate contained 10 plots, of 3m×5m sizes giving 15m2 gross plot and 9m2 net plot and separated by 1m allay pathway. Thus a total of 30 plots were used for the experiment.

Sowing of one seed per hole was done on the 22nd July 2019.The various plant spacing gave the different plant populations. Maize seeds were sown at depth of 3cm in plots measuring 5m x 3m using five different spacing’s listed above. Fertilizer and weed control practices was done appropriately. Agronomic parameters taken includes plant height (cm), leave area index, stem diameter (cm), plant stand count, number of days to 50% tasseling and silking and grain yields (tons/ha).

Data collected were subjected to Statistical analysis for Analysis of Variance (ANOVA) using SAS – Statistical Analytical Structure procedure and the means were separated using Least Significant Difference (LSD)

RESULTS

The results showed that variety and spacing were significantly (P< 0.05) different throughout the period of evaluation and positively affected the stand count. The effect of intra-row spacing on the stand count of two maize varieties Dekalb 920 and Dekalb 818 is shown in Table 1. The two varieties gave statistically similar percent stand count in respect to the intra-row spacing however, varying intra-row spacing shows significant differences in emergence of two maize varieties. Spacing 14 cm gave the highest count stand while 30 cm gave the least stand count of maize.

There were significant differences also in the plant height of the maize varieties investigated. Variety 920 gave taller plants of 287.7 cm at 9th weeks after sowing, followed by 818 with height of 281.7cm. With respect to spacing, maize plants sown at 14 cm in 2019 gave taller than other plants spacing during the 9th weeks with height of 287.7 cm and 281.7cm for variety one and two respectively at 9thweeks. These were followed by plants sown at 18cm; 21cm and 25cm. Plants sown at 30cm were the shortest. The results showed that variety and spacing were significantly (P<0.05) different throughout the period of the evaluation and positively affected plant height. Varietal differences did not result in significant differences in LAI in the evaluation. Varying spacing caused significant differences in LAI, with each decrease in spacing significantly increasing LAI in sampling period. The results showed that variety and spacing were significantly (P < 0.05) different and positively affected leaf area index of maize.

Variety 920 had the highest stem girth of 11.20cm, while variety 818 had 11.00cm at 9th week after sowing. Based on spacing, maize plants sown at spacing of 30 cm were superior in stem girth while plants sown at spacing of 14 cm had the smallest stem girths. The results showed that variety and spacing were significantly (P < 0.05) different and positively affected stem girth of maize.

Table 1: Effect of variety and intra-row spacing on Stand Count/Plot, Plant Height (cm), leaf Area Index, Stem Diameter, Days to 50% tasselling and Grain yield (t/ha) of maize

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Spacing (cm)** | **Stand Count/**  **Plot** |  | **Plant Height (cm)** |  | **leaf Area Index** |  | **Stem Diameter**  **(cm)** |  | **Days to 50% tasselling** |  | **Gain yield (t/ha)** |  |
| **Variety 1** | **Variety 2** | **Variety 1** | **Variety 2** | **Variety 1** | **Variety 2** | **Variety 1** | **Variety 2** | **Variety 1** | **Variety 2** | **Variety 1** | **Variety 2** |
| **14** | **138.67** | **139.67** | **287.7** | **281.7** | **14.03** | **13.77** | **8.2** | **8.03** | **56.67** | **56.33** | **7.7** | **7.33** |
| **18** | **107** | **108** | **275.3** | **275.7** | **13.07** | **13** | **8.7** | **8.57** | **56.67** | **57.33** | **6.3** | **7.27** |
| **21** | **94** | **92.33** | **272.7** | **271** | **12.5** | **12.33** | **9.13** | **9.03** | **57.33** | **56.33** | **6.63** | **6.27** |
| **25** | **75.33** | **76** | **275** | **266** | **12.2** | **12.13** | **9.77** | **9.5** | **56.67** | **57** | **8** | **7.13** |
| **30** | **64.67** | **63** | **268** | **260.3** | **11.57** | **11.4** | **10.33** | **10.23** | **56.67** | **56.33** | **6.03** | **5.33** |
| **Grand Mean** | **88.67** | **88.67** | **273.06** | **267.7** | **12.44** | **12.29** | **9.56** | **9.39** | **56.67** | **56.67** | **6.77** | **6.61** |
| **LSD**  **(α <0.05)** | **2.95** | **2.88** | **7.53** | **10.11** | **0.18** | **0.45** | **3.07** | **2.63** | **0.99** | **0.81** | **1.12** | **0.94** |

**Means with the same letter in a column of each factor are not significantly different at (P ≤ 0.05), LSD = Least Significant Difference, V1= Dekalb 920, V2 = Dekalb 818**

There was no significant difference between Dekalb 920 and 818 maize varieties on number of days to 50% tasseling and silk. The results showed that variety and spacing were not significantly (p > 0.05) different.

The analysis revealed that the effect of variety and intra-row spacing and the plant density was significant (P < 0.05) for grain yield as shown in (table 9). Mean comparisons showed that Dekalb 920 maize variety at 25cm spacing had the highest yield of (8.00ton/ha average) and was followed by 14cm spacing which had (7*.*7*0* ton/ha average) which was due to grain weight. Also, Dekalb 818 variety at 14cm spacing had the third highest yield (7.33ton/ha average) and was followed by 18cm spacing which had (7*.*27ton/ha average). The result shows that the two varieties at 14cm intra- row spacing had a higher grain yield compared to the 30cm intra- row spacing which means that the trend of changes in the two maize varieties to row spacing was similar and positively affected grain yield of maize.

DISCUSSION

The differential growth with respect to plant height observed among the two varieties may be attributed to differences in genetic characteristics of the individual varieties, including rapid growth rates, tallness or shortness of the varieties. This is similar to the findings of Ibrahim *et al.* (2000) that attributed the differences in growth indices of crops to genetic constitution. Maize plants spaced 14cm intra-row spacing was taller than other plants possibly because of increased competition for space, sunlight and available nutrients. It is also consistent with the reports of Al-Rudha and Al-Youmis (1998) that maize sown at 15cm had the highest plant height compared with their counterparts sown at wider intra-row spacing. The increase in plant population with the decrease of plant spacing obtained in this study is obvious since plant spacing is used as a tool to increase or decrease plant density. These results were supported by Roy and Biswas (1992) who reported that, narrow plant spacing had resulted in high plant population.

The highest leaf area index obtained in 14cm intra-row spacing by the two varieties in this study could be due to variation in environmental factors, influenced by genotype, plant population, climatic condition and soil fertility. Higher plant population produced which offset the effect of large leaf area produced at 30cm intra-row spacing. This result is supported by Winter and Ohlrogge (1973) who reported that leaf area index increased with the increase of plant population. The comparison of means indicated the maximum of days to 50% tasseling (57 days) was recorded in all intra-row spacing. Gungula *et al.* (2003) suggested that increase in plant density might have increased the rate of photosynthesis and delayed pheno­logical characteristics such as tasseling in maize. Amanullah *et al*. (2009) reported that, plots maintained at high density took slightly more time to tasseling and physiological ma­turity than the plots maintained at low density.

The superiority of Dekalb 920 maize variety over Dekalb818 maize with respect to grain yield may be attributed to the special qualities credited to the hybrids, including disease resistance, early maturity, uniformity in flowering and ear-placement, and very high yield and the genetic make-up of the Variety. This is similar to the findings of Udoh (2005) who reported that, some hybrid maize varieties have yield advantage over other maize varieties because they possess such special qualities as high yield, disease resistance, and early maturity, uniformity in flowering and ear placement. Maize plants sown at spacing of 25cm were superior in grain yield and closely followed by maize sown at spacing 14cm. However, the higher grain yield obtained at closer intra-row spacing (25cm and 14cm), could be attributed to higher number of plants and harvestable cobs at optimum spacing. This result was in conformity with the findings of Okan *et.al.* (2004) that obtained highest grain yield from closest intra-row spacing of 20cm.There was no significant differences in yield ha-1 between the two varieties.

CONCLUSION AND RECOMMENDATION

The result of present study showed that Variety and Intra-row spacing had significant influences on the growth parameters, yield and yield components of maize. The result also indicated that variety Dekalb 920 was the more suitable of the two maize varieties tested, and 14cm and 25cm intra-row spacing was better to achieve optimum yield in FCT

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## RESPONSE OF HYBRID LINES OF SWEET POTATO TO THE APPLIED PLANT EXTRACTS, WOOD ASH AND NPK FERTILIZER IN ABUJA, NIGERIA

R. I. Joseph; M. O. Akinyele; O. C. Ogunremi; U. A. Ekwere; S. E. Adeboye; D. A. Adeshina and O. E. Akpan

Agricultural Biotechnology Department, National Biotechnology Development Agency, (NABDA) Umaru Musa Yardua Express Way, Lugbe - Abuja, Nigeria

Corresponding author: akroseline85@yahoo.com

ABSTRACT

The study, conducted to determine the response of hybrid lines (UMOSPO 1 and KWARA) to the applied plant extracts (Moringa oleifera), wood ash and NPK fertilizer was conducted at the Teaching and Research farm of National Biotechnology Development Agency, Abuja - Nigeria. Factorial treatment arrangement fitted into Randomized Complete Block Design with 3 replications was used and the results showed that the status of some basic elements, (N, P, K, Mg and Ca) was significantly enhanced especially in the plots that received Moringa extract and wood ash. Soil pH of the plots that received wood ash increased from 5.2 to 6.7 while those given Moringa extracts increased from 5.2 to 5.8 irrespectively of varieties of sweet potato. Stand count of the stands per plot before harvest showed that stands amended with various treatments were higher than that of the control plots by the following percentage, Moringa extract (20%), NPK (18%), and wood ash (12%) respectively. When compared with the yield from control plots, plots amended with Moringa extract produced 74% more root yield than the control, wood ash by 58%, and NPK fertilizer by 70% respectively. While stands of sweet potato treated with Moringa leave extract produced significantly, (p< 0.05) greater number of marketable roots, those that received NPK fertilizer produced more unmarketable roots followed by those in the control plots in terms of severity of infection by Cylas weevils on the storage roots, stands treated with Moringa extracts showed very mild symptoms while those applied with wood ash showed moderate symptoms but roots from NPK Fertilizer amended plots and the control plots showed severe symptoms of infection.

**Keywords:** Sweet potato; Wood ash; Moringa leaf extract; NPK fertilizer; Cylas weevil

INTRODUCTION

Sweet potato [*Ipomoea batatas* (L.) Lam.] is one of the world’s most important food crops, with annual production which amounted to approximately 89.5 million metric tons (FAO, 2019). Of the staple food crops grown, including cassava, rice and maize, sweet potato is the crop with the highest potential for commercial exploitation (Kenneth, 2009). The crop is the fifth most important food crop after rice, wheat, maize and cassava (FAO, 1998) and an important food and vegetable crop that grows throughout the world, especially in the tropics and warm tropical areas for its edible tubers. Although, sweet potato is not usually regarded as source of protein, but it contributes 3.40% to total protein intake compared with 4.5%, 4.8% and 5.8% contributed by eggs, fish and cheese respectively (Wolfe, 1992).

Many studies have suggested that increasing consumption of plant foods like sweet potatoes decreases the risk of obesity, diabetes, heart disease and overall mortality while promoting a healthy complexion, increased energy, and overall lower weight (Ewell and Mutuura, 1991). In addition, sweet potato skin contributes significant amounts of fiber, potassium and quercetin, (Ewell and Mutuura 1991).

One of the most limiting factors in sweet potato production has been lack of desirable varieties. Currently the problem seems to have been taken care of by the production of highly advanced breeding Lines capable of producing more than 30 tones ha 1, by Agricultural research Institutions such as National Root Crop Research Center, Umudike. Unfortunately, most of these high yielding varieties are highly susceptible to the weevil known as, *Cylas*. *Cylas* spp is a very serious pest of sweet potato, especially the orange-fleshed varieties (Fig 1 and 2). They feed on the tubers of the sweet potato, leaving behind numerous small black holes on the affected tubers which render its qualities - eating and market, useless.

The study is intended to achieve the following objectives.

1. To compare the effects of the plant extracts, wood ash and chemical fertilizer on the soil properties and the yield of the varieties of sweet potato used in the study.
2. To determine whether the plant extracts and wood ash would be suitable alternatives to chemical fertilizers in the production of sweet potato.

MATERIALS AND METHODS

The study, conducted to determine the response of hybrid lines (UMOSPO 1 and KWARA) to the applied plant extracts (*Moringa oleifera*), wood ash and NPK (20:10:10) fertilizer was conducted at the Research farm of National Biotechnology Development Agency in 2018 cropping season, along Airport Road, Abuja, Nigeria. Abuja, the Federal Capital Territory, is located in the Guinea Savannah of the West Africa. The sweet potato vines UMOSPO 1 and KWARA were sourced from National Root Crop Research Institute Umudike, Nigeria. The varieties used are high yielding and have been under Pre – Release evaluation for recommendation to farmers in Nigeria. These varieties constitute factor A (UMOSPO 1 (A1) and KWARA (A2) while Factor B; wood ash (B1), *Moringa* leaves extracts (B2) NPK20:10:10(B3) control (B4), thus a 2x4 factorial combination, making a total of 8 treatment combinations was used. Randomized Complete Block Design with 3 replications was used. Factorial arrangement was used to organize treatments which were fitted into the design. Each replicate contained 8 plots and Plot size was 3m x3m and planting spacing was 1m x 0.3m. Plant population per plot was 30 stands and inter plot spacing was 1m. During planting, 2/3 of the length of each vine (20cm long) was inserted into the soil, at an angle of 60o. The soil around the vine was firmly pressed to ensure proper contact of the vine with the soil for easy establishment. First weeding was done three weeks after planting using hoes and fertilizer NPK 20:10:10 was applied after weeding, at the rate of 400kg per hectare. A plot received 360g of N.P.K fertilizer. Thus, each ridge received 120g of N.P.K 20:10:10 fertilizer. Two times weeding was done before the vine leaves covered the ground surface, suppressing weed in the process.

**Data collected were.**

Stand count at harvest, mean marketable (> 150g) root weight (kg/plot), mean unmarketable root weight (kg/plot), mean number of marketable roots per plot, mean number of unmarketable roots per plot, mean root *Cylas* weevil incidence (i.e. total number of roots with *Cylas* weevil),

Mean root *Cylas* weevil severity score, where

1 = All tubers clean of *Cylas* damage across the plot

2. = <20% of each tuber in the plot damaged

3. = 21 – 50% of each tuber in the plot damaged

4. = 51 – 80% of each tuber in the plot damaged by *Cylas*

5. = >80% of each of the tubers in a plot damaged

Soil analysis data collected were subjected to analysis of variance (ANOVA) using Duncan Multiple Range Test to separate means.

RESULTS AND DISCUSSION

Result Tables

Table 1: Pre – planting Soil Physicochemical properties of the experimental site

**Parameters Before Planting**

pH in water (1:2.5) 5.2

% Organic matter 0.52

Total Nitrogen 0.43

P (ppm) 10.3

K (Cmol kg-1) 0.47

Mg (Cmol kg-1) 2.38

Na (Cmol kg-1) 1.44

Clay (%) 36.6

Silt (%) 16.9

Sand 41

Table 2: Mean Root yield and Yield Components of selected sweet potato used

**Varieties Application Stand Marketable Unmarketable Root**

**Count/plot Roots/plot Roots/plot Yield/t ha-1**

UMOSPO 1 wood ash 24cd 23.4cd 10.3e 7.5g

UMOSPO 1 *Moringa* extracts 28a , 38.5a 8.2e 19.3b

UMOSPO 1 NPK20:10:10 25bc 20.9d 21.1b 17.2c

UMOSPO 1 control. 20e 6.5i 16.2c 3.5h

KWARA wood ash 24cd 26c 5.3f 10.2f

KWARA *Moringa* extracts 28a 38.2a 5.2f 21.8a

KWARA NPK20:10:10 27a 20.7e 26.3a 21.6a

KWARA control. 20e 8.4i 15.6c 3.1h

DMRT (P>0.05)

Table 3: Severity of infestation of *Cylas* weevil on the Storage roots of the Selected Sweet Potato.

**Varieties Application No. of Roots with Severity Score**

***Cylas* weevil/plot**

UMOSPO 1 wood ash 8.3 3

UMOSPO 1 *Moringa* extracts 5 2

UMOSPO 1 NPK20:10:10 18 4

UMOSPO 1 control. 14 4

KWARA, wood ash 4 2

KWARA *Moringa* extracts 4 2

KWARA NPK20:10:10 17 4

KWARA control. 12 3

Mean SPVD severity score at 10 weeks after planting where

1. = No visible SPVD symptoms on all plants in the plot
2. = Very mild symptoms on infected plants
3. = Moderate symptoms on infected plants
4. = Severe symptoms on infected plants and
5. = Very severe symptoms on infected plants (plants are stunted, leaves shriveled)

**Fig 1:** *Cylas formicarius* **Figure 2:** Storage damage caused by *Cylas* spp

Table 4: Post-harvest Soil Properties on the response of sweet potato hybrids used

**Varieties Application Physical properties Elements %organic matter**

Clay Silt Sand pH N P K Mg % ppm <-cmolkg-1->

UMOSPO 1 wood ash 38 18 43 6.7 0.12 12.4 0.57 2.61 0.43

UMOSPO 1 *Moringa* extracts37 18 40 5.8 0.41 8.6 0.51 2.37 0.58

UMOSPO 1 NPK20:10:10 37 17 40 4.8 0.53 14.7 0.51 1.88 0.37

UMOSPO 1 control. 38 17 40 4.5 0.21 9.5 0.34 1.10 0.11

KWARA wood ash 38 18 41 6.6 0.48 10.2 0.48 1.43 0.36

KWARA *Moringa* extracts38 18 40 5.8 0.48 8.5 0.44 1.18 0.46

KWARA NPK20:10:10 38 18 40 4.8 0.55 13.6 0.53 1.34 0.27

KWARA control. 38 18 41 4.6 0.24 5.6 0.33 0.74 0.28

Table 1 shows the fertility status of the experimental site determined before the commencement of the experiment. The result indicates that the soil fertility was relatively poor and that may be attributed to the continuous cropping in the area as indicated by the cropping history. The site was under one year fallow following a two-year Okra trial. Esu, (2010) classified the soil in the area as Alfisols, well drained and strongly acidic giving credence to the pre-planting soil analysis that showed a soil pH value of 5.2.

However, after the experiment, Postharvest soil analysis showed that the status of some basic elements, (N P K Mg Ca) was significantly enhanced especially in the plots that received a *Moring*a extract and wood ash (Table 4). Percent nitrogen and phosphorus were relatively higher in plots that were given NPK fertilizer. The large concentration of phosphorus in the NPK amended plots may be due to the immobilization of the element due to low soil pH. Soil pH was significantly improved with the application of wood ash and *Moringa* extracts respectively. The pH of the plots that received wood ash increased from 5.2 to 6.7 while those given *Moringa* extracts increased from 5.2 to 5.8 irrespective of varieties of sweet potato. Onwuka e*t al.,* (2009) reported that application of wood ash improved the soil pH level thereby creating conducive environment for healthy plant growth. Enhanced pH values tend to increase the Cation Exchange Capacity of the soil. Under this situation the basic cations are significantly available to the plant for their nutrition. Thus the enhanced performance of the varieties of potato that were given wood ash and *Moringa* extract respectively might partly be due to improved soil pH. *Moringa* has been reported to significantly improve soil fertility if used as a green manure, (Davis 2000). In control plots, the pH decreased from 5.2 to 4.6 and from 5.2 to 4.8. Inorganic fertilizers are known to increase the hydrogen ion concentration in the soil thereby reducing the soil pH drastically. Owolabi *et al.,* (2003) further added that at lower pH values, potatoes can suffer from aluminum and other heavy metal ion toxicity, as well as restricted P or Mo availability. In this study, the values of sodium ions increased as the soil pH decreased (Table 4), giving credence to the reports of Onwuka *et al.,* 2009. Concentration of sodium ions is known to be detrimental to crop growth and development. The physical properties of the soil remained fairly the same even after the trial.

Table 4 showed the yield and yield component of the selected varieties of sweet potato as influenced by *Moringa* leaf extract, wood ash and NPK fertilizer. Stand count of the stands per plot before harvest showed that stands amended with various treatments were higher than that of the control plots by the following percentage, *Moringa* extract (20%), NPK (18%), and wood ash (12%) respectively. Thus, crop survival was more in plot amended with *Moringa* extracts than others. Phiri, (2003) pointed out that *Moringa oleifera* leaves have high zeatin content. Zeatin is a plant growth hormone from the cytokynesis group. It plays an important role in cell division and cell elongation (Taiz and Zeiger, 2000), thus improving crop growth and yield.

Generally, application of the various treatments significantly (P>0.05) improved the root yield of the varieties of potato selected in this study. High root dry matter (DM) content (25.5% and above) is preferred in the Sub-Saharan Africa especially in Nigeria because of the various food preparations that sweet potato is generally used for. When compared with the yield from control plots, plots amended with *Moringa* extract produced 74% more root yield than the control, wood ash by 58% and NPK fertilizer by 70% respectively. While stands of sweet potato, irrespective of varieties, treated with *Moringa* leave extract produced significantly (p< 0.05) greater number of marketable roots, those that received NPK fertilizer produced more unmarketable roots followed by those in the control plots. In Zambia, Moringa has been reported to increase crop growth and yield, (Foidl, *et al.,* 2001). *Moringa* accelerates rate of young plants, strengthens plants, prolongs life span, increases number of roots, stems and leaves, produces more and large fruits and generally increased yield by 20 – 35%, (Fugile, 2000).

Irrespective of treatments applied, UMOSPO1 performed relatively higher compared to the local variety, Kwara. In terms of severity of infection by *Cylas* weevils on the storage roots, stands treated with *Moringa e*xtracts showed very mild symptoms while those applied with wood ash showed moderate symptoms but roots from NPK Fertilizer amended plots and the control plots showed severe symptoms of infection. Fugile, (2001) reported that *Moringa* extracts improve resistance to pests and diseases.

CONCLUSION AND RECOMMENDATION

Irrespective of application, UMOSPO1 was higher in terms of yield. Also, Moringa and wood ash gave a better post soil quality and Cylas symptoms was very mild to zero effect, thus, farmers can adopt this practice.

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## DETERMINATION OF IRON AND ZINC CONTENTS OF RICE VARIETIES AND LAND RACES IN NIGERIA USING ATOMIC ABSORPTION SPECTROMETRY ANALYSIS (AAS)

Ayeleke, D. A\*1., Gana, A. S2., Salaudeen, M. T2 and Falusi, M. O2.

1Federal Department of Agriculture, Federal Ministry of Agriculture and Rural Development, P.M.B. 135, Garki, Abuja

2Department of Crop Production, Federal University of Technology, P. M. B. 65, Minna, Niger State, Nigeria

\*Corresponding author: ayelekedaud@yahoo.com  +2348039404680

ABSTRACT

Reliable information on the Iron (Fe) and Zinc (Zn) content in rice varieties is crucial to developing an effective breeding program to produce micronutrients dense food through biofortification. The development of elite and superior rice progenies combining high yield with high Fe and Zn content would offer a practical solution to combat nutritional problems affecting the burgeoning populations in Africa. In this study, therefore, 61 rice genotypes (comprised of 48 released varieties and 13 landraces) were screened to determine their Fe and Zn status. The screening exercise was conducted in the Laboratory of the Department of Biotechnology, National Cereals Research Institute (NCRI), Badeggi, Niger State, Nigeria in March 2020. The experiment involved the preparation of samples, wet digestion and determination of Fe and Zn content using an Atomic Absorption Spectrometry machine (AAS- WIN 500 PG INSTRUMENT). The results obtained showed significant variability in the content of Fe and Zn in all the samples tested. The majority of the released and commercial and commonly cultivated varieties such as FARO-44 (Fe: 1.614, Zn: 1.708), FARO-52 (Fe: 1.373, Zn: 2.041) and FARO-67 (Fe: 1.494, Zn: 1.920) contained very low Fe and Zn content. While NGB 00782 and FARO 27 with outstanding Fe content of 6.675 mg kg-1 are good sources of Fe, NGB 00791 (6.697 mg kg-1) and FARO- 49 (6.159 mg kg-1) appeared to be best for Zn.

**Keywords:** Rice; iron, zinc, atomic absorption spectrometry

INTRODUCTION

Rice which is consumed as a staple food in one form or the other by people globally regardless of their social status is a poor source of essential micronutrients such as iron (Fe) and zinc (Zn) (Mallimar et al., 2017). While Fe is an essential component of blood, Zn is the main co-factor of several vital enzymes required by the human body to function well (Swamy et al., 2018). Thus, an average adult has 3–4 g of iron and 1.5–2.5 g of zinc in the body (Karen et al., 2013).

Zinc being a vital cofactor for several enzymes and regulatory proteins performs a significant function in the synthesis of DNA and RNA as well as the expression of genes ([Garcia-Oliveira](https://www.ncbi.nlm.nih.gov/pubmed/?term=Garcia-Oliveira%20AL%5BAuthor%5D&cauthor=true&cauthor_uid=30013590) et al., 2018). Since Zn controls Fe absorption in the intestines, its deficiency tends to be significantly related to anaemia induced by a lack of Fe in the body (Graham et al., [2012](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6036604/#B39)). Studies also revealed that globally, mortality of nearly 500,000 children (<5 years of age) is recorded annually due to Fe and Zn deficiencies (Black et al., 2013).

Cereal crops and meat are the two major sources of human beings who derive iron and zinc (Karen et al., 2013).

****MATERIALS AND METHODS****

****Collection of the screening population****

Seeds of rice genotypes used for this experiment include FARO 4, FARO 15, FARO 16, FARO 17, FARO 19, FARO 20, FARO 21, FARO 22, FARO 24, FARO 27, FARO 31, FARO 32, FARO 33, FARO 34, FARO 37, FARO 38, FARO 41, FARO 44 (SIPI), FARO 45, FARO 49, FARO 51 (CASIDANE), FARO 52, FARO 56 (NERICA-2), FARO 57 (TOX 4004), FARO 58, FARO 61, FARO 62, FARO 63, FARO 64, FARO 65, FARO 66, FARO 67, NCRO 48, NGB 00773, NGB 00775, NGB 00777, NGB 00778, NGB 00779, NGB 00781, NGB 00782, NGB 00783, NGB 00784, NGB 00786, NGB 00789, NGB 00791, NGB 00794, NGB 00827, NGB 00887, THAI JEMEELA, N/ATIME-EJU, N/GORKOCHA, N/MAI-ALURI INJECTION, N/TUDU GAMBO, N/ CHINA CARGO, N/ DOGO-BURI, N/ BIDA ALASKA, N/JANKARA, N/ALOGANI, T/YAR ADIZA, T/ YAR-MAS and T/CD. They were collected from various sources such as the National Cereal Research Institute, Badeggi, Niger State, National Center for Genetic Resources and Biotechnology, Ibadan, Oyo State, National Agricultural Seed Council Abuja as well as farmers’ fields from Taraba and Nasarawa States.

****Screening of rice population for Fe and Zn contents****

Screening of the entire 61 rice genotypes to determine Fe and Zn contents was carried out at the laboratory of the Biotechnology department, National Cereal Research Institute, Badeggi, Niger State in March 2020. The screening exercise involves the preparation of samples, wet digestion and determination of Fe and Zn using the Atomic Absorption Spectrometry machine (AAS- WIN 500 PG INSTRUMENT).

****Samples preparation****

Ten grams of each rice genotype were collected and cleaned for 30 seconds using a 1.7 mm sieve to remove both organic and inorganic foreign matters. The samples were manually dehusked. The grains obtained were further cleaned with a 1.6 mm sieve to remove immature/shrivelled grains. The whole grains (samples) obtained were later ground into powder using a Thomas Willey milling machine (Model ED-5). The grain powder of each genotype was kept inside a well-labelled paper envelope.

**Wet digestion and analysis of samples**

Wet digestion of all 61 samples was carried out in the laboratory of the Department of Biotechnology, National Cereals Research Institute, Badeggi, Niger State. The screening of samples was carried out following the procedure below:

With the aid of an electronic scale, 0.2 g of sample was measured into a 100 ml volumetric flask.

1. Thirty millilitres (30 ml) of wet digestion acid (650 ml of Nitric acid, 80 ml of Perchloric acid and 20 ml Tetra Oxo Sulphate VI acid) was added into a 1000 ml beaker and stir properly.
2. The samples were placed in a fume cupboard and digested until the sample was reduced to 20 ml volume.
3. The samples were continuously heated until the white fumes of Nitric acid disappear and the sample volume was reduced to 10 ml.
4. The samples were then transferred into a 50 ml volumetric flask and made to mark with distilled water and were shaken vigorously and then filtered through a what man 0.45 um filter paper
5. One millilitre (1 ml) of the clear digest was pipetted into another 50 ml volumetric flask and made up to mark with distilled water.
6. The iron and zinc contents in the samples were determined using Atomic Absorption Spectrometer machine (AA WIN 500 PG INSTRUMENT) with an appropriate wavelength for each of the two micronutrient elements.

****Results****

The entry point to biofortification through conventional breeding is the screening of the available germplasm to appropriately select promising lines for the target traits. The result of Fe content presented in Table 1 showed significant variability among the various rice genotypes. The highest value (6.675 mg kg-1**)**was recorded in NGB 00782 and FARO 27 while the lowest (0.048 mg kg-1) was recorded in FARO 45. Furthermore, FARO 19 and NGB 00775 had 6.193 mg kg-1 which was the second highest value**.** The next was 6.079 mg kg-1 recorded in THAI JAMEELA. Others which include FARO 20, NGB 00779 and FARO 31 had 6.072 mg kg-1. Genotypes N/ ALOGANI, FARO 38 and NGB 00794 recorded 5.952 mg kg-1. FARO 65 was the next genotype with 4.250 mg kg-1. This was followed by NGB 00827, FARO 51(CASIDANE), and FARO 49 which possessed 4.239 mg kg-1. Next to these were FARO 66 and NGB 00786 with 4.218 mg kg-1. N/ATIME-EJU, NGB 00789, N/MAI-ALURI INJ., N/DOGO-BURI and N/TUDU GAMBO were the next Fe-rich genotypes with 4.196 mg kg-1. This was followed by 4.185 mg kg-1 recorded in FARO 16, NGB 00773 and FARO 33. Also, FARO 63 and FARO 22 recorded 4.175 mg kg-1 while the least in this category were NGB 00791 and N/JANKARA with 4.164 mg kg-1. The remaining genotypes recorded less than 2.0 mg kg-1.

Similarly, Table 2 presented the results of zinc content which also exhibited wide variability among the various genotypes with NGB 0079 appearing the best with 6.697 mg kg-1 while N/CHINA CARGO had the lowest zinc of 1.506 mg kg-1. N/MAI-ALURI INJ with 6.187 mg kg-1 recorded the second highest zinc content. Both FARO 49 and N/TUDU GAMBO recorded 6.159 mg kg-1 while FARO 63, FARO 16, NGB00773 and N/ATIME-EJU had 6.130 mg kg-1. FARO 33 recorded 6.101 mg kg-1 followed by FARO 66 with 6.043 mg kg-1. Others include FARO 51 and NGB 00827 containing 6.014 mg kg-1 and were followed by N/DOGO-BURI and NGB 00789 with 5.957 mg kg-1. FARO 65 recorded 5.928 mg kg-1 which was the same recorded in NGB 00786. FARO 22 recorded 5.813 mg kg-1 while N/JANKARA had 5.553 mg kg-1. The remaining genotypes recorded values below 2.2 mg kg-1 and appeared not good enough to develop zinc-dense varieties.

Discussions

The results of the screening indicated the existence of variability in Fe and Zn concentration in the various rice genotypes examined. Both the released varieties and landraces have a fair amount of these micronutrients even though the location of these elements in the grain is not determined by this study.

Most of the old and unpopular varieties, as well as landraces, were found to contain an appreciable amount of Fe and Zn. This corroborates the report published by Aladejana and Faluyi (2007) that wild varieties of the crop are a reservoir of desirable traits exploitable for yield and other genetic improvement purposes. NGB 00782 and FARO 27 are loaded with Fe (6.675 mg kg-1) while NGB 00791 and FARO- 49 are Zn dense containing 6.697 mg kg-1 and 6.159 mg kg-1 respectively.

On the other hand, the majority of the released and commercially cultivated varieties such as FARO-44, FARO-52, and FARO-67 contained a very low amount of Fe and Zn. This could probably be attributed to the fact that yield and resistance to biotic and abiotic stresses are the prominent breeding target in sub-Saharan Africa to cater for the food needs of the ever-increasing population despite the nutritional quality. High stability indicated by low Standard Deviation (SD) formed part of the basis for the selection of best genotypes.

It was also observed that Fe and Zn exhibited a positive correlation because most of the varieties that possess low iron also have low zinc content. This agreed with the findings reported by Karen *et al*. (2013) that deficiency of iron and zinc is believed to occur concurrently in the human body.

Table 1: Iron (Fe) content of 61 rice genotypes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S/NO** | **Genotypes** | **Grain Fe (mgkg-1)** | **SD** | **S/NO** | **Genotypes** | **Grain Fe (mgkg-1)** | **SD** |
| 1 | FARO 4 | 1.735 | 0.0001 | 32 | FARO 67 | 1.494 | 0.0001 |
| 2 | FARO 15 | 0.410 | 0.0150 | 33 | NCRO 48 | 1.494 | 0.0020 |
| 3 | FARO 16 | **4.185** | 0.0007 | 34 | NGB 00773 | **4.185** | 0.0008 |
| 4 | FARO 17 | 1.614 | 0.0037 | 35 | NGB 00775 | 6.193 | 0.0003 |
| 5 | FARO 19 | 6.193 | 0.0001 | 36 | NGB 00777 | 1.735 | 0.0003 |
| 6 | FARO 20 | 6.072 | 0.0002 | 37 | NGB 00778 | 1.494 | 0.0007 |
| 7 | FARO 21 | 5.952 | 0.0004 | 38 | NGB 00779 | 6.072 | 0.0004 |
| 8 | FARO 22 | **4.175** | 0.0008 | 39 | NGB 00781 | 0.289 | 0.0204 |
| 9 | FARO 24 | 1.735 | 0.0002 | 40 | NGB 00782 | 6.675 | 0.0003 |
| 10 | FARO 27 | 6.675 | 0.0010 | 41 | NGB 00783 | 0.771 | 0.0132 |
| 11 | FARO 31 | 6.072 | 0.0002 | 42 | NGB 00784 | 1.494 | 0 |
| 12 | FARO 32 | 0.892 | 0.0125 | 43 | NGB 00786 | **4.218** | 0.0020 |
| 13 | FARO 33 | **4.185** | 0.0009 | 44 | NGB 00789 | **4.196** | 0.0004 |
| 14 | FARO34 | 1.494 | 0.0002 | 45 | NGB 00791 | **4.164** | 0.0003 |
| 15 | FARO 37 | 1.373 | 0.0001 | 46 | NGB 00794 | 5.952 | 0.0007 |
| 16 | FARO 38 | 5.952 | 0.0005 | 47 | NGB 00827 | **4.239** | 0.0002 |
| 17 | FARO 41 | 1.494 | 0.0026 | 48 | NGB 00887 | 1.494 | 0.0006 |
| 18 | FARO 44 (SIPI) | 1.614 | 0.0001 | 49 | THAI JEMEELA | 6.079 | 0.0005 |
| 19 | FARO 45 | 0.048 | 0.0206 | 50 | N/ ATIME-EJU | **4.196** | 0.0003 |
| 20 | FARO 49 | **4.239** | 0.0011 | 51 | N/GORKOCHA | 1.012 | 0.0093 |
| 21 | FARO 51 (CASIDANE) | **4.239** | 0.0005 | 52 | N/MAI-ALURI INJ | **4.196** | 0.0005 |
| 22 | FARO 52 | 1.373 | 0.0002 | 53 | N/ TUDU GAMBO | **4.196** | 0.0007 |
| 23 | FARO 56 (NERICA-2) | 1.253 | 0.0044 | 54 | N/ CHINA CARGO | 1.735 | 0.0004 |
| 24 | FARO 57 (TOX 4004) | 1.735 | 0.0002 | 55 | N/ DOGO-BURI | **4.196** | 0.0006 |
| 25 | FARO 58 | 0.892 | 0.0088 | 56 | N/ BIDA ALASKA | 1.494 | 0.0006 |
| 26 | FARO 61 | 1.614 | 0.0004 | 57 | N/ JANKARA | **4.164** | 0.0008 |
| 27 | FARO 62 | 1.494 | 0.0046 | 58 | N/ ALOGANI | **5.952** | 0.0003 |
| 28 | FARO 63 | **4.175** | 0.0006 | 59 | T/YAR ADIZA | 1.614 | 0.0005 |
| 29 | FARO 64 | 1.012 | 0.0090 | 60 | T/ YAR-MAS | 1.253 | 0.0081 |
| 30 | FARO 65 | **4.250** | 0.0004 | 61 | T/ CD | 1.614 | 0.0006 |
| 31 | FARO 66 | **4.218** | 0.0005 |  |  |  |  |
|  |  |  |  |  |  |  |  |

SD = Standard Deviation

Table 2: Zinc (Zn) content of 61 rice genotypes

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **S/NO** | **Genotypes** | **Grain Zn (mgkg-1)** | **SD** | **S/NO** | **Genotypes** | **Grain Zn (mgkg-1)** | **SD** |
| 1 | FARO 4 | 1.678 | 0.0040 | 32 | FARO 67 | 1.920 | 0.0059 |
| 2 | FARO 15 | 2.052 | 0.0005 | 33 | NCRO 48 | 1.839 | 0.0036 |
| 3 | FARO 16 | **6.130** | 0.0030 | 34 | NGB 00773 | **6.130** | 0.0047 |
| 4 | FARO 17 | 1.839 | 0.0025 | 35 | NGB 00775 | 1.698 | 0.0047 |
| 5 | FARO 19 | 1.759 | 0.0045 | 36 | NGB 00777 | 1.708 | 0.0033 |
| 6 | FARO 20 | 2.082 | 0.0022 | 37 | NGB 00778 | 2.092 | 0.0018 |
| 7 | FARO 21 | 1.971 | 0.0044 | 38 | NGB 00779 | 1.991 | 0.0030 |
| 8 | FARO 22 | **5.813** | 0.0030 | 39 | NGB 00781 | 1.870 | 0.0034 |
| 9 | FARO 24 | 1.829 | 0.0048 | 40 | NGB 00782 | 1.688 | 0.0014 |
| 10 | FARO 27 | 1.546 | 0.0019 | 41 | NGB 00783 | 1.759 | 0.0040 |
| 11 | FARO 31 | 2.052 | 0.0016 | 42 | NGB 00784 | 2.112 | 0.0036 |
| 12 | FARO 32 | 1.678 | 0.0030 | 43 | NGB 00786 | **5.928** | 0.0056 |
| 13 | FARO 33 | **6.101** | 0.0024 | 44 | NGB 00789 | **5.957** | 0.0042 |
| 14 | FARO34 | 2.102 | 0.0015 | 45 | NGB 00791 | **6.697** | 0.0032 |
| 15 | FARO 37 | 2.082 | 0.0005 | 46 | NGB 00794 | 1.981 | 0.0010 |
| 16 | FARO 38 | 2.072 | 0.0022 | 47 | NGB 00827 | **6.014** | 0.0054 |
| 17 | FARO 41 | 1.849 | 0.0032 | 48 | NGB 00887 | 1.890 | 0.0048 |
| 18 | FARO 44 (SIPI) | 1.708 | 0.0048 | 49 | THAI JEMEELA | 2.092 | 0.0006 |
| 19 | FARO 45 | 1.637 | 0.0030 | 50 | N/ ATIME-EJU | **6.130** | 0.0055 |
| 20 | FARO 49 | **6.159** | 0.0022 | 51 | N/GORKOCHA | 1.627 | 0.0011 |
| 21 | FARO 51 (CASIDANE) | **6.014** | 0.0048 | 52 | N/MAI-ALURI INJ | **6.187** | 0.0028 |
| 22 | FARO 52 | 2.041 | 0.0056 | 53 | N/ TUDU GAMBO | **6.159** | 0.0029 |
| 23 | FARO 56 (NERICA-2) | 1.546 | 0.0019 | 54 | N/ CHINA CARGO | 1.506 | 0.0002 |
| 24 | FARO 57 (TOX 4004) | 1.860 | 0.0043 | 55 | N/ DOGO-BURI | **5.957** | 0.0036 |
| 25 | FARO 58 | 2.041 | 0.0036 | 56 | N/ BIDA ALASKA | 2.092 | 0.0047 |
| 26 | FARO 61 | 1.870 | 0.0049 | 57 | N/ JANKARA | **5.553** | 0.0031 |
| 27 | FARO 62 | 1.587 | 0.0020 | 58 | N/ ALOGANI | 1.971 | 0.0005 |
| 28 | FARO 63 | **6.130** | 0.0009 | 59 | T/YAR ADIZA | 1.900 | 0.0025 |
| 29 | FARO 64 | 1.597 | 0.0037 | 60 | T/ YAR-MAS | 1.617 | 0.0014 |
| 30 | FARO 65 | **5.928** | 0.0041 | 61 | T/ CD | 1.951 | 0.0028 |
| 31 | FARO 66 | **6.043** | 0.0034 |  |  |  |  |
|  |  |  |  |  |  |  |  |

SD = Standard Deviation

Conclusion

Since the majority of the resource-poor farm families who grow and rely solely on commercial varieties (FARO- 44, FARO-52 and FARO- 67) as their staple food might be deficient in iron and zinc, NGB 00782, FARO 27, NGB 00791 and FARO- 49 could be exploited to fortified the deficient commercial lines via hybridization to boost their economic and nutritional benefits. Field trials are also recommended on some landraces such as N/TUDU GAMBO and N/MAIALURI INJECTION that showed an appreciable amount of iron and zinc for genetic purity and further improvement.

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## EFFICACY OF SOME BOTANICAL EXTRACTS ON THE MANAGEMENT OF FALL ARMYWORM *(Spodoptera frugiperda*J.E. SMITH*)* ON MAIZE *(Zea mays* L.*)*

\*1R. O. Oyewale, 1H.Chijioke, 2M.O. Akinyele, 1H.M. Ibrahim and 1R.O.Ibrahim

1Department of Crop Production, Federal University of Technology, Minna, Niger State, Nigeria

2Department of Agricultural Biotechnology, National Biotechnology Development Agency Lugbe, Abuja, Nigeria

\*Corresponding Author: [r.oyewale@futminna.edu.ng](mailto:r.oyewale@futminna.edu.ng); 08069532552

ABSTRACT

A field experiment was conducted during the 2021 rainy season at the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus to evaluate the efficacy of some botanical extracts for the management of Fall Armyworm on Maize.The treatments were arranged in Randomized Complete Block Design (RCBD) with three replicates. Growth and yield parameters were recorded. The data were subjected to Analysis of Variance and means were separated using Duncan multiple rang test. The results revealed that botanical extracts had vary effects among the six (6) plant botanicals with Neem leaves extracts having the lowest infestation, also had the highest number of plant height, stem diameter, fresh yield weight, dry yield weight and grain yield weight. Therefore, the use of Neem leaves extract was recommended for the management of all army worm of maize.

**Key words:** Maize; botanical extracts; *Sporodeptera frugiperpa;* variety; pests

INTRODUCTION

The management of insect pests largely depends on the use of synthetic insecticides in the field and store. However, indiscriminate use of many synthetic insecticides, human technical’s, environmental non target organisms, resistance of insect pest, food and product contamination with toxic residue, biodiversity, erosion and other side effects (Sallam and Allsopp, 2002). In addition, non-availability of insecticides to country side farmers and ventilation restriction in stored grain are the negative effects of synthetic chemicals. As a result, organochlorine has been reportedly banned in developed countries. These resurcitated the idea of botanical insecticides as a promising alternative to pest control. Botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soiland are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides (Ebenezer, 2010). Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insect developing resistance to botanical insecticide is less likely ( Isman, 2013). Laboratory and field tests have shown the effectiveness of this plant extracts against armyworm, leaf-cutting caterpillars, ants, whiteflies and the three stages of mosquitoes (Zhen and Zhang, 2000).

Fall army worm (FAW) can be one of the most difficult insect pests to control in field corn ((Pogue 2002). Late planted field and late maturing hybrids are more likely to become infested. Fall army worm causes serious leaf feeding damage as well as direct injury to the ear. Fall army worm can damage corn plant in nearly all stages of development, it will concentrate on later plantings that have not yet silked(FAO, 2018). Therefore, this research work was to test for the efficacy of some botanical extracts such as Neem leaf extract, Red stem fig leaf extract, Flamboyant leaf extract, Billy goat weed leaf extract, Moringa leaf extract and Masquerade leaf extract as bio pesticides to control the infestation of fall armyworm of maize crop and boost yield of maize crop in Nigeria. Therefore, the objective was to determine the most effective botanical in the management of fall army worm of maize.

MATERIALS AND METHODS

Experimental Site

The field experiment was conducted during 2021 rainy season at the Teaching and Research farm of School of Agriculture and Agricultural Technology, Federal University of Technology Minna, Gidan Kwano campus ( latitude 6 ° 33'E and Longitude 9 ° 37'N, with altitude 1475 m above sea level) located in the Southern Guinea Savannah agro-ecological zone of Nigeria. It has a peak temperature of 40 °C from March to April. The mean annual rainfall ranges from 120-130mm. (Ojanuga, 2006). The soil type varies from loamy or silty loam soil or silty clay loam.

Source of Experimental Materials

A maize variety OBA 98 was obtained from the Department of Crop Production, Federal University of Technology Minna, Niger state, Nigeria.

Preparation and Application of Botanical Leaf Extract

The botanical leaves were plucked around the school Premises, School of Agriculture and Agricultural Technology, Federal University of Technology, Minna, Niger state.The leaves of six different botanicals were collected and washed with clean water. 1 kg of the leaves was weighed using weighing balance scale (sensitive weighing balance manufactured by Metler instruments LTD) in the Laboratory. After weighing, the leaves were then choped with the use of knife into smaller pieces and blended (electric blender) with 1 litre (L) of Distilled water and mixed properly. Aluminium foil was used to cover the concentration to prevent evaporation, dirt and dust, after which the samples were kept for 24 hours on the laboratory bench to undergo fermentation, after 24 hours, the solution was stirred and sieved using muslin cloth and was labeled. Half litter of the botanical extract was added to 2 liters of water for the spraying of maize plant using knapsack sprayer.

Experimental Design and Field Layout

The experiment was arranged in Randomized Completely Block Design (RCBD) with three replicates. The net plot size was 14 x 24 m2. Each replicate consisted of 7 plots, replicate measuring 4 x 24 m2 and each plot measuring 4 x 3m2. Each plot consists of five ridges with 1 m as alley between the replicate and 0.5 m between plots. Plant spacing is 75 cm between rows and 25 cm within row.

Cultivation Practices

The first fallow was cleared with hand implements such as hoes and machete in order to keep the soil loose for good seedbed and subsequent effective germination and seedling emergence. Land was prepared manually in form of ridge of 3 m long, sowing was done at the full establishment of rainfall. Maize seeds were sown two per hole with inter-row and intra-row spacing of 75 cm and 25 cm respectively. Plant was thinned to one per stand at 2WAS, weeding was done at 3 and 6 WAS. At three weeks after sowing, (WAS) NPK 20:10:10 fertilizer was applied by side placement at the rate of 9.6 g per plant (5 cm away from the plant stand) at 3 WAS using a bottle cover of NPK 20:10:10 as source. At six weeks after sowing and three weeks after application of N. P. K 20:10:10 fertilizer, urea fertilizer was applied at the rate of 9.6 g per plant (5 cm away from the plant stand) at 6 WAS using a bottle cover of urea as source, this is to complete the N requirement of the crop

Data Collection

Ten plant samples were randomly selected and measured from the ground level to the tip of the tallest leaf using a meter rule at 10WAS.The stem diameter of ten plants were measured by using Vernier Calliper at 10WAS. Ear rot was rated on a scale of 1-5, where 1= little or no visible ear rot and 5 = extensive visible ear. The number of days from planting to the time when 50 % of the plants have tasseled shading polar were counted and recorded. The number of ear per plant was counted, Fresh weight was taken after harvesting of the plant using electronic weighing balance. Dry weight was taken after sun drying the maize using electronic weighing balance. Grain weight was done after threshing from the cob using electronic weighing balance. Plant stand was physically checked for the appearance of Fall Armyworm infestation.

Fall Armyworm severity was determined by scoring Armyworm damage to maize plant, using the following scale;

Visual rating damage Numerical score Resistant reaction

No damage 0 likely escape

Few pin hole 1 highly resistance

Few short holes on few leaves 2 Resistance

Several short holes (<50%) 3 Resistance

Several leaves with short holes (>50%) 4 moderately resistance

Elongated lesion on a few leaves 5 moderately resistance

Elongated lesion on several leaves 6 Susceptible

Several leaves with long lesions or tattering 7 Susceptible

Sever tattering 8 Highly Susceptible

Plant drying as a result of foliar damage 9 extremely sensitive to damage.

Source: CIMMYT, (2011)

Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) using Statistical Analysis System (SAS) procedure version 9, 2002 model. The treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % probability level.

RESULTS AND DISCUSSION

Before the application of the botanical extracts, all of the treatments plots have been infected by Fall Armyworm Table 1, but there was no significant difference in the infestation rate among the treatments plots with Masquerade leaf extract recording the highest infestation rate followed by Red stem fig leaf extract, Neem leaves, while control and Flamboyant leaves recorded similar infestation rate, Billy goat weed and then Moringa recorded the lowest infestation rate.

After the first, second and third applications, there were no significant difference among the botanicals except in the case of control which differs significantly (P≤ 0.05) from the botanicals.

Table 2 showed the plant height and number of days to 50 % tasseling of maize. There was no significant difference among the treatments to attain 50 % tassseling. Similarly, there was no significant different among the botanical extracts on plant height. Neem leaf extracts recorded the highest plant height followed by Control, Masquerade leaves extracts, Red stem fig leaf extracts, Moringa leaves extracts, Billy goat weed leaves extracts, respectively and shortest plant height was recorded on Flamboyant leaves extracts, but were not significantly different from one another. This result disagree with the earlier model of Thornley (1998) that increase in stem diameter of infected plant will lead to decrease in the plant height while increase in plant height will result to decrease in stem diameter of the plant.

Table 3 showed the number of ear per plant and number of rotten ear of maize.Numbers of ear per plant was not significantly differed among the botanical extracts. Red stem fig leaves had the highest number of ear per plant followed by neem leaf extract flamboyant leaves, billy goat weed leaves, while moringa leaves and masquerade leaves had similar number of ear per plant and then control having the lowest. There was significant difference between control and the botanical extracts, but there no significant difference among the botanical extracts with control recording the highest number of rotten ear and significantly (P≤ 0.05) different from botanical extracts.

Table 4 showed the stem diameter and fresh cob weight of maize.There was no significant difference among the botanical extracts with respect to stem diameter despite that Neem leaves recording the highest stem diameter followed by Moringa leaves and Red stem fig leaves, while Masquerade leaves recorded the thinnest stem diameter. Similarly, no significant difference among the botanical extracts on fresh yield weight. Neem leaves recorded the highest fresh yield weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy goat weed leaves and least was recorded in Masquerade leaves.

Table 5 showed cob weight and grain yield weight.There was no significant difference among the botanical extracts on the cob weight. Neem leaves recorded the highest cob weight followed by Red stem fig leaves, Flamboyant leaves, Moringa leaves, Control, Billy Goat weed leaves and the lowest was recorded at Masquerade leaves. Similarly, there was no significant difference among the botanical extracts on the grain yield weight. The highest was recorded from Neem leaves followed by Red stem fig leaves, Moringa leaves, Flamboyant leaves, Billy goat weed leaves, control and the lowest was recorded in Masquerade leaves. According to Nailul *et al*., (2018), research conducted in Andalas University Padang, Indonesia, that botanical extract of *Gentiana linearis* recorded the highest plant height, leaf area, fresh cob weight and grain yield which was in conformity to this study The study also confirm the study (effect of moringa leaf extract on growth and yield of maize) conducted by Biswasn *et al.,* 2016,which showed that there was positive effects of moringa leaf extract on the number of leaf, root length, fresh weight and grain yield of maize. Similarly it also confirm another study on the (Yield performance of maize treated with neem seed extracts against stem borers) by Wahed I *et al.,* 2016 which shows that neem seed extracts were effective in protecting the maize plants from maize stem borers infestation.

Table 1: Effect of botanical extracts on the incidence of fall armyworm.

|  |  |
| --- | --- |
| Treatment | Before After first After second After third application application application application |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 5.10 2.43b 1.23b 0.63c  5.90 3.73b 2.60b 1.80bc  5.00 4.90a 5.30a 5.47a  5.00 3.37ab 2.70b 2.00b  4.93 3.20ab 2.53b 1.63bc  4.53 3.70ab 2.47b 1.73bc  6.07 3.70ab 2.33b 1.47bc  0.24 0.24 0.30 0.34 |

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 2: Effect of botanical extracts on the plant height and number of days to 50 % tasseling.

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Plant height(cm) Number of days to 50%  tasselling |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 210.40 52  204.23 52  207.53 52  191.43 52  198.97 52  199.20 52  204.77 52  3.98 0.00 |

Means with the same letter(s) in the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 3: Effect of botanical extracts on the number of ear per plant and number of rotten ear.

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Number of Number of rotten ear  ear per plant |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 1.23 1.80b  1.27 1.93b  1.00 3.80a  1.17 1.80b  1.10 1.67b  1.07 1.80b  1.07 1.80b  0.04 0.19 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 4: Effect of botanical extracts on stem diameter and fresh cob weight of maize.

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Stem diameter Fresh cob weight |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 5.63 193.41  5.33 179.18  5.11 154.42  4.79 165.75  5.08 150.27  5.52 164.72  4.66 140.59  0.16 6.63 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

Table 5: Effect of botanical extracts on cob weight and grain yield weight of maize.

|  |  |
| --- | --- |
| Treatment | Parameters |
|  | Cob weight Grain yield weight |
| Neem leaf  Red stem fig leaf  Control  Flamboyant leaf  Billy goat weed  Moringa leaf  Masquerade leaf  SE± | 116.78 100.05  98.86 83.36  89.12 75.21  95.63 78.62  88.80 75.93  92.96 79.10  82.93 71.19  3.91 3.40 |

Means with the same letter(s) within the same column are not differ significantly according to Duncan Multiple Range Tests at 5 % level of probability. SE± (Standard error of mean).

CONCLUSION

From the result obtained above, it was concluded that Neem leaves extracts had the lowest infestation in most of the parameters taken. Neem leaf had the highest number of plant height, stem diameter, fresh yield weight, dry yield weight and grain yield weight. This showed that, the use of Neem leaves botanical extracts on the management of fall armyworm of maize had low fall armyworm infestation.

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## EFFECT OF FRUIT AND MOTHER-PLANT AGES ON THE VIABILITY AND LONGEVITY OF OKRA (*Abelmoschus esculentus* L.Moench) SEEDS.

\*ABDULLAHI, Mohammed Ladan., H. Ibrahim and O. A. Adediran

Department of Crop production, Federal University of Technology, Minna

\*Corresponding Author E-Mail:\*amladan3319@gmail.com

Phone No. 08033190432

ABSTRACT

The study was carried out to determine the effect of fruit and mother-plant ages on the viability and longevity of okra (Abelmoschus esculentus L. Moench) seed. Mass planting experiment for seed production was carried out at the teaching and research farm of The Federal Polytechnic, Bida, Niger State, Nigeria, during the 2021 rainy season. The experiment consisted of two varieties of okra and nine fruit harvesting stages at different days after anthesis (DAA), which gives 2x9 treatment combinations arranged in completely Randomized Design (CRD) and replicated four times. Data were collected on the mother-plant ages at harvest on the quality of okra seed, based on seed moisture content, 100-seed weight, fruit length, number of fruits per plant, plant height, leave area, seed colour, fruit weight, seed germination test. Data collected were subjected to analysis of variance (ANOVA) using mini tab version 19 and means were separated using turkey test at 5% level of probability. The results indicated that okra seeds are influenced by age of the fruit. Also that timing of harvest is an important factor since both early and late harvest reduces seed quality. It is concluded that okra fruit age should be considered in okra seed viability.

**Keywords:** Fruit, Mother-plant, okra, seed, viability

INTRODUCTION

Okra (*Abelmoschus esculentus* L.), belonging to the family *Malvaceae*, is commonly known as Lady’s finger, as well as by several vernacular names, including okra, in the different geographical regions of its cultivation (Abd Elmoneim, 2021). Okra is believed to have originated near Ethiopia, where it was frequently cultivated by the Egyptians during the 12th century, and thereafter spread throughout the Middle East and North Africa **(**Kumar *et al.*, 2013**).** Okra is an annual shrub that is cultivated mostly within tropical and subtropical regions across the globe and represents a popular garden crop, as well as a farm crop. It is a widely cultivated vegetable crop and is globally known for its palatability (Yuennan *et al.,* 2014). The immature green pods of okra are usually consumed as vegetables, while the extract of the pods also serves as a thickening agent in numerous recipes for soups, as well as sauces, to augment their viscosity (Archana *et al.,* 2015). Another noteworthy application of okra fruit is their wide use in the pickle industry. The polysaccharides present in okra are used in sweetened frozen foods such as ice creams, as well as bakery products, due to their health benefits and longer shelf-lives (Islam, 2019). Historically, okra pods were utilized for various purposes, such as in food, appetite boosters, astringents, and as an aphrodisiac (Durazzo *et al.,* 2018). Furthermore, okra pods have also been recommended to cure dysentery, gonorrhea, and urinary complications (Durazzo *et al.,* 2018). They are important source of oil and protein.

Seed longevity is a measure of how long seeds can be stored and remain viable under a given set of conditions. Seed longevity in storage varies greatly among species (Hay *et al*., 2011) and is also determined by the cumulative effect of environment during seed maturation and harvesting. Several studies describe the relative longevity of seeds in medium- and long-term gene bank storage (Ellis *et al*., 2018).

There are several factors that can affect the viability and longevity of seeds after harvest, including: ageing, improper storage methods, high temperature during drying, rapid drying or over drying, initial quality of seeds before storage such as fruit and plant ages during seed harvest.

Use of poor-quality seeds (poor quality of farmer saved seeds) is one of the factors responsible for low yield on farmer’s field. Poor quality seed results in poor germination and poor crop stands which is significant factor affecting okra productivity. Proper and uniform stand establishment are the key factors for successful crop production in all cropping systems. To ensure such stand, even under adverse conditions, high quality seed must be planted.

Seed quality and quantity are affected by maternal identity (Farzi and Bigloo, 2010), such as maternal age (Birhanu, 2010) and maternal environment (Mathewos, 2012), which will influence the natural regeneration processes. Mother-plant and fruit ages have significant effect on seed quality.

With increasing awareness of health benefit of okra and the role it plays in pharmaceutical industries, the demand for okra is on the rise. Thus, to increase the productivity of okra to meet the increasing demand, it is important to plant high quality seeds of okra. The results emanating from this study will provide farmers with information on the fruit and mother-plant ages at which the best quality seeds can be obtained. Therefore, the objective of this study was to determine the best okra fruits harvesting stage to obtain high quality seed for the two different okra seeds variety.

MATERIALS AND METHODS

Mass planting for seed production was carried out at the teaching and research farm of The Federal Polytechnic, Bida (Latitude 9o 51 N and Longitude 6o 44 E) during the 2021 rainy season. The site is located in the southern Guinea savannah ecological zone of Nigeria. Annual rain fall distribution is between April and early October with the peak around August.

Average rainfall in this area is 120 mm while temperature ranges from 35 oC to 40 oC, the relative humidity is between 40 to 60 % around January, which later increases to between 60 to 80% towards July.

The seeds of the two varieties were sourced from National Horticultural Institute (NIHORT) Ibadan. The experiment consisted of two varieties of okra and nine fruit harvesting stages at (14, 21, 28, 35, 42, 49, 56, 63, and 70) days after anthesis (DAA). Which resulted in 18 (2 × 9) treatment combinations fitted into completely Randomized Design (CRD) and replicated four times. The field were cleared of vegetation and other debris and an area of 50m x 50m was marked out for ridges. Two seeds of okra were sown on manually constructed ridges. Thinning was done two weeks after sowing leaving one per stand. Manual weeding was done at two weeks after planting and subsequently as found necessary. NPK fertilizer were applied (20:15:15) at 200 kg/ha at the rate of 60 kg N, 30 kg P and 10 kg K at four weeks after sowing.

Date tagging of fruit from position 1-3 on the mother-plant were carried out on daily bases as the flowers open. Fruits that developed from the tagged flower were harvested at 14, 21, 28, 35, 42, 49, 56, 63, and 70 days after anthesis (DAA). The seeds extracted from the two varieties and 9 harvested fruit ages were stored in an oven at 37o C and 75 % relative humidity to accelerate the ageing process of the seeds.

100- Seed weight (g)

One hundred seeds were counted at random from the harvested produce of each treatment combinations in four replicates, weighed using Mettler balance and their mean weight was recorded in grams. Data were collected on germination percentage, germination rate index and germination index. Germination percentage was done by counting four replicates of 50 seeds each of the treatment combinations and placed on a water-moistened filter paper. Germination counts were taken at every-other-day. The incubation period was 28 days, and the results were expressed in percentages.

Germination rate index (GRI) and germination index (GI) were calculated and seed leachate electro- conductivity measured as indices to determined seed vigour during the storage periods. Germination rate index (GRI) shows the percentage of germination per day. This was calculated using the relationship developed by Esechie (1994). Germination index is a comprehensive vigour measuring parameter which combines both germination percentage and speed (speed, duration, high and low events).

Electro-conductivity test

The electro-conductivity test was done by counting four replicates of 50 seeds from each of the treatments into beakers to which 30 ml of distilled water was added. The seeds were left in water for 24hours after which the mixture was stirred and the supernatant decanted into clean beaker (ISTA, 2006) the electro-conductivity of the supernatant was measured using jenway DDS-307 Conductivity meter. The values were expressed in siemens per meter(sm). Data in percentages were transformed to arc sin values in order to obtain a reliable interaction between treatments before they were analysed.

The data collected were subjected to analysis of variance (ANOVA) using mini tab statistical package version 19 and means were separated using turkey test at 5% level of probability.

RESULTS AND DISCUSSION

The experiment revealed that okra seeds are influenced by age of the fruit. Table 1 shows the effect of fruit ages at harvest on the viability of okra seeds. sharp increase in seed germination percentage, germination rate index and also germination index from 28, 53, 42, 49, 56, 63 and 70 (DAA) The seeds harvested at 14 and 21 (DAA) were not viable and no germination, with L.D 88 germinating significantly than variety NHAe47-4 in all viability test. The increase in germination percentage, germination rate index (GRI) and germination index (GI) with increase in maturity could be attributed to greater inflow of assimilate with progress in seed maturation as reported by Chen et al. (2009), Kavak et al. (2012) that timing of harvest is an important factor since both early and late harvest reduces seed quality.

Table 1. Effect of fruit ages at harvest on the viability of okra seeds

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Treatment Parameters**

**Varieties (V)** G.P (%) GRI (% day-1) GI (%)

NHAe47-422.50b 1.98b 56.64b

L.D 88 24.62a 2.50a 92.88a

S.E ±

**Fruit age (DAA)**

14 0.00e 0.00e 0.00e

21 0.00e 0.00e 0.00e

28 45.13c 0.10d 7.98d

35 77.92b 0.52c 26.60c

42 79.04b 0.98c 52.50b

49 80.30a 1.68b 76.50b

56 83.82a 1.80b 89.25a

63 85.50a 2.00a 91.50a

70 91.61a 2.20a 92.70a

SE±

**Key:** V= Variety, GP= Germination percentage, GRI= Germination rate index, GI= Germination index

CONCLUSION

It is concluded in this research that okra fruit age should be considered in okra seed viability. This is because age of okra fruit is a major determinant of okra seed quality. Therefore, both the early and late harvest could result to low quality of okra seed.

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## PROFILING OF SOYBEAN (*Glycine Max* (L.) GENOTYPES WITH HIGH FUNCTIONAL OIL CONTENT FOR INDUSTRIAL AND DOMESTIC APPLICATIONS

M. O. Akinyele(\*) A.S. Gana; E. Daniya and K.D . Tolorunse.

Agricultural Biotechnology Department, National Biotechnology Development Agency, Umaru Musa Yar’dua Express Way, Lugbe Abuja.

Department of Crop Production, School of Agriculture and Agricultural Technology, Federal University of Technology, P.M.B 65, Minna, Niger State, Nigeria.

**Corresponding Author’s E-mail: akindupe@rocketmail.com.**

**Phone number: +2347038795413.**

ABSTRACT

Globally, bio-based industrial and domestic chemical sources are becoming increasingly demanded in the chemicals and materials industries. Soybean oil is produced within the beans (seeds) of soybean plant (*Glycine max* (*L*.) as an edible product. With the use of appropriate methods such as crushing and refining processes, soybean oil contains varying degrees of polyunsaturated fatty acids, monounsaturated fatty acids, and saturated fatty acids but depends on the varietal genetic makeup and some environmental factors. The aim of this study was to estimate the oil contents of Twenty-three (23) soybean genotypes to explore their oil contents on comparative bases in order to elucidate their nutritional, pharmaceutical, and medicinal values using standard proximate analytical methods of the Association of Official Analytical Chemists (AOAC, 1999). The results showed the presence of (mean) fat contents ranging from 22.37- 31.15%. The presence of high fat contents such as observed in this study means that most of the soybean genotypes used here could be considered as sources of quality raw materials for food (including human and animal) and for pharmaceutical applications.

**Keywords**: Edible oil, Bio-based, Nutritional, Fat and Genotype

INTRODUCTION

Throughout the world, Soybean (Glycine max (L*.)*Merr.) is highly cultivated as an important leguminous crop. It is grown in both the tropical, subtropical, and temperate climates where it provides abundant protein and oil for human diet and animal feed supplements (Wajid *et al*., 2020). The seeds of many varieties of soybean seeds contain on average of about 36% protein, 30% carbohydrates, and appreciable amounts of dietary fiber, vitamins, and minerals. The oil contents of about 20% makes soybean the most important crop for edible oil production. In Nigeria, the seeds of soybean have been used for the preparation of varieties of both dried, fermented and fresh foods. There are many soybean-based food products such as soy milk, soy sauce, tofu, etc that are obtained from soybean during one form of processing or the other for human and animal consumption. Also, soy oil is extracted from the soybean as soy meal which are nutritionally balanced for domestic and industries especially for pharmaceutical product applications and other products such as paint, plastics, paper, inks etc (Arewa *et al*., 2018).

Soya bean oil is highly unsaturated and as such it is hydrogenated in order to produce products such as shortening and margarines by the industrial additions of Hydrogen to the double bonds of the triglycerides in order to increase their respective melting points. The process of Hydrogenation also helps to saturate the partially double bonds in soybean oil which eventually increases the oxidative stability ([Rekhadevi](https://pubmed.ncbi.nlm.nih.gov/?term=Perumalla%20Venkata%20R%5BAuthor%5D) and [Rajagopal,](https://pubmed.ncbi.nlm.nih.gov/?term=Subramanyam%20R%5BAuthor%5D) 2016).

The use of soybean as a feedstock for fatty acids in industries has several advantages. For these reasons, if an industrial fatty acid is the target, and it is not compatible with feed usage, it may be prudent to use an alternative crop whose seeds are not used for animal feed as the host for this trait (Lan *et al*., 2007).

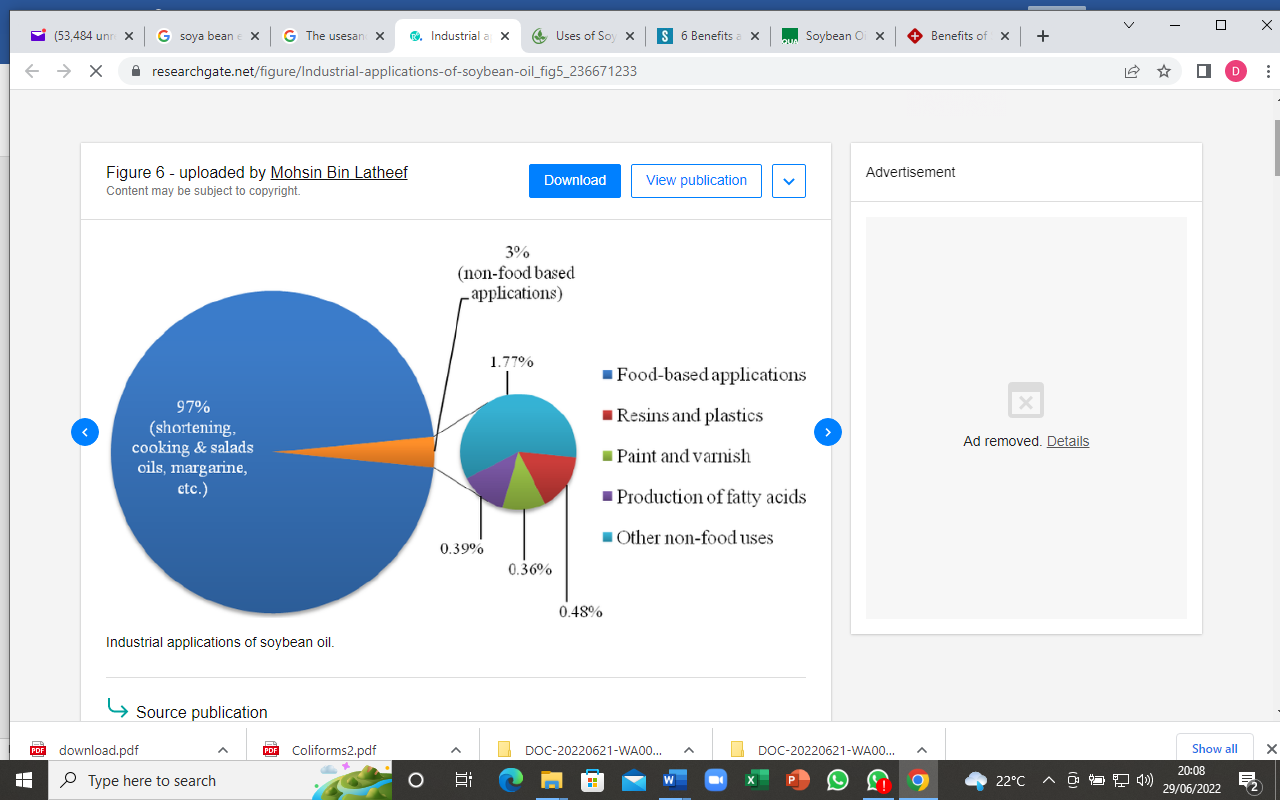


Fig. I: Industrial Applications of Soybean Oil

The presence and possibility of increasing the components of soy oil proportionately using genetic and environmental conditions has been one of the targets for the nutritional improvement of soy oil for higher grade food and feed applications (Javier *et al*., 2022). For instance, it has been reported that soybean oils with enhanced ω-3 fatty acid levels have more value in both food and feed applications. About 85 percent or more of them is further processed into soy oil and soy meal by various means especially through crushin. The meal is mostly used as part of animal feed stock while the oil may either be converted to biodiesel or used domestically as food. However, with the current economic challenges occasioned by Covid-19 and other challenges, the cost of importation has sky rocketed leading hike in the prices of soybean-derived products such as animal feeds and their products. With the knowledge of genetic improvement of soy bean with consequence improved nutrition oil both in quantity and in quality, feedstock for animal and biofuels from soy oil could trigger further research innovations that will stimulate the development of soybean genotypes for higher oil yields in quality and quantity in Nigeria and beyond. Due to the current importance and needs for soybean oil, it is necessary to investigate their proximate chemical composition across various genotypes. Therefore, this study was carried out to estimate the active components especially the total oil content (TFC) across 23 genotypes using standard procedure (AOAC, 1999).

MATERIALS AND METHODS

This research was conducted in two stages. The first aspect of the experiment involve the cultivation of fifty soybean genotypes under field condition for morpho-agronomic characteristics and the second stage was to assess the genetic variability using the nutritional contents that was analyzed using standard proximate analytical methods such as the Association of Official Analytical Chemists, (AOAC, 1999). The study was designed objectively to estimate the extent of genetic variability of the soybean genotypes.

Sample Collection and Preparation

The soya bean seeds were obtained from the first stage of the experiment which involved growing the seeds of the selected genotypes The obtained seeds were grounded with pestle and mortar and then packed in an air tight container and stored in a desiccator (containing silica gel) and further analysed. All the chemicals that were used were of analytical grade (AOAC, 1999).

Determination of Proximate Composition

The proximate compositions of the grounded soya bean seed were determined using standard analytical methods and were carried out at Kembiz Scientific & Laboratories Nigeria Ltd, Kuje Road, Gwagwalada, Abuja, Nigeria. All measurements were done in triplicates and values presented in percentage (Nancy et al., 2012).

Moisture Content

Two grams (2 g) of the grounded soya bean seed were oven-dried in a crucible at 105 °C for 12 hours. The dried sample were then cooled in a desiccator for 1hr and its constant weight were determined. The percentage loss in weight were expressed as percentage moisture content (Nancy *et al*.*,* 2012).

Ash Content

Ashing was carried out using 2 g of dried milled soya bean seeds in a muffle furnace at 550 °C for 6 hr. The residual ash in the crucible was cooled in a desiccator and weighed. The percentage of residue weighed was expressed as ash content (AOAC*,* 1999).

Crude Lipid Content

Continuous extraction of lipid was done for 5 hr with petroleum ether in a soxhlet extractor using 2.00 g of the sample to determine the crude lipid content (Udo and Oguwele, 1986).

Crude Protein Content

Kjeldahl method was used to determine total protein. Here 1 g of the sample was placed in a filter paper and introduced into a Kjedahl flask, 10 ml of concentrated H2SO4 was added and digested in a fume cupboard until the solution become colorless. The distillation was carried out with 15 ml of 50% of NaOH. The tip of the condenser was dipped into a conical flask containing 6 ml of 4% boric acid in a mixed indicator until a green coloration was observed. Titration was done in the receiver flask with 0.01 M HCl until the solution turned red (Gabriel *et al*., 2018).

Crude Fibre Content

Estimation of the crude fiber was done by acid and alkaline digestion methods in which 2.00 g of each sample was used with 20% H2SO4 and NaOH solution (Gabriel *et al*., 2018).

Carbohydrate Content

The carbohydrate content of the sample was then determined by estimation using the arithmetic difference method (De Conto *et al*., 2011; James, 1995) as defined by equation (1). % Carbohydrate = 100 (% Moisture + % Fat + % Ash + % Fibre + % Protein) (Nancy *et al*.*,* 2012).

Results

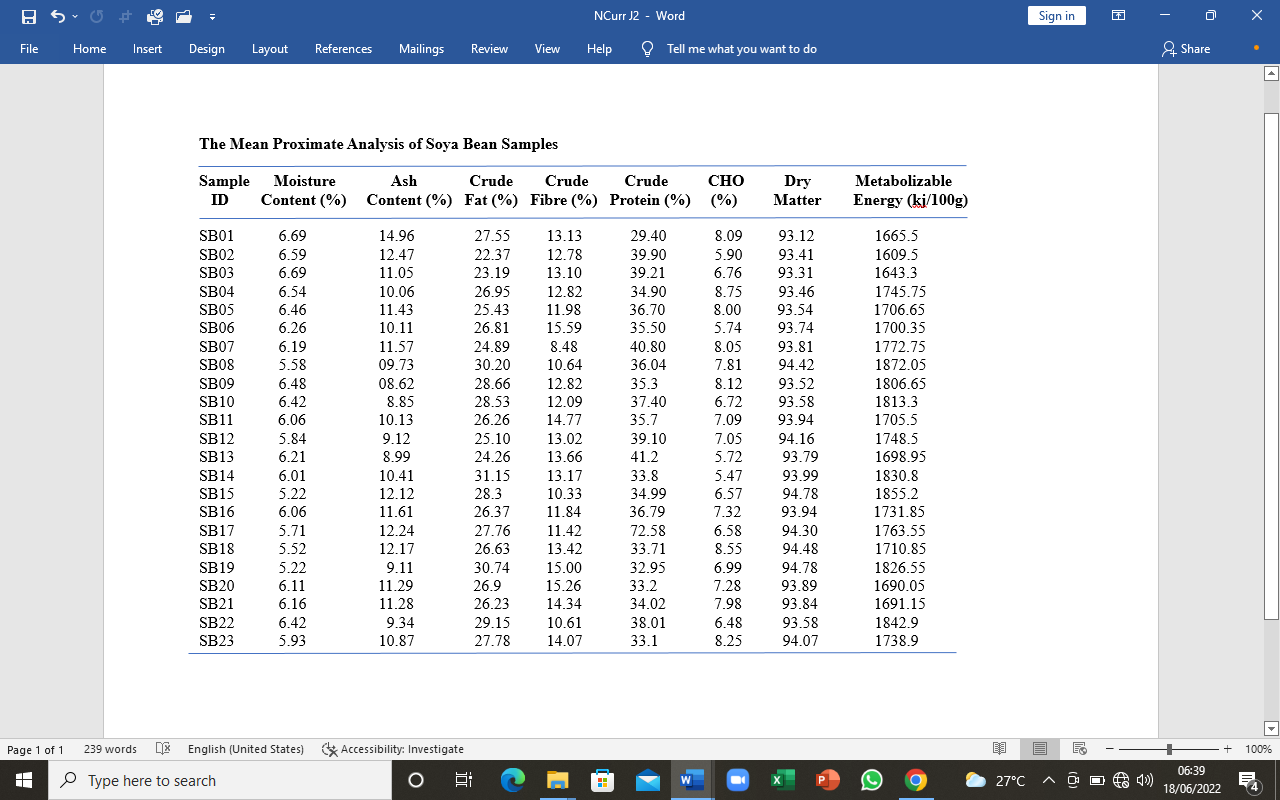
Table I below shows the general proximate composition of the major constituent of the 23 samples of the soybean genotypes.

The proportion of the oil contents in the twenty-three soy bean samples are distributed in the ranges (%), 20-25; 26-30 and 31-35 and presented in figure II Above. Highest proportion of the soya bean examined had oil content range between 26-30%. While the next had 20-25% and least in the proportion has oil content of 31-35%.

Discussion

Studies have been carried out to evaluate and to show the variation of quality attributes among oils from different soybean varieties, Bovender special, Foster and F-8827 (Farooq *et al*., 2016).

Table I: Mean Proximate Composition of the Experimental Soya Bean



SB = *Soya Bean*

From the table, the mean value of the soy bean oil (fat) ranges from 22.37 to 31.15% as recorded from samples SB02 and SB14 respectively.

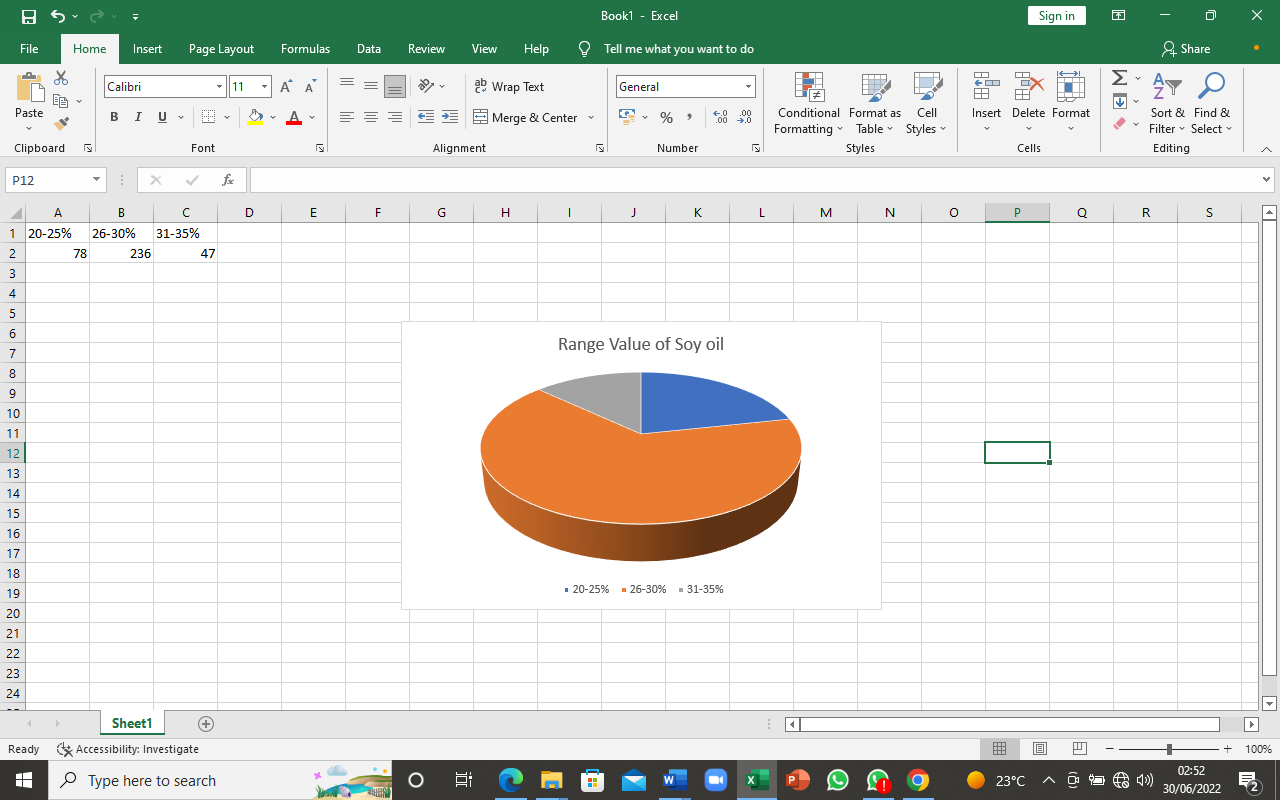


Fig. II: The proportion of soy bean oil within the 23 samples.

The oil content of most soybean reported ranges from 13% to 25%, with a commodity-range of 16% to 23% (Li *et al*., 2013). Our study recorded higher values as indicated above. This implies that the cultivars can be used in many feeds formulation and industrial applications depending on the oil content needed for the particular occasion. For instance, since Bio-diesel fuel for bio-diesel engines are being produced from soybeans through trans-esterification by the removal of glycerin from the oil, the high oil content of many of the cultivars used in this work could be utilized for soy bio-diesel production for clearer burns with reduction of particle emissions, non-toxicity, renew ability, and environmentally-friendliness features (Daming *et al*., 2011). The high oil contents of the soybean also implies that they could be used for industrial production of crayon which according to [Tom](https://pubmed.ncbi.nlm.nih.gov/?term=Clemente%20TE%5BAuthor%5D) and [Edgar](https://pubmed.ncbi.nlm.nih.gov/?term=Cahoon%20EB%5BAuthor%5D), (2009) could replace the petroleum-based regular crayons making them non-toxic and safer for children. The research report by Ojewumi *et al.* (2019) showed that candles made with soybean oil burn longer, but with less smoke and soot justifying the fact that soybean seeds used in this research could be utilized for similar purpose because of their high oil contents.

According to Farooq *et al*. (2016), soybean oil has a relatively high smoke point of about 450°F (230°C) against the unrefined extra-virgin olive oil of about 375°F (191°C) and canola oil 428–450°F (220–230°C) with the consequence of good option for high-heat cooking like roasting, baking, frying, and saucing, as it can withstand high temperatures without breaking down. Soybean genotype with high oil content gives higher yields of the desirable oil.

Conclusions

The study has revealed that there was variation among the 23 genotypes of soybean evaluated for various levels of oil contents. It was revealed that SB 14, SB 19 and SB 08 has higher level of oil contents of 31.15, 30.74 and 30.20 respectively. The levels of oil content information obtained from the study provide base line information to breeders on improvement of soybean for high oil contents, industries and for Pharmaceutical purposes. It opens opportunities to investigate the grades and qualities of the oil obtained from the research work.

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## EFFECT OF SEED SIZE AND POSITION OF SEEDS IN POD ON THE SEED VIGOUR OF FLUTED PUMPKIN *(Telfaria occidentalis* Hook)

Ibrahim, R. O\*.Adediran O. A. and Ibrahim H.

Department of Horticulture, Federal University of Technology, Minna, Nigeria.

\*ibr.otaru@futminna.edu.ng +2348036325681

ABSTRACT

Selection of high-quality seeds is important for optimum productivity of fluted pumpkin. This study aimed to evaluate the effects of seed position in pod and size of seeds on the vigour of fluted pumpkin seeds. It was a 3 x 3 factorial combination of 3 seed position in pod viz: anterior, middle and posterior section (close to pedicel) and three seed sizes viz: (big, medium and small). These were arranged in completely randomized design with five replicates. Data were collected on number of days to emergence, percentage emergence, emergence rate index. Data collected were subjected to analysis of variance (using Statistical Analysis System SAS) version of 9.2. The results showed that the first emergence count was observed at 7 days after sowing (DAS) in big and medium seeds. Anterior seeds consistently had the highest emergence percentage at 12-19 DAS. Anterior seeds had the highest emergence rate index value statistically similar to the value recorded in the middle seeds. The medium sized seeds had the significantly highest emergence rate index. It can therefore be concluded that medium sized seeds extracted from the anterior and middle position of fluted pumpkin pods has the potential to give more vigorous seedlings in a non-stressed environment.

**Keywords:** fluted pumpkin, seed quality, seed position, seed size and seed vigour

INTRODUCTION

Seed is a vital element in increasing crop yield and output. Improving seed quality is one of the most affordable and effective agricultural growth inputs since it can considerably increase any crop's potential output (Jerlin and Vadivelu, 2014). Seed is a mature, fertilized ovule that is protected by a seed coat. It is a component of horticultural, sericultural, and silvicultural plants used for sowing. Given its significance in the development of agriculture and agrarian communities, seed quality has always been revered. The early growth and development of a plant is supported by the abundance of protein, carbohydrate, and oil in its seed. Seed vigour is defined as the ability of seed to germinate and establish seedlings rapidly and robustly across diverse environmental condition (Finge-Savage and Bassel, 2016)

Fluted pumpkin (*Telfaria occidentalis*) commonly called ‘ugu’ is a very important vegetable that is popular in West Africa. It belongs to the family of *cucurbitaceae*. It is a leafy vegetable that produces fruits used for culinary purposes. Due to its nutritional value, it is used to increase the dietary quality of soups (Nwosu *et al.,* 2012; Akanni-John, 2020). The main method of fluted pumpkin propagation is seed. Seed size is a measure of seed qualitythat can affects seedling growth and establishment in crops (Nik *et al*., 2011). Vigor, germination, and seedling establishment are all impacted by seed size. Position of seeds in the pod also affects the quality of the seed hence, the performance of the resultant crop (Modupeola *et al.*, 2014).Germination and consequent seedling emergence depend on the ability of seeds to use reserves more effectively (Bewley *et al*., 2013). Fluted pumpkin seed is recalcitrant in nature with short viability duration and erratic seedling emergence and establishment which affects the yield per unit area and reduces the return on investment. Sowing mixed seeds of a species may result in a non-uniform stand establishment which may lead to heterogeneity in the plant vigour and size (Nik *et al*., 2011).This study was carried out to evaluate the effects of seed size and seed position in pod on the seed vigour of fluted pumpkin.

METHODOLOGY

The experiment was carried out at the horticultural nursery Federal University of Technology, Minna, Niger State. Five fluted pumpkin pods of equal sizes were obtained from Niger river basin authority, Minna Niger state. The pods were gently opened and the bunch of the seeds were measured and divided into three equal portions viz, interior, middle and posterior section (close to pedicel) of the fruit. The seeds from each position were collected separately and washed under running water. The seeds were air dried for four days in the laboratory and sorted into three sizes: big, medium and small respectively i.e The weight range are ≥ 8.6g as big, 7.6 - 8.5 as medium and ≤ 7.5g as small. Top soil was collected and sterilized; a kilogram of the sterilized soil was filled intoeach polythene bag.

Treatments and Experimental Design

The experiment was a 3 x 3 factorial combination of three seed position in pod (anterior, middle and posterior section) and three seed sizes(big, medium, and small). The treatments were arranged in completely randomized design with five replicates. Each of the polythene bags was planted with one seed each at 7cm depthand watered every day. Data were collected on number of days to emergence, percentage emergence, and emergence rate index. Emergence rate index was calculated as:

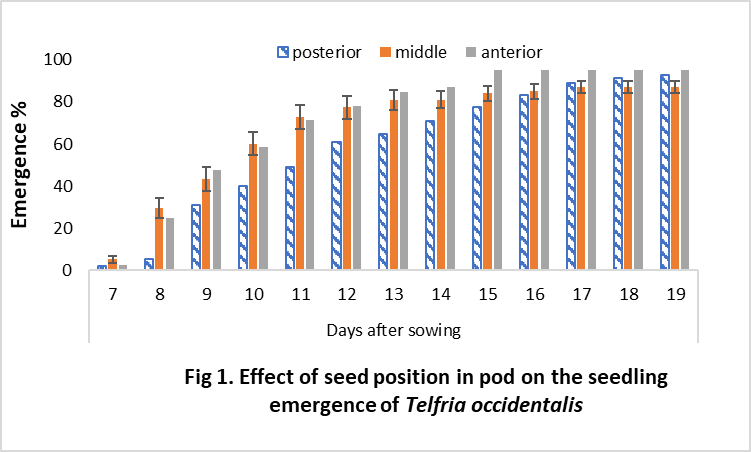
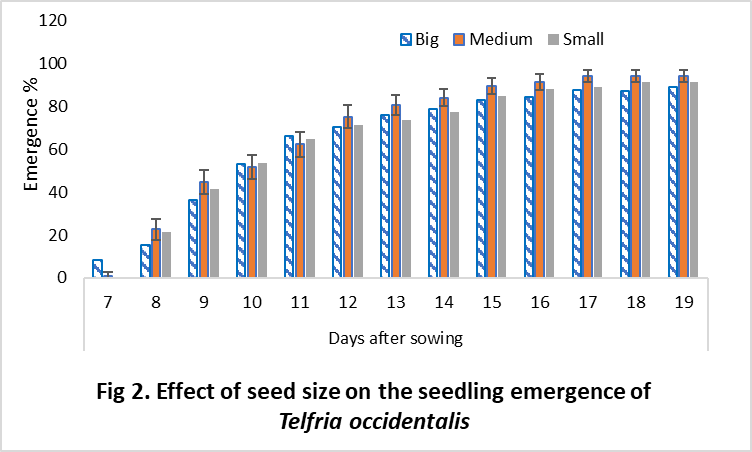
Where ERI= Emergence rate index, EP1, EP2, EPn corresponds to the emergence percentage at first, second, up to the last count respectively and N1, N2, Nn represent the number of days to the first, second up to the last count respectively (Adapted from Hartman *et al*., 2007).

Data Analysis

Data collected were subjected to analysis of variance using Statistical Analysis System (SAS) version 9.2. The means were separated using least significant difference (LSD), where treatment means shows significant differences.

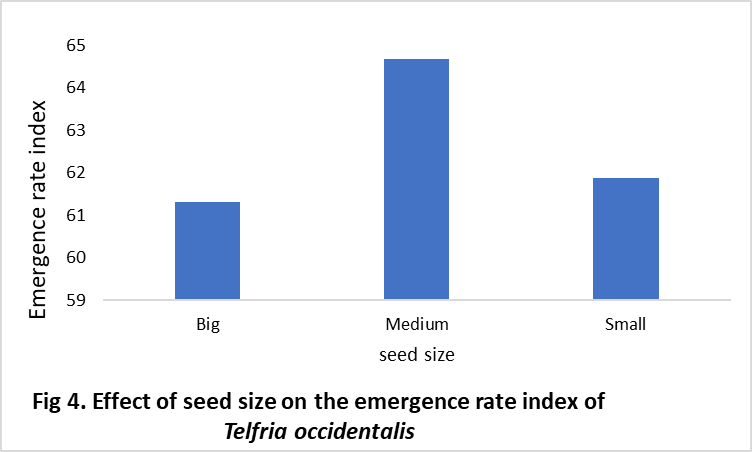
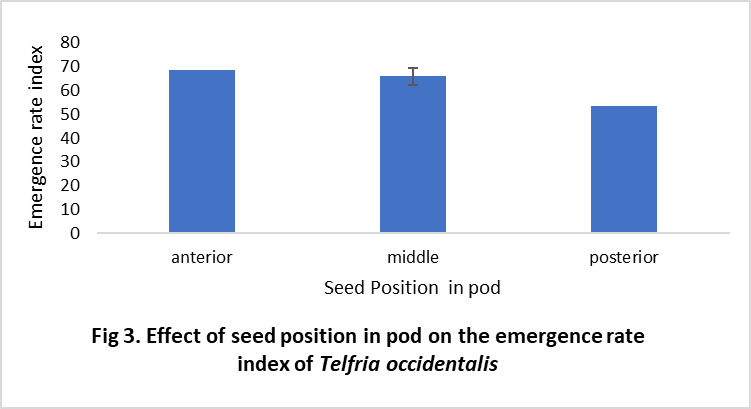
RESULTS AND DISCUSSION

Seeds extracted from the middle position had the highest (29.58%) seedling emergence at 8days after sowing. This was statistically similar to the value recorded (24.71%) for seeds from the anterior position. The least value (5.11%) was recorded for seeds in posterior end of the fruit. Similar trend was observed at 11,13, and 15 days after sowing. The posterior seeds consistently had the least emergence percentage up to 16 days after sowing (DAS) while the anterior seeds consistently had the highest emergence percentage at 12-19 DAS (Figure 1). Ekwealor *et al*., 2019 reported that seeds extracted from the middle of fluted pumpkin pod had higher germination percentage, vine length, stem girth, number of leaves and leaf area, which corroborates the result obtained at 12-19 DAS in this study. Aremu and Akinwale (2012) observed that seeds from the anterior position had the highest vigour performance. However, in their own study, Ekwealor *et al*. (2019) reported the least emergence percentage was recorded in the anterior (near head) position. The disparity in result may be attributed to the genetic make up and growth environment of the seeds, both of which influences germination and seedling growth. In seed formation, pod encapsulate the seeds and protect the seeds. It is the immediate environment of growing seeds. Pods can regulate seed growth and maturity (Bennette *et al*., 2011). Signals originating from the pod may act to coordinate grain filling and regulate the reallocation of reserves from damaged seeds to those that have retained viability.

Big sized seeds were the fastest to emerge having significantly highest emergence percentage at 7 DAS. None of the small seed emerged at 7DAS. Big sized seeds contain more food reserve for the growing embryo than their smaller counterpart. Therefore, it is generally believed that large seeds have higher surviving rate than smaller seeds. Saeed and Sauka (2000), reported that larger seeds of *Senna occidentalis* emerged more rapidly than the smaller seeds. This was attributed to the longer root and shoot observed in the larger seeds. They however reported that smaller seeds germinated faster (had higher germination velocity). In this study, the middle seeds consistently had the highest emergence percentage from 12-19 DAS similarly at 8 and 9 DAS (Figure 2)

Anterior seeds had the highest (input value here) emergence rate index value and it was statistically significant as well as the value recorded in the middle seeds. The least was recorded in the posterior seeds (Figure 3). The medium sized seeds had the significantly highest emergence rate index while the values recorded in the small sized seeds and the big sized seeds were at par (Figure 4). The emergence rate index is an indicator of vigour. It reveals the germination capability and the speed of emergence. Rapid seedling emergence increases the chance of seedling establishment. Sousa and Fagundes (2014) reported that small seeds had higher germination percentage and germinated faster than larger seeds though larger seeds gave more vigorous seedlings. The significantly higher emergence rate index observed in the medium seeds in this study might be attributed to the fact that the medium seeds being midway combined the advantages of faster germination of smaller seeds and longer plumule and radicle length of larger seeds to obtain higher emergence rate index. There was no significance interaction between the position of seed in pod and size of seed in all the parameter measured.



CONCLUSION

The position of seed within the pod and their sizes had significant effects on the seed vigour of fluted pumpkin. Medium sized seeds extracted from the middle and anterior position of fluted pumpkin pods appear to have more potential to give uniform and better field establishment for optimum productivity of the crop.

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## EFFECTS OF MOISTURE STRESS AT DIFFERENT GROWTH STAGES ON THE PERFORMANCE OF ONION (*Allium cepa* L.) VARIETIES

M. B. AYAWA1\*, O. A. ADEDIRAN2, and H. IBRAHIM2

1Department of Crop Production, Federal University of Technology Minna, Nigeria

2 Department of Horticulture, Federal University of Technology Minna, Nigeria

\*Corresponding author; [ayawabello@gmail.com](mailto:ayawabello@gmail.com), 2347030577257

ABSTRACT

Climate change is imparting negatively on global **crop production** and compromising food security worldwide. To breed for moisture stress tolerance in any given crop, it is important to know the precise water needs of the plants and the growth stage at which moisture stress affect the crop most. Hence, this research aimed at determining the response of onion varieties to moisture stress at different stages of growth. The field experiment was carried out at Maizube Farms Limited field, Minna, Niger State (latitude 903817.10N; longitude 6032i04.20E). The treatments consisted of five varieties of onion (red creole, sivan, prema, wuyan makwarwa, wuyan bijimi) and moisture stress at three growth stages of the plant (flag leaf emergence to two true leaves stage (10-50 days post seeding (PS)), three to seven leaves stage (50-90 days PS), bulb initiation to bulb enlargement stage (90-170 days PS) as well as irrigation throughout the growth stages on a daily basis and at 3 days interval. The 5 x 5 factorial experiments were laid out in Completely Randomized Design (CRD) with three replications. Data were collected on growth and yield parameters. The result obtained shows that the varieties responded to moisture stress in similar ways. Drought stress significantly reduced the growth and yield of the onion varieties tested at all the growth stages compared to plants watered throughout the growth stages at 3 days interval which produced the highest number of leaves, plant height and bulb yield. However, the effect of the drought stress was more critical at the early growth stage (flag leaf to two true leaf stage) reducing bulb yield by 57.74%. Similarly, daily irrigation induced flood stress in onion and significantly reduced onion bulb yield by 59.22% .

**Key words:** Moisture stress; Onion, Growth stages, Climate change, Irrigation

INTRODUCTION

Water is the most important factor in agricultural production for proper development and productivity. Every plant needs optimum water supply to meet its physiological requirements (Evans and Sadler, 2011). Water stress is referred to as a limited water supply to plant roots (drought stress) or too much water resulting in flood stress in plant. Water stress results in disruption of agriculture, hence it affects food production in the world, resulting in famine (Chaves *et al*., 2012). Drought stress commonly affect crops; reduces the rate of transpiration in plants thereby affecting metabolism, growth and development of crops. The profound alterations to physiological processes under dehydration slow down or even arrest growth and endanger yield stability (Anjum *et al*., 2011). Yield losses in the field under drought typically range between 30% and 90%; they differ between crop species (Hussain *et al*., 2019). Flood stress similarly impair gaseous exchange thereby causing energy imbalance and reduction of photosynthesis.

Onion (*Allium cepa* L.) is one of the most important vegetable crops commercially grown in the world. It is a popular vegetable and its bulb is used raw, sliced for seasoning salads, and cooked with other vegetables and meat. Onion bulbs are essential ingredients in many African sauces and dishes. The leaves, whole immature plants called ‘salad onion’ or leafy sprouts from germinating bulbs are used in the same way. It probably originated from Central Asia between Turkmenistan and Afghanistan where some of its relatives still grow in the wild (Brewster, 1999). It is a shallow rooted crop; its root penetration is around 0.18 m which indicates it cannot take up moisture from deep soils. This makes it sensitive to drought stress. Bulk of the onions planted in Nigeria is produced in the north where irrigation water is a limiting factor. It is mostly planted at the onset of dry season so that it matures into the dry season to avoid flood stress. Previous studies indicated that water deficit negatively affects onion bulb formation which resultantly hinders its quality and yield (Chaudhry *et al*., 2020; Ghodke *et al*. 2020). Water stress at specific stages can negatively impact onion size and quality (Pérez-ortolá and Knox, 2015). To reduce the impact of climate change on food security, it is important to use moisture stress tolerant varieties. To breed for moisture stress tolerance in any given crop, it is important to know the precise water needs of the plants and evaluate the growth stage at which moisture stress affect the crop most. Hence, this research aimed at determining the response of onion varieties to moisture stress at different stages of growth.

MATERIALS AND METHODS

The field experiment was carried out at Maizube Farms Limited field, Minna, Niger State (latitude.903817.10N; longitude 6032i04.20E). It is semi- arid with average rainfall of about 750- 1209.7 mm per annum. The relative humidity ranges from 21- 47% and 51-79% during the dry and rainy seasons respectively. Temperature averages between 14-30oC during the rainy season and 27-41oC during the dry season (NNN, 2020).

The onion cultivars were obtained from the Institute of Agricultural Research (IAR), Zaria Nigeria. The treatments were five varieties of onion (Red creole, Sivan, Prema, Wuyan makwarwa, Wuyan bijimi) and moisture stress at three growth stages of the plant (flag leaf emergence to two true leaves stage (10-50 days post seeding (PS)), three to seven leaves stage (50-90 days PS), bulb initiation to bulb enlargement stage (90-170 days PS), irrigation at 3 days interval throughout the growth stages) and daily irrigation throughout the growth stages). The 5 x 5 factorial experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The seeds were planted at a spacing of 20 cm between rows and 15 cm within rows. The net plot size was 2 m x 3 m. Drip irrigation was used in wetting the crop at root level through the use of hose with emitters, the emitters emit water in a trickle form. The diameter of the drip tape was 16 mm and emitters were spaced at 15 cm. The water emission rate was 4 liters per hour per treatment plot. Moisture stress was imposed at the different stages by delaying irrigation till plants show symptoms of temporary wilting. Data were collected on plant height, number leaves, leaf area index, number of days to flowering, bulb diameter and length, bulb yield (kg/ha). The data collected were subjected to Analysis of Variance (ANOVA). Means were separated using least significant difference (LSD) at 5% level of probability.

RESULT

The effect of moisture stress at different growth stages on the plant height of onion varieties is presented in Table 1. Plant to which moisture stress was imposed at 10-50 days had the least plant height (8.57cm) at 4 WAS. The value was statistically similar to plants that were watered every day. Similar trend was observed at 8 and 12 WAS but at 16 WAS, plant stressed at 10-50 days PS appeared to have overcome the initial stress having statistically similar plant height with plants watered at three days interval throughout the growth stages. Plants watered throughout the growth stages at three days interval had the tallest plants throughout the sampling period except at 4 WAS. The varieties responded to moisture stress in similar ways as there was no significant difference (p>0.05) among the varieties in respect of plant height throughout the sampling period. The interaction between moisture stress treatments and varieties were not also significant

The effect of moisture stress at different growth stages on the number of leaves of onion varieties is presented in Table 2. There was no significant difference between the moisture stressed and control plants at 4 WAS. At 8 WAS however, the plants stressed at the different growth stages had similar number of leaves which were significantly lower than the values recorded in the non-stressed plants watered at 3 days interval. Daily watered plants had similar lower number of leaves like the plant stressed at different growth stages. Similar trend was observed at 12 WAS. At 16 WAS however, plant stressed at the bulb formation stage had the least number of leaves. The value obtained was however similar to what was recorded in the daily watered plants. The highest number of leaves was recorded in the non-stressed plants watered at 3 days interval throughout the sampling period. There was no significant difference among the varieties in respect of the number of leaves throughout the sampling period.

Table 3 shows the effect of moisture stress at different growth stages on the bulb size and yield of onion varieties. The stressed plants produced significantly shorter bulbs than the non-stressed plant watered at 3 days interval except plants stressed at mid growth stage (three to seven leaf stage) which had statistically similar bulb length with the non-stressed plants. The daily watered plants also had similar short bulb with the drought stressed plants. Bulbs of the daily watered plants were the smallest (with the least bulb diameter). The value obtained was however statistically similar to what was recorded in plant stressed at the early (flag leaf emergence to two true leaves stage) and mid growth stage. Non stressed plants watered at 3 days interval throughout the growth stages had the highest yield (4299.95 kg ha-1). Moisture stress at flag leaf to two true leaf stage reduced onion yield by 57.74% compared to the non-stressed plants. While drought stress at mid growth stage and bulb formation stage reduced bulb yield by 40% and 48.54 % respectively compared to the non-stressed plants. The highest yield reduction (59.22%) was observed in the daily watered plants when compared to the non-stressed plant watered at three days interval throughout the growth stages. The value obtained (1753.35 kg ha-1) were however similar to the bulb weight recorded in plants stressed at the flag to true leaf stage (1817.35 kg ha-1). There was no significant difference among the varieties in respect of the bulb length and diameter. Sivan variety produced the highest bulb yield (2754.15 kg ha-1) but statistically similar to the value recorded in Red creole, Prema and Wuyan Bijimi. The least yield was obtained in Wuyan makwarma (2018.55 kg ha-1).

Table 1: Effect of moisture stress at different growth stages on the plant height(cm) of onion varieties

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments** | **Weeks after sowing** | | | 16 |
| 4 | 8 | 12 |
| **Moisture stress (M)** |  |  |  |  |
| 10 – 50 days | 8.57c | 14.26b | 18.89b | 36.46a |
| 50 – 90 days | 10.83a | 17.23a | 21.37a | 35.62ab |
| 90 – 140 days | 10.13ab | 15.55ab | 20.97a | 36.20ab |
| Daily watering | 9.21bc | 15.17b | 19.88ab | 32.79b |
| 3 days Interval watering | 10.27ab | 17.39a | 21.65a | 39.17a |
| **LSD (0.05)** | 1.14 | 1.96 | 1.95 | 3.67 |
| **Varieties (V)** |  |  |  |  |
| Red creole | 9.65a | 15.66a | 19.83a | 35.75a |
| Sivan | 9.69a | 15.93a | 20.97a | 36.77a |
| Prema | 10.17a | 16.63a | 21.68a | 36.32a |
| Wuyan makwarwa | 9.88a | 16.44a | 20.09a | 36.47a |
| Wuyan bijimi | 9.64a | 14.93a | 20.19a | 34.92a |
| **LSD (0.05)**  **Interaction M x V** | 1.14 | 1.96 | 1.95 | 3.67 |
|  | NS | NS | NS | NS |

Means followed by same letter(s) in a column within the same factor are not significantly different at 5% level of probability using least significant difference (LSD). NS- Not significant

Table 2: Effect of moisture stress at different growth stages on the number of leaves of onion varieties

**Treatments Weeks after sowing**

4 8 12 16

**Moisture stress (M)**

10 – 50 days 2.00a 3.13b 4.00b 6.07b

50 – 90 days 2.13a 3.07b 4.07b 5.80bc

90 – 140 days 2.00a 2.93b 4.20ab 5.40c

Daily watering 2.27a 3.13b 4.07b 5.47bc

3 days watering interval 2.46a 3.60a 4.73a 6.80a

**LSD** (**0.05)** 0.49 0.41 0.56 0.66

**Varieties (V)**

Red creole 2.07a 3.07a 4.07a 6.07a

Sivan 2.33a 3.27a 4.33a 6.20a

Prema 2.13a 3.13a 4.13a 5.60a

Wuyan makwarwa 2.20a 3.27a 4.40a 5.93a

Wuyan bijimi 2.13a 3.13a 4.13a 5.73a

**LSD (0.05)** 0.49 0.41 0.56 0.67

**Interaction (M x V) NS NS NS NS**

Means followed by same letter(s) in a column within the same factor are not significantly different at 5% level of probability using least significant difference (LSD). NS- Not significant

Table 3: Effect of moisture stress at different growth stages on the Bulb length, bulb diameter and bulb yield of onion varieties

**Treatments Bulb length (cm) Bulb diameter (cm) Bulb yield (kg ha-1)**

**Moisture stress (M)**

10 – 50days 4.49b 4.08bc 1817.35c

50 – 90days 4.83ab 4.09bc 2583.15b

90 – 140days 4.47b 4.36b 2212.75bc

Daily watering 4.52b 3.89c 1753.35c

3 days watering interval 5.07a 5.43a 4299.95a

**LSD (0.05)** 0.53 0.30 715.6

**Variety (V)**

Red creole 4.54ab 4.42a 2664.15ab

Sivan 5.06a 4.27a 2754.15a

Prema 4.55ab 4.45a 2548.55ab

Wuyan makwarwa 4.69ab 4.23a 2018.55b

Wuyan bijimi 4.53b 4.49a 2681.15ab

**LSD (0.05)** 0.53 0.30 715.6

Interaction (M xV) NS NS NS

Means followed by same letter(s) in a column within the same factor are not significantly different at 5% level of probability using least significant difference (LSD). NS- Not significant

DISCUSSION

Drought stress significantly reduced the growth and yield of the onion varieties compared to the non-stressed plants in this study. This was expected as water is needed for cell division and elongation which is responsible for increase in plant growth. Onion is a shallow-rooted plant that requires frequent irrigation to achieve good yield. Drought induces a complex array of responses in plants including stomatal closure, reduced turgor pressure, altered leaf gas composition and reduced photosynthesis rates leading to reduced growth and crop yield (Farooq *et al*., 2012). Al-Jammal *et al*. (2000) reported that onions under water deficiency decrease in its evapotranspiration and consequently yield. Plants watered daily similarly had reduced growth and bulb yield like the drought stressed plants. This is an indication of overwatering which results to flood stress in plants. Too much soil moisture presents another extreme condition for plants leading to inhibition of gas exchange; oxygen is depleted which restricts respiration and therefore causes energy imbalance and reduction of photosynthesis. Olalla F. *et al*. (2004) reported that the lower the volume of water onion received, the higher the efficiency obtained. However, if the volume of water is low enough to induce moisture stress in the plant, growth and yield will be affected.

There was significant reduction in the plants performance when drought stress was introduced at the different growth stages but plant stressed at the early growth stage; flag leaf to two true leaf stage appears to be more affected. Pelter *et al* (2004) similarly reported that moisture stress at 3-7 leaf stage reduced onion bulb yield by 26% compared to the control which were irrigated throughout the growth stages. Contrary to the result obtained in this study however, Dirirsa *et al* (2021) reported that moisture stress at early growth stage did not significantly reduce the bulb yield of onion. The difference may be as a result of the extent of the moisture stress in the two studies as well as the varieties used. Plants stressed at the early growth stage had the least survival rate in this study. This contributed to the reduced yield recorded compared to the moisture stress imposed at other stages. The mid growth stages was not as affected as much as early growth and bulb formation stage in this study. Dirirsa et al (2021) similarly reported that depriving onion water at bulb formation stage resulted in lower bulb yield compared with the other stages. The significantly lowest number of leaves recorded in plant stressed at the bulb formation stage may be attributed to preferential partitioning of assimilates to bulb at this stage which is further aggravated by insufficient moisture. At reproductive stage, plants partition more assimilates to the reproductive structures than other organs. With the occasion of drought stress, the plant will rather partition the little assimilate available to the reproductive structures than the leaves. This explains why the drought stressed plant senesce faster. Sivan variety produced significantly higher yield than Wuyan makwarwa in this study. This may be attributed to the fact that Sivan is a hybrid and Wuyan makwarwa a landrace. Hybrids possess higher yield traits and tolerance/resistant to environmental stress than unimproved varieties. Adediran (2020) reported between 143-318% increase in grain yield and gross margin increase by 300% and above in cowpea when some improved varieties were used compared to landraces.

CONCLUSION

Drought stress significantly reduced the growth and yield of the onion varieties tested at all the growth stages compared to the control. However, drought stress introduced at the early growth stage (flag leaf to two true leaf stage) appeared to be more critical. Furthermore, overwatering significantly affected onion growth and yield more than drought stress hence should also be avoided as much as drought stress in onion production. Watering at 3 days interval throughout the growth stages is therefore recommended for optimum performance of onion in the agro-ecology.

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## WEEDING FREQUENCY EFFECT ON GROWTH AND YIELD OF MAIZE IN SOUTHERN GUINEA SAVANNAH

\*Mamudu, A. Y., Salawu, A. I., Oyewale, R.O.

Department of Crop Production Federal University of Technology Minna, Niger State, Nigeria

*\*Corresponding Author:* a.mamudu@futminna.edu.ng

ABSTRACT

A field trial was conducted in 2018 cropping season on the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano campus to investigate the effect of weeds on the growth and yield of maize and determine the best time and frequency of weeding for optimum yield. The Treatments (no weeding (control), weeding at 2WAS, weeding at 4WAS, weeding at 6WAS, weeding at 8WAS, weeding at 10WAS, weeding at 2 and 4WAS, weeding at 4 and 6WAS, weeding at 6 and 8WAS, weeding at 8 and 10WAS) were layout in a randomized complete block design (RCBD), replicated three (3) times. The data collected on various parameters were subjected to analysis of variance (ANOVA) using statistical package (SAS 2016) and means were partitioned using Duncan multiple range test (DMRT) at 5% level of probability. The results obtained showed that the use of hybrid maize variety with early weeding at 4 and 6WAS which resulted in lower weed cover score, lower weed dry weight, lower number of days to 50% tasseling, maize taller plant, high maize cob weight and high yield could be an effective weed management strategy.

**Keywords:** Maize, Weeding frequency, Growth; Yield

INTRODUCTION

Maize (*Zea mays* L.) has long been seen to be one of the world's most promising cereal grains for human consumption (Tandzi and Mutengwa 2020). Among the factors constraining the production of maize in the tropics are inadequate supply of nutrients in the soil most especially nitrogen and intense competition with weeds. At the early stage of crop growth and development, the weed and rice plant requirements for nutrients are met but as growth advances for the two plant species, the nutrient supply normally falls short of the combining demands leading to competition (Musa and Timbale 2013). Maize is highly susceptible to weed competition particularly at the early stage of growth. In Nigeria, yield losses as high as 51 to 100% have been recorded in maize due to weed competition (Akobundu and Ekeleme 2000). According to Rao and Kang (Rao and Kang 2010), high cost of inputs such as fertilizer, improved seeds were of no use if not accompanied with efficient weed control. Maize (*Zea mays L*) is a member of the family Graminae and it is an annual crop serving as a good source of food for human consumption in form of maize powder, maize meal and confectionaries such as bread, biscuits and cakes. Maize is world’s one of the three most popular cereal crops. It is grown worldwide on approximately 130 million ha annually with a production of 574 million metric tons (Itos 1998). For the past five decades, since Nieto *et al*. (1968) introduced the concept of ‘critical periods of the crop growth cycle for competition from weeds’, it has been accepted by the international community that there are certain periods in the life cycle of a crop when weeds pose challenges to the resource competition and must be removed to accelerate crop growth; it is believed that thereafter the presence of weed species could insignificantly interfere with crop yield. In particular, the concept considers the period from sowing to a specific stage/phase of the crop to advocate cultural, mechanical or chemical weed management practices. Critical period of weed control (CPWC) consider the yield loss due to the presence of all weeds present in the crop cycle. The CPWC is the time interval between the critical timing of weed removal (CTWR) and the critical weed-free period (CWFP), and the weed presence before and after the extremes of CTWR and CWFP may not significantly reduce crop yield. Although CPWC has been defined in different ways, it is generally accepted that CPWC is a time interval between two components viz., the critical timing of weed removal (CTWR) and the critical weed-free period (CWFP), and the weed presence before and after CPWC should not significantly reduce crop yield. In general, three relationships exist in CPWC (Nadeem *et al*., 2013): (a) Maintaining the crop weed-free for the same duration that a weed infestation can be tolerated to avoid yield loss if weed control is performed during this period; (b) CWFP is lesser than CTWR so that yield loss will not occur if weeds are managed between these extremes; and (c) CWFP is of no longer duration than the CTWR, the crop must be kept weed-free between these timings to prevent yield loss. Knezevic *et al*. (2002) considered CPWC as a window for the removal of weedy species. IITA (2007) also reported that weedness of maize field may increase the incidence of insect pest infestation which can cause yield loss to about 60-85%.

MATERIALS AND METHODS

A field trial was conducted in 2019 cropping season at the Teaching and Research Farm of the Federal University of Technology, Gidan Kwano Campus Minna, Niger State, located in the Southern Guinea Savannah Agro-ecological Zone of Nigeria. The Treatments (no weeding (control), weeding at 2WAS, weeding at 4WAS, weeding at 6WAS, weeding at 8WAS, weeding at 10WAS, weeding at 2 and 4WAS, weeding at 4 and 6WAS, weeding at 6 and 8WAS, weeding at 8 and 10WAS) were layout in a randomized complete block design (RCBD). Two seeds were sown per hole at 25cm by 75cm intra and inter-row spacing respectively and later thinned to one per stand after two weeks. Weeding was done according to the experimental treatment. N.P.K 15:15:15 was applied at the rate of 180kg N, 90kg P205 and 90kg K2O ha-1 plant stand at 3WAS. Data were collected on weed cover score, weed dry matter, maize plant height, number of days to 50% tasseling, dry cob weight and grain yield. Weed cover score was taken from each plot on visual rating 1 to 6, where, 1- Clean plot, 2- Moderately Clean plot, 3- Fairly Clean plot, 4- Moderately weedy plot and 5- Fairly weedy. Samples of fresh weed were taken from a 50cm quadrant thrown in each net plot prior to each weeding operation at 6, 8 and 10 WAS. The weed samples were weighed to obtain the fresh weight, oven dried at 700c to a constant weight and weighed to obtain dry matter content (grams per m-3).Plant height of the randomly tagged selected maize plants were measured using measuring tape from the ground levels to the apex of the flag leaf at 4, 6, and 8 WAS. The number of days to 50% tasseling was taken by visual observation and recorded, the maize cobs weight were randomly sampled per each plot and weight using weight balance in gram (g). Maize grain yield from each plot after shelling and winnowing were weighed with a meter balance and expressed in gram(g).The data collected were subjected to analysis of variance (ANOVA) using statistical package (SAS 2016) and means was partitioned using Duncan multiple range test (DMRT) at 5% level of probability.

RESULTS

Effect of time of weeding and weeding frequency on weed cover score and weed dry weight

Weeding at 4 and 6WAS significantly (P<0.05) recorded lower weed cover score compared to other treatments and control (Table 1). Weeding at 2WAS, 6WAS and 4 and 6W was significant, implying that they succeeded in reducing weed plants as compared to other treatments (Table 1).

Effect of time of weeding and weeding frequency on maize plant height and number of days to 50% tasseling

Plant heights were significantly difference (p < 0.05) throughout the sampling period, weeding at 2 and 6WAS produced taller plant height compared to other treatments (Table 2). Lower number of days to 50% tasselling was seen on weeding at 2 and 4WAS compared to other treatments

Effect of time of weeding and weeding frequency on maize cob weight and grain yield

The effect of time of weeding and weeding frequency on cob weight were differed significantly (p < 0.05) in which treatment with weeding at 4 and 6WAS recorded higher cob weight compared to other treatments (Table 3). Grain yield were significantly difference (p < 0.05) with weeding at 4 and 6WAS recorded higher grain yield compared to other treatments

Table 1: Effects of time of weeding and weeding frequency on weed cover score and weed dry weight.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | Weed Cover Score | | |  | Weed Dry Weight | | |
| 4WAS | 6WAS | 8WAS |  | 6WAS | 8WAS | 10WAS |
| No Weeding (Control). | 5.00a | 5.67a | 6.00a |  | 35.38a | 59.20a | 63.62a |
| Weeding at 2 WAS | 3.00d | 3.33d | 3.67c |  | 12.14c | 22.41c | 40.61b |
| Weeding at 4 WAS | 3.33c | 2.67d | 3.67c |  | 10.78d | 17.67d | 37.18b |
| Weeding at 6 WAS | 4.33b | 4.67b | 2.33d |  | 30.03b | 14.26d | 12.90d |
| Weeding at 8 WAS | 4.33b | 4.67b | 4.33c |  | 33.21a | 39.26bc | 12.74d |
| Weeding at 10 WAS | 4.67ab | 5.33ab | 5.00b |  | 34.81a | 57.97a | 57.77ab |
| Weeding at 2 And 4 WAS | 4.33b | 2.67d | 2.00d |  | 13.72c | 14.75d | 17.79c |
| Weeding at 4 And 6 WAS | 4.67ab | 2.67d | 2.00d |  | 12.90c | 13.83d | 15.15c |
| Weeding at 6 And 8 WAS | 4.33b | 4.38b | 4.00c |  | 30.69b | 14.81d | 12.35d |
| Weeding at 8 And 10 WAS | 4.67ab | 5.67a | 5.76ab |  | 31.44b | 46.19b | 57.12a |
| SE ± | 0.22 | 0.33 | 0.39 |  | 21.61 | 5.45 | 4.67 |

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05. WAS: Week after Sowing

Table 2: Effect of time weeding and weeding frequency on maize plant height and number of days to 50% tasselling

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Treatment | Plant Height (cm) | | | Days to 50% tasseling | |
| 6WAS | 8WAS | 10WAS |  |  |
| No Weeding (Control). | 60.40d | 115.00d | 158.33d | 63.33 a |  |
| Weeding at 2 WAS | 80.87a | 133.67c | 166.33cd | 57.67bc |  |
| Weeding at 4 WAS | 75.93b | 131.33c | 183.33bc | 59.33abc |  |
| Weeding at 6 WAS | 66.33c | 117.33b | 193.33b | 59.33 abc |  |
| Weeding at 8 WAS | 63.40c | 130.00c | 180.67bc | 60.00 abc |  |
| Weeding at 10 WAS | 64.43c | 117.00d | 171.33c | 60.67 ab |  |
| Weeding at 2 And 4 WAS | 81.87a | 179.00a | 201.67a | 54.67 c |  |
| Weeding at 4 And 6 WAS | 70.03bc | 153.00b | 198.00a | 57.67bc |  |
| Weeding at 6 And 8 WAS | 68.27bc | 137.67bc | 175.67bc | 62.00 ab |  |
| Weeding at 8 And 10 WAS | 62.33cd | 117.00d | 166.00cd | 62.33 ab |  |
| SE ± | 1.83 | 4.06 | 4.15 | 0.63 |  |

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05. WAS: Week After Sowing.

Table 3: Effect of time of weeding and weeding frequency on cob weight and grain yield

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatment** |  | **Cob weight (g/plot)** | **Grain Yield (g)** |
| No Weeding (Control). |  | 2833.3 b | 2133.3cd |
| Weeding at 2 WAS |  | 3633.3 ab | 2066.7cd |
| Weeding at 4 WAS |  | 3000.0 b | 2166.7cd |
| Weeding at 6 WAS |  | 3466.7 ab | 2733.3bc |
| Weeding at 8 WAS |  | 3433.3 ab | 1933.3cd |
| Weeding at 10 WAS |  | 2700.0 b | 1833.3d |
| Weeding at 2 And 4 WAS |  | 4400.0 a | 3500.0ab |
| Weeding at 4 And 6 WAS |  | 3733.3 ab | 3633.3a |
| Weeding at 6 And 8 WAS |  | 3400.0 ab | 2700.0bcd |
| Weeding at 8 And 10 WAS |  | 2966.7 b | 2233.3cd |
| SE ± |  | 133.97 | 131.99 |

Means followed by the same letter(s) on a column are not significantly different according to Duncan Multiple Range Test (DMRT) at p=0.05.WAS: Week after Sowing.

DISCUSSION

Lower weed cover score and lower dry weight in weeding at 4 and 6WAS could be as a result of the ability of the treatments to reduce weed presence which did not allowed weeds to grow to maturity thus, could not be woody at that time and produced the lower dry weight compared to other treatments. This is in agreement with the work of Rao, (2000) who reported that weed controlled within two or three weeks of emergence reduces weed covers score and weed dry weight. Taller plant heights recorded could be as a result of lower weed presence and early weeding intervention at 4 and 6WAS, better weed management ecreased competition for resources thus, provided optimum supply of resources for growth and development of maize which has translated into taller height. This is in agreement with the finding of Ofunsun-Anim and Limani (2007) reported that provided weeds were subsequently removed, infestation for the first 3WAS did not have adverse effects on the growth and yield of crops. Number of days to 50% tasseling could be as a result of early weeding which helps the plant to have good head start over the weeds. This is in agreement with the findings of Adeosum (2005), Ado (2007) and Osipitan (2010) who all reported that critical period of weed competition occurs during the first 40 days of most crop growth. Higher Cob weight and grain yield could be as a result of lower weed cover and taller plant height which has translated into better yield. This is in agreement with the finding of Shinggu *et al.,* (2009) who reported that effective weed control measures in maize during the first 4-5 weeks after sowing are essential for maximizing the yields in maize.

CONCLUSION

On the basis of this study it is suggested that the use of hybrid maize variety with early weeding at 4 and 6WAS which resulted in lower weed cover score, weed dry weight, taller plant, therefore, it is advisable for the farmers or the growers of maize to do their first weeding 4-6weeks after planting in order to get optimum yield.

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EFFECT OF FOLIAR FERTILIZER APPLICATION ON PHYSIOLOGICAL CHARACTERISTICS AND HERBAGE YIELD OF AMARANTHUS AND CORCHORUS.

Ameh, B.K\* Saidu, A.\*Tolorunse, K.D and Daniya.E

Department of Crop Production, Federal University of Technology, P.M.B 65 Minna Niger State-Nigeria

\*Corresponding author: [kizitobarthlome@gmail.com](mailto:kizitobarthlome@gmail.com) +2348165045418,08054785060

Crop Production

ABSTRACT

One-third of children deaths in Africa are attributable largely to protein energy malnutrition and micronutrient deficiencies which can be solved by exploring underutilized nutritious crop. Experiment was conducted at the Crop Production Screen House and Albishiri Irrigation Farm both in Minna during the dry Season of 2021. The objective was to determine he effect of application of organic foliar fertilizers rates on physiology and yield response of leafy vegetables in Minna. The experiment consisted of factorial combination of (10 treatments) in completely randomized design and five rates of foliar fertilizer 0 L ha-1, 0.5 L ha-1, 1.0 L ha-1, 1.5 L ha-1 and 2.0 L ha-1 and total of 40 pots. Data were collected on plant height, number of leaves, fresh shoot weight and dry weight, leaf area The results indicated that, the effects of organic foliar fertilizer rates on plant height at 4,5 and 6 WAS rate of 2.0 L ha-1 produced significantly taller plant the lowest plant height, Number of Leaves respectively it is therefore recommended that farmer should adopt the application of organic foliar fertilizer(Super Agro) at the rate of 2.0 L ha-1.

**Keywords:** Foliar Fertilizer, Amaranthus, Corchorus, Irrigation, Herbage yield

INTRODUCTION

Vegetables refers to the fresh, edible part of a plant that can be consumed raw or cooked (Ward, 2016). This can be classified into fruit vegetables such as tomatoes, cucumber, okra; root and tuber vegetables such as potato, sweet potato, radish; green leafy vegetables such as amaranthus, celery, cabbage and bulb vegetables such as onion, garlic and shallot (Abewoy, 2018). Vegetables are important for nutrition in terms of bioactive nutrient molecules like dietary fiber, vitamins, and minerals (Keatinge et al., 2011). They are resources for overcoming micronutrient deficiencies and provide smallholder farmers with much higher income and more jobs (Abewoy, 2018). Vegetable are produced all over the world but in a varied extent. Asia is the largest vegetable producer. China and India is the two largest vegetable producer of Asia covering 62 % of world’s total production with an individual country contribution of 554 and 127 million metric tons respectively (Shahbandeh, 2020). However, on the way of achieving higher yield, they face various challenges such as climate change impacts (Kabir, 2015). Therefore the objectives are to determine the effect of foliar application of organic fertilizer rates on physiology and yield responses of leafy vegetables, to investigate the factors that influence utilization and production of the leafy and nutritional quality of leafy vegetable under the application of different rates of foliar fertilizer.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted in the dry season of 2021 at the Crop Production Screen House Federal University of Technology and Albishiri Irrigation Farm both Minna (9O 37’N, 6O 28’E). In the Southern Guinea Savanna of Nigeria.

Soil Collection and Sampling of the field experiment

Soil samples were ollected at random across the experimental site at the depth of 0 – 15cm along a transect and then bulked together to form the composite sample.

Experimental materials

Landraces of Amaranthus and corchorus varieties were obtained from the irrigation farmers in Minna Niger State and it was used for the experiment.

Source of foliar fertilizer and its active ingredient

Foliar fertilizer was obtained from an Agro-chemical shop in Minna. The Super gro fertilizer contained Nitrogen 72 g, Phosphorus 45 g, Potassium 30 g, Sulphur 15 g, Calcium 9 g, Magnesium 7 g, Iron 5 mg, Iodine 3 mg, and Zinc 1 mg per litre.

Treatments and experimental design

The screen house experiment were factorial combination laid out in a completely randomized design (CRD) vegetables varieties (Amaranthus and Corchorus) and five rate of foliar fertilizer (Super Gro) (0 L ha-1, 0.5 L ha-1, 1.0 L ha-1, 1.5 L ha-1 and 2.0 L ha-1). A total of 40 (pots) treatments. The field experiment was a factorial combination laid out in a Randomized Complete Block Design (RCBD) with three replications.

Land preparation and check basin construction

The land was dug, ploughed and leveled. Then check basins of 3 m x 3 m were constructed the gloss plot size was 3m x 3m (9 m2) and a net plot of 1.5 m x 3 m (4.5 m2). An alley of 0.5 m was left between treatments and replicates.

Watering of pots and irrigation of plots

The pots were watered (3liter) before planting and watering was done every other day until harvest.

Data collection

Growth parameters

Five plants in each treatment plot were randomly selected and tagged for the measurements of growth parameter (Plant height, number of; leaves, stem girth, number of branches, leaf area) at 2, 3, 4 and 5 WAS. The length and breadth of the leaves were multiplied by a constant 6 and the mean was then calculated.

Fresh shoot weight (kg ha-1)

The fresh whole plants in pot were uprooted and the root washed of soil then weighed using a scale weighing balance, and then extrapolated to per hectare in the screen house.

Dry shoot weight (kg ha-1)

The fresh whole plants in pot were uprooted and the root washed of soil, oven dried (140°F)to a constant weight and then weighed using an electronic weighing balance in the laboratory.

Root length (cm)

The root length of five randomly selected plants were measured using meter rules and mean recorded for both screen house and field experiments.

Fresh Root weight

The root of five randomly selected plants were weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Dry Root Weight

The root of five randomly selected plants were oven dried to a constant weight then weighed using an electronic weighing balance in the laboratory and recorded for both screen house and field experiments.

Harvesting

The vegetables were harvested by uprooting the whole plant at maturity (6 WAS).

Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) using the Statistical Analysis System (SAS) package version 9.0 means were separated using Duncan Multiple Range Test (DMRT) at P≥0.05.

Table 1 Effect of foliar application of foliar fertilizer rates on plant height of

Corcurus and Amranthus at 4, 5 and 6 WAS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Plant height (cm) | | |
|  |  | Weeks after sowing | | |
| Treatment |  | 4 | 5 | 6 |
| **Fertilizer (F) (L ha-1)** |  |  |  |  |
| 0 |  | 28.85c | 39.23c | 46.95c |
| 0.5 |  | 40.81b | 60.18a | 66.60b |
| 1.0 |  | 50.85a | 59.60a | 67.60b |
| 1.5 |  | 41.39b | 52.43b | 72.37a |
| 2.0 |  | 51.83a | 63.97a | 73.60a |
| SE± |  | 1.82 | 2.24 | 1.24 |
| **Vegetables (V)** |  |  |  |  |
| Amaranthus |  | 58.62a | 77.06a | 89.92a |
| Corchorus |  | 26.87b | 33.11b | 40.92b |
| SE± |  | 1.15 | 1.42 | 0.78 |
| **Interaction** |  |  |  |  |
| F × V |  | \*\* | \*\* | \*\* |
|  |  |  |  |  |

Means with the same letter(s) under the same column are not significantly different from each other at P≤ 0.05 by DMRT.

Table 2: Effect of foliar application of organo mineral fertilizer rates on plant height of

some vegetables at 4, 5 and 6 WAS grown under irrigation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | Plant height (cm) | | |
| Treatment |  | 4WAS | 5WAS | 6WAS |
| **Fertilizer (F) (L ha-1)** |  |  |  |  |
| 0 |  | 11.02c | 17.64c | 31.47c |
| 0.5 |  | 16.18b | 29.08b | 41.48b |
| 1.0 |  | 24.33a | 36.37ab | 52.75a |
| 1.5 |  | 22.85a | 31.48b | 52.93a |
| 2.0 |  | 23.60a | 39.56a | 57.25a |
| SE± |  | 1.48 | 2.57 | 2.87 |
| **Vegetables (V)** |  |  |  |  |
| Amaranthus |  | 26.72a | 43.26a | 65.84a |
| Corchorus |  | 12.47b | 18.39b | 28.51b |
| SE± |  | 0.93 | 1.62 | 1.81 |
| **Interaction** |  |  |  |  |
| F × V |  | \*\* | \* | NS |

Means with the same letter(s) under the same column are not significantly different at P≤ 0.05 by DMRT.

Discussion

The tallest plants obtained with the application of foliar fertilizer (Super gro) at the rate of 2.0 L ha-1 could be attributed to the availability of sufficiently high content of macro and micro nutrients in the foliar fertilizer which in turn provided the plants with required nutrient that may be insufficiently supplied through the root system in the soil. This finding is in conformity with the results of Shafeek *at al*. (2013) who reported that the superiority of highest levels of Stimufol foliar nutritional compound fertilizer at the highest levels of 200 g enhancing plant growth may be attributed to its high contents of macro and micro nutrients which provides the plants with required nutrients which one or more of them were insufficiently supplied through the root system in such low fertile soil. The authors also stated that foliar feeding is often the most effective and economical way to correct plant nutrient deficiencies. Abou-El-Nour (2002) reported that foliar application of nutrients could improve the nutrient utilization and lower environmental pollution through reducing the amounts of fertilizer added to soil.

Conclusion

From the results obtained it is concluded that the application of organo mineral fertilizer at the rate of 2.0 L ha-1 should be adopted in this agro ecological Zone.

Recommendation

It is recommended that farmers in this agro-ecological zone of Nigeria should adopt the application of (Super gro) at the rate of 2.0 L ha-1 for higher growth, yield and nutritional qualities of Amaranthus and Corchorus.

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## RESPONSE OF SESAME (*Sesamum indicum* L.) TO DIFFERENT NUTRIENT SOURCES IN ANYIGBA, KOGI STATE, NIGERIA

Yusuf M.1\*, Akowe, I. I 2, Beida, A. S2, Iyaji, J.2, Abdulhakeem, S.2, Alao, A. O.3

1,2 Department of Agricultural Technology, Kogi State Polytechnic, PMB 1101 Lokoja, Kogi State Nigeria.

3Department of Agricultural Economics and Extension, Ladoke Akintola University of Technology, PMB 4000 Ogbomoso, Oyo State Nigeria.

\*Corresponding Author: [*momohjimohyusuf@kogistatepolytechnic.edu.ng*](mailto:momohjimohyusuf@kogistatepolytechnic.edu.ng)

ABSTRACT

This field experiment was conducted during the 2021 cropping season at the Prince Abubakar Audu University Research and Demonstration farm, Anyigba. The study investigated the comparative effect of Cow dung (CD), Poultry manure (PM) and NPK fertilizer on the seed emergence, growth and yield of sesame. The research consisted of three sources of fertilizer (Cow dung, Poultry manure and NPK fertilizer), fifteen (15) treatments in total with each factor consisting of five levels of application (0, 150, 300, 450, 600 kg/ha) respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD), with three (3) replications. Parameters measured include: Days to seedling emergence, plant height, number of leaves, number of branches, stem girth, number of capsules, fresh weight of capsules, dry weight of capsules and seed weight/plot. Growth and yield characters measured were significantly influenced by 300 kg/ha NPK fertilizer and 600 kg/ha of cow dung and 600 kg/ha poultry manure respectively. however, cow dung had no significant influence on number of capsule/plant. Highest seed yield was obtained at 600 kg/ha poultry manure and thus recommended. Alternatively, integrated use of 300kg/ha NPK + 600kg/ha PM will suffice for best performance given their complementary use.

**Keywords**: Cow dung, Integrated Nutrient Use, NPK fertilizer, Poultry manure, Sesame.

INTRODUCTION

Sesame (sesame indicium L) belongs to the family Pedaliaceae. The genus consists of about thirty-six species of which the most commonly recognized is Sesame indicum L popularly known as beniseed in Nigeria (Alegbejo et al., 2003). It is an erect, flowering annual plant which grows 50 cm to 250 cm tall or more, as determined by the soil or environmental conditions and varieties (Sharma, 2005). Sesame is usually propagated by seeds and matures in 70 to 120 days after sowing, depending on the variety (Indu and Savithri, 2003). Sesame originated from the tropical Africa where the greatest genetic diversity exists but was believed to have been introduced to India at a very early date, where a secondary Centre of diversity is well developed (; Olaoye 2007). Its cultivation is now extended beyond the tropical and subtropical zones to temperate and sub temperate zones of the world (Boureima *et al*., 2007). Sesame utilization includes human consumption, health treatments, beautification, livestock feeding and industrial uses (Sharma, 2005; El- Habbasa *et al*., 2007).

Sesame is produced mainly in savanna agro- ecological zones of Nigeria by small holders' farmers on relatively poor soils with limited inputs, thereby resulting in low average yield. Among the traditional sesame growers in Nigeria (particularly in the north central part), fertilizer application has not been a common practice because it is considered as a minor crop and can do well even on poor soils (Haruna and Usman, 2005). However, nutrition studies in the tropics have shown that the crop perform well with the applications of organic and/or inorganic fertilizers (Olowe and Busari, 2000; Okpara *et al*, 2007). The growth and yield of Sesame when fertilizer is not applied are generally low.

The average yield of sesame obtained by Nigerian farmers is reported to be 300 - 350 kg ha-1 in Nigeria when compared to Venezuela (1960 kg/ha), Saudi Arabia (1083 kgha-1) (Okpara *et al*. 2007).

Manures such as cow dung and poultry manure are key fertilizers in organic and sustainable soil management. They contain many of the elements that are needed for plant growth and development. Apart from increasing soil fertility, manure serve as soil amendment by adding organic matter to the soil. Organic manure has also been reported to greatly improve water holding capacity, soil aeration, nutrient retention and microbial activity (Anonymous, 2007). Cow dung is an important source of nitrogen for crops. It helps farmers reduce inputs of commercial fertilizer, thereby increasing the profit margin of the farmers. Nutrients contained in cow dung are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect (Shama and Mittra, 1991) thus supporting better root, development, leading to high crop yields.

NPK fertilizer application on the other hand is an important option that should be adopted in order to improve crop yields in most soils of the Northern parts of Nigeria and most parts of Africa because Nitrogen, Phosphorus and Potassium are among the limiting nutrients of the savanna soils. Adequate supply of Nitrogen is beneficial for carbohydrates and protein metabolism, promoting cell division and cell enlargement.

Today in most part of Kogi State, specifically the eastern part of the state, little or no fertilizer have been implored in sesame production. However, Anyigba soil is generally known to be constrained with limiting Nitrogen and supplementary nutrient use is required to improve crop yield. Hence, the need to conduct performance evaluation on the nutrient sources to adduce a prescription on rates of application for optimum yield in this location. Therefore, the objective of this research was to determine the effect of different nutrient sources on the growth and yield of sesame at Anyigba.

MATERIALS AND METHODS

Description of the study site

This field study was conducted during the 2021 cropping season at the Prince Abubakar Audu University Research and Demonstration farm, Anyigba, Kogi State Nigeria. The State is situated on latitude 7o 29' N and longitude 7o 11' E on elevation of 420 m above sea-level. Anyigba is located within the Southern Guinea Savannah Ecological Zone of Nigeria. It is characterized by an average rainfall of about 180 mm per annum mostly distributed between the months of April and October. Mean monthly minimum and maximum temperature of about 17o C and 36.2o C respectively. The soils generally are sandy to sandy-loam. Mean Monthly temperature varies between 15.1o C and 31.3o C. (Metrological Station Data, 2019).

Treatment and Experimental Design

Soil sample from the experimental location was obtained using tubular auger, bulked and analyzed for its physio-chemical properties at the Soil and Environmental Management Laboratory, Prince Abubakar Audu University, Anyigba (results presented in table 1). N, P & K composition of cow dung and poultry manure used in the experiment was also analyzed and result presented in table 2.

The experiment consisted of a total of 15 treatments laid in a Randomized Complete Block Design (RCBD) with three replications. Treatments consisted of cow dung, poultry manure and NPK 15:15:15 fertilizer, each applied at varying rates; 0 kgha-1, 150 kgha-1, 300 kgha-1, 450 kgha-1, and 600 kgha-1 respectively. Forty-five plots (15 x 3) were obtained in total, each measuring 3m x 4m (12m2). Each plot was separated by 0.5 m discard row to minimize variation within replications. Each replication was also spaced 1.0 m apart to minimize inter replication variation. Treatments were assigned equally to every plot with a random number system to avoid biasness. Total land area used for the experiment measures 67.5m x 11.0m = 742.50m2 (0.0743ha). Sesame seeds (variety E-8) and NPK fertilizer were sourced from Kogi State Agricultural Development Project (ADP), Anyigba branch office. Cow dung and poultry manure was obtained from Kogi State University Livestock Teaching and Research Farm. Sowing was done on ridges of 75cm apart by means of seed drilling at rate of 5kg/ha and a depth of 1.5 cm as described by Bruno (2014). Cow dung and Poultry manure was incorporated into the soil and then left on the field to decompose into the soil for two weeks, before sowing the sesame seeds since they are slow in releasing nutrients to the soil, NPK fertilizer was applied to the plots at the time of sowing.

Cultural practices

Weed Control

Weeding was done manually by simple hand pulling at every point of appearance on the plots The inter plot weeds and discard rows were hoed.

Insect Pest and Disease Control

No visible insect pest was observed during the period of the experiment, however, experimental field was kept drained to prevent root and stem diseases associated with waterlogging and damping-off diseases.

Data Collection and Analysis

Data was collected on the following growth and yield parameters; germination count, plant height, number of leaves, stem girth, number of branches/plant, capsules/plant, fresh capsule weight/plant, dry capsule weight/plant and seed weight/plant.

Data collected were subjected to Analysis of Variance (ANOVA) as outlined by Steel and Torrie (1980). Separation of treatment means for significant effect was done using the fishers least significant difference (F-LSD)

RESULTS

Table 1. Physio-chemical Characteristics of the soil sample taken from the experimental site before the conduct of the experiment.

|  |  |
| --- | --- |
| Soil characteristics | Depth (0 – 30cm) |
| Particle size fraction |  |
| Sand (%) | 85.0 |
| Silt (%) | 9.6 |
| Clay (%) | 4.4 |
| Textured class | Sandy-loam |
| pH(H20) | 5.3 |
| Organic Matter (%) | 15.5 |
| Total Nitrogen (%) | 0.87 |
| Available P (mg/kg) | 5.35 |
| Exchangeable K (cmol/kg) | 0.17 |
| C.E.C (cmol/kg) | 10.13 |

Table 2: N, P & K composition of cow dung and poultry manure used in the experiment

|  |  |  |
| --- | --- | --- |
| Chemical composition | Cow dung (%) | Poultry manure (%) |
| Nitrogen | 1.56 | 1.98 |
| Phosphorus | 1.90 | 3.12 |
| Potassium | 1.06 | 1.11 |

Source: Soil and Environmental Management Laboratory, Faculty of Agriculture, Kogi State University, Anyigba.

Effect of Cow dung, Poultry manure and NPK Fertilizer on Growth characters of Sesame crop in Anyigba Kogi State.

Results obtained for application of Cow Dung, Poultry Manure and NPK fertilizer on growth characters of sesame is presented in table 3.

There were significant differences in heights of plants when treated with CD, PM & NPK fertilizer. Application of 600, 450 & 300kgha-1 CD gave taller plants which are statistically at par to each other. Control plots and application of 150 kgha-1 gave shorter plants while behaving alike. Similarly, 600 & 450 kgha-1 PM gave taller plants in the same manner followed by application of 300 & 150 kgha-1 of PM. Control plots gave the shortest height of sesame.

Application of 300 kgha-1 of NPK fertilizer produced the tallest plants (305.3cm) followed by 450 & 150 kgha-1 NPK which are significantly not different from each other. However, application of 150 kgha-1 NPK produced shorter plants.

Application of 600 kgha-1 CD gave plants which higher leaf numbers, this was however not significantly different from number of leaves produced when 450 & 300 kgha-1 CD was applied. Similarly, leaf numbers produced when 0, 150 & 300 kgha-1 CD was applied are statistically the same. PM behaved the same way as CD application. However, 300 kgha-1 of NPK produced crops with the highest number of leaves followed by application of 150 & 450 kgha-1 NPK. 600 kgha-1 and control plots gave the least number of leaves which are statistically at par.

Application of 600 & 450 kgha-1 CD produced higher number of branches which are significantly not different from each other, control plots, 150 & 300 kgha-1 CD responded in the same manner as they gave the same number of branches. PM fertilization behaved in the same manner with application of CD. NPK influenced branch number significantly as application of 300 kgha-1 produced plants with the highest number of branches which is significantly different from other NPK application rates. this was followed by 150, 450 & 600 0 kgha-1 respectively. Control plots gave the lowest number of branches.

CD, PM and NPK Fertilizer significantly influenced (P ≤ 0.05) the girth od sesame stems as presented in table 3. Application of 600 kgha-1 CD produced plants with thicker stems. However, this result was not significantly different from those obtained when 450 & 300 kgha-1 CD was applied. In the same manner, 450, 300 & 150 kgha-1 produced the same girth sizes of stems statistically. Control plots produced the thinnest stem girth.

Similarly, PM application behaved alike with CD application. 600 kgha-1 PM produced plants with thicker stems. This was statistically at par with those produced when 450 and 300 kgha-1 PM was used. Control plots also produced the thinnest stem girth.

Application of 300 kgha-1 NPK produced the thickest stem girth which was significantly different from other rates. 450 & 600 kgha-1 produced girths which are statistically the same. Also, control plots and application of 150 kgha-1 NPK gave the least girth sizes which are also at par to each other.

Table 3: Effect of CD, PM and NPK Fertilizer on growth characters of sesame crop in Anyigba environment.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Treatments (kgha-1)** | **Weeks after sowing** | | | |
|  | Plant height (cm) | Number of leaves/plant | Number of Branches/plant | Stem girth (cm) |
| CD |  | | | |
| 0 | 218.85b | 157.65c | 110.0b | 4.50c |
| 150 | 238.15b | 169.30bc | 114.95b | 4.63bc |
| 300 | 252.2a | 177.95abc | 117.9b | 4.85ab |
| 450 | 259.75a | 195.95ab | 144.55a | 4.90ab |
| 600 | 273.30a | 210.65a | 153.7a | 4.95a |
| F-LSD(0.05) | 29.1 | 32.9 | 11.2 | 0.30 |
| PM |  | | | |
| 0 | 221.85c | 157.75c | 112.50b | 4.50c |
| 150 | 247.30b | 179.65bc | 120.80b | 4.65bc |
| 300 | 253.90b | 188.65abc | 127.90b | 4.85abc |
| 450 | 263.10ab | 209.85ab | 150.00a | 4.95ab |
| 600 | 279.05a | 216.80a | 163.30a | 5.05a |
| F-LSD(0.05) | 24.8 | 32.9 | 18.8 | 0.40 |
| NPK |  | | | |
| 0 | 221.85c | 157.85d | 111.90e | 4.50c |
| 150 | 268.45b | 330.0b | 234.10b | 4.70c |
| 300 | 305.30a | 412.0a | 289.50a | 6.40a |
| 450 | 273.35b | 264.0c | 190.40c | 5.45b |
| 600 | 230.55c | 201.3cd | 146.65d | 5.35b |
| F-LSD(0.05) | 29.0 | 64.0 | 18.2 | 0.25 |

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 4: Effect of CD, PM and NPK Fertilizer on yield characters of sesame crop in Anyigba environment.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Yield Characters** | | | | | |
|  | Number of capsules/plant | | | Fresh capsule weight (g/plot) | | |
| **Treatments (kgha-1)** | Fertilizers | | | Fertilizers | | |
|  | CD | PM | NPK | CD | PM | NPK |
| 0 | 43.3 | 43.3b | 43.3b | 24.5b | 24.5bc | 24.5d |
| 150 | 44.3 | 56.6a | 76.6a | 24.6b | 25.8b | 61.1b |
| 300 | 46.6 | 58.3a | 86.6a | 27.2b | 29.3ab | 66.9a |
| 450 | 48.3 | 60.0a | 73.3a | 27.8b | 31.8a | 45.6c |
| 600 | 51.6 | 63.3a | 48.3b | 34.2a | 35.0a | 30.9d |
|  | | | | | | | |
| LSD (0.05) | ns | 8.5 | 16.3 | 5.8 | 6.2 | 5.7 |
| C.V (%) | 27.63 | 17.06 | 28.25 | 25.32 | 24.06 | 25.96 |

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 4 shows the effect of CD, PM & NPK on the number of capsule/plant and fresh capsule weight of sesame crop in Anyigba environment. Cow dung application had no significant influence (P ≥ 0.05) on capsules/plant. However, poultry manure and NPK fertilizer significantly influenced (P ≤ 0.05) number of capsules produced per plant. Application of 600 kgha-1 of PM gave the highest number of capsules/plant (63.3), this was however not significantly different from those obtained when 450 kgha-1, 300 kgha-1 and 150 kgha-1 of PM was applied. Control plots gave the least number of capsules (43.3).

Application of 300 kgha-1 of NPK gave the highest number of capsules/plant (86.6) this was however not significantly different from those obtained with 150 kgha-1 and 450 kgha-1 NPK application. Control plots and application of 600 kgha-1 of NPK gave the least number of capsules.

Similarly, CD, PM, & NPK significantly influenced fresh capsule weight of sesame crop in Anyigba environment (table 4).

Application of 600 kgha-1 of CD produced the highest weight of fresh capsule (34.2g), all other levels of application including the control pots are statistically at par.

Application of 600 kgha-1 PM also produced the highest capsule weight (35.0g). However, this result is not significantly different from those obtained when 300 kgha-1 and 450 kgha-1 PM was applied. Control plots and 150 kgha-1 PM gave the lowest fresh capsule weight (24.5g, 25.8g).

Alternatively, application 300 kgha-1 of NPK fertilizer produced the highest capsule weight (66.9g) which was significantly different from other application rates. this was followed by 150 kgha-1 (61.1g), 450 kgha-1 (45.6g) in that order. However, control plots and 600 kgha-1 NPK application produced the least shoot weight (24.5g, 30.9g).

Table 5: Effect of CD, PM and NPK Fertilizer on yield characters of sesame crop in Anyigba environment.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Yield characters | | | | | |
|  | Dry weight of capsules (g/plot) | | | Seed Yield (g/plot) | | |
| Treatments (kgha-1) | Fertilizers | | | Fertilizers | | |
|  | CD | PM | NPK | CD | PM | NPK |
| 0 | 11.4d | 11.4c | 11.5c | 6.5e | 6.5c | 6.5c |
| 150 | 13.8c | 14.8b | 25.6b | 7.1d | 7.4c | 13.6a |
| 300 | 15.1bc | 15.3ab | 32.7a | 7.6c | 8.0bc | 14.8a |
| 450 | 15.4ab | 16.3ab | 24.1b | 7.9b | 9.8b | 11.0b |
| 600 | 16.9a | 17.1a | 14.3c | 8.2a | 16.6a | 7.2c |
|  | | | | | | |
| LSD (0.05) | 1.5 | 2.05 | 5.8 | 0.3 | 0.41 | 2.1 |
| C.V (%) | 16.34 | 15.85 | 28.15 | 5.20 | 17.12 | 22.52 |

Means with similar letter(s) in the column are not significantly different at probability level of 0.05

Table 5 shows the effect of CD, PM & NPK on the dry capsule weight and seed yield of sesame crop in Anyigba environment. Application of 600 kgha-1 CD produced the highest dry weight of capsules (16.9g). this result was however not statistically significantly different from those produced when 450 kgha-1 of CD was applied (15.4g). similarly, 300 kgha-1 and 150 kgha-1 of CD produced dry capsule weight that are statistically at par to each other. Control pots, gave the lowest dry capsule weight (11.4g).

Similarly, 600 kgha-1 PM gave the highest dry capsule weight (17.1g) which was statistically at par with those obtained when 450 kgha-1 and 300 kgha-1 PM was applied. Additionally, 150 kgha-1, and 450 kgha-1 PM application produced weights that are statistically at par as control pots (0 kgha-1) gave the least result (11.4g).

NPK fertilizer produced dry capsule weight higher than both organic fertilizers used. Application of 300 kgha-1 of NPK produced plants with the highest dry capsule weight (32.7g). This was followed by 150 kgha-1, 450 kgha-1 and 600 kgha-1 in that order. Application of 150 kgha-1 and 450 kgha-1 gave capsule weight that are statistically at par. However, control plots and 600 kgha-1 gave the least yield.

Results obtained (table 5) showed that PM influenced the highest seed yield. application of 600 kgha-1 PM produced the highest seed yield (16.6g). this was significantly different from other PM application rates. application of 300 kgha-1 and 450 kgha-1 produced yield that are not significantly different from each other. Similarly, seed yield obtained when 300 kgha-1,150 kgha-1 and 0 kgha-1 was applied are statistically at par.

CD applied at 600 kgha-1 gave the highest seed yield followed by 450 kgha-1, 300 kgha-1, 150 kgha-1 application rates in that order. control plots gave the least yield. similarly, NPK fertilizer applied at 300 kgha-1 gave the highest seed yield. however, this was not significantly different with those obtained with 150 kgha-1 NPK application. Application of 450 kgha-1 gave yield following 300 kgha-1 NPK application. 600 kgha-1 and control plots gave the least yield.

Discussion

Significant increases recorded on both growth and yield characters of sesame crop shows that the crop performs well with the application of organic or inorganic fertilizers, this is in agreement with Olowe and Busari, (2000), Okpara *et al.,* (2007). Significant influence of organic (CD, PM) and inorganic (NPK) fertilizers on plant height, stem girth, number of branches and number of leaves has been reported Ojonugwa *et al,* (2022), Chukwu *et al.,* (2012), Agbede (2009). The influence of yield characters and yield on application of organic and inorganic characters has also been reported in many researches. Haruna and Aliyu (2012) reported that yield and economic returns of sesame were better with the applications of 5 t ha-1 of poultry manure, 60 kg ha-1 of Nitrogen. From this research, 600kg/plot of Poultry manure produced the highest seed yield. this is supported by Vaiyapuri *et al*. (2004).

All growth and yield characters measured responded best to 300kg/ha NPK fertilizer throughout the sampling periods of the experiment. However, these responses do not translate to seed yield. this is a clear indication that N released from inorganic fertilizer helps to improve organic matter decomposition and function in soil organic amendment which produced a better organic condition for highest seed yield (as evident by PM application) but NPK in its entirety only showcased this effort on growth and yield characters. This assertion is supported by Adeniyan and Ojeniyi (2003), Duhoon *et al.,* (22004), Hossain *et al.,* (2007) who asserted that lower rates of NPK could lead to incomplete organic matter decomposition resulting from enhanced soil micro-organisms as N release from component NPK fertilizer enhanced soil microbial activities thus increasing nutrient concentration of soil necessary for optimum yield. this is also supported by Jakusko and Usman (2013) who reported highest yield components in sesame from application of 300kg/ha NPK fertilizer in Northeastern Nigeria.

CONCLUSION

Organic fertilizer rates (CD & PM) and inorganic fertilizers (NPK) has proven effective in overall growth yield of sesame crop in Anyigba environment. Comparatively, growth and yield characters responded best to the application of 300kg/ha NPK which does not translate to final seed yield. alternatively, Poultry manure application at 600kg/ha gave the highest seed yield and thus recommended. For optimum growth seed yield, most literatures have recommended application of both organic and inorganic fertilizers due to its complementary benefits as evident by this research. Therefore, application of 300kg/ha NPK or 600kg/ha PM is suggested for best sesame performance at Anyigba.

AUTHOR CONTRIBUTIONS

This research was jointly conducted by all the authors mentioned in this manuscript. Authors Yusuf, M. and Akowe, I. I. designed this study, initiate the protocols and data interpretation. Author Yusuf, M. supervised and anchored the field work, obtained field data and performed preliminary data analysis. Authors Beida, A S., Iyaji, J., Abdulhakeem, S. & Alao, A. O. managed the literature searches and review to produce the initial draft. Final manuscript was read and approved by all the authors.

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## DIVERSITY AND COMPOSITION OF UNDERSTORY SPECIES IN *Cedrela odorata* AND *Pinus caribaea* PLANTATIONS IN OMO BIOSPHERE RESERVE, AREA J4, OGUN STATE

1 A. O. Oladoye, 1 L. A. Osobase,., 1 C. A. Henry, , 1Ojo, , 2 A. B. Oyedokun , and 3Ezenwenyi, J. U.

1Federal University of Agriculture, Abeokuta, Nigeria

2Forestry Research Institute of Nigeria, Ibadan,Nigeria

3Nnamdi Azikwe University, Awka, Anambra, Nigeria

Corresponding Author- [oladoyeao@funaab.edu.ng](mailto:oladoyeao@funaab.edu.ng) +2348035144795

ABSTRACT

*Plantation, as a part of terrestrial ecosystem, is of immense value for their production and protection potential. The study on the diversity of understory species in Cedrela odorata and Pinus caribaea plantation was carried out in Ogun State Forestry Plantation Project, Area J4, Ogun state. Twenty plots of 2 m x 2 m quadrants were laid randomly in each of the plantation to enumerate the understory composition, density, frequency, relative density, relative frequency and important value index. Similarity and diversity statistics were used to analyse the data in PAST version3 software. A total density of 192,750 individuals/ha from 71 species from 37 families in Cedrela odorata plantation and 136,000 individuals/ha of 43 species from 30 families in Pinus caribaea plantation was recorded. Species common to both plantations include Abrus precatorius, Albizia zygia, Baphia nitida, Canthium subcordatum, Carpolobia alba, Chromolena odorata, Cnestis ferugia, and Combretum platypterum The species dominance was higher in Pinus caribaea (0.05) than in Cedrela odorata (0.03), diversity was higher in Cedrela odorata (0.97) than in Pinus caribaea and Species similarity between the two stands is 53%. The abundance of species of Leguminosae, Euphorbiaceae, Poaceae and Apocynaceae may indicate that seedlings/saplings of these families contributed greatly to the composition of the understory in the forest floor. The presence of abundance of some species like Cedrela odorata, Chromolena odorata, Discorea bulbifera and Baphia nitida in nearly all the plots and their high density in the entire study area may indicate their wider range of ecological adaptation. Cedrela odorata plantation was typically richer in species composition than the Pinus caribaea plantation, this is evident in their number of species present and density/ha of the total species in each of the site (71 species; 192,750/ha) and (43 species; 136,000/ha) respectively. Conclusively, Cedrela odorata and Pinus caribaea plantation supports regeneration of the native and a productive plant community.*

**Keywords**:*Cedrela odorata, Pinus caribaea, Understory, Diversity, Similarity, Importance Value Index*

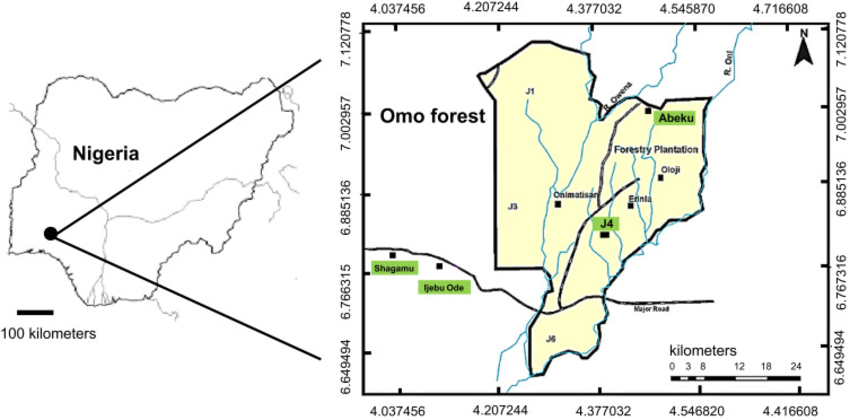
INTRODUCTION

Plantation, as a part of terrestrial ecosystem, is of immense value for their production and protection potential. They usually include exotic species or native species or native species typically forming extensive pure stands. There is a common belief that the managed forests negatively influence biodiversity, but recent studies (Parrotta, 1995; Viisteensari *et al*., 2000; Yirdaw, 2001) have shown that they can help in enhancing the recruitment, establishment and succession of native woody species by functioning as foster ecosystems as they stabilize the soil and create conditions favourable for native animals and plants to re-colonize (Parrotta, 1995; Yirdaw, 2002**).** Plantations are established for a variety of purposes including wood production, soil and water conservation, carbon sequestration. In many parts of the world, plantation also play a key role in restoring local ecosystem services and by reducing runoff and erosion on previously degraded sites (Lugo, 1997, Christian *et al*., 1998, Ratsirarson *et* *al* 2002). Despite these positive attributes, plantation forests are widely viewed in a negative light in relation to biological diversity conservation, especially when intensive monocultures of exotic species are involved (Carnus, *et al.,* 2003). However, many understory species may affect the development of overstory species at seedling stage by regulating nutrient cycles, modifying climatic conditions, or competing for site resources (Kimmins, 1987; Gilliam and Tunill, 1993; George and Bazzaz, 1999; Tremblay and Larocque, 2001). Therefore, this study is aimed at identifying important understory species and to provide a quantitative description of the structure and floristic composition of understory species in *Cedrela odorata* and *Pinus caribaea* plantations in Omo Biosphere Reserve, Area J4, Ogun state.

MATERIALS AND METHODS

The study area

The plantation used is *Cedrela odorata* and *Pinus caribaea* plantation in Ogun state Forestry Plantation Project, Area J4, Ogun state.Omo Biosphere Reserve is located between latitudes 60 351  to 70 051 N and longitudes 40 191  to 40 101 E in the Ijebu area of Ogun state (Badejo and Ola-Adams, 2000); about 135 km north-east of Lagos, about 120 km east of Abeokuta and about 80 km east of Ijebu Ode (Ola-Adams, 1999). The reserve shares a common boundary in its northern part with two other forest reserves-Ago Owu and Shasha in Osun state. It also has a common eastern boundary with Oluwa Forest Reserve in Ondo state (Karimu, 1999). It covers 130,500 hectares of land. The reserve falls within the tropical wet-and-dry climate characterized by two rainfall peaks separated by a relatively less humid period usually in the month of August. The mean annual rainfall is about 1750mm and the mean relative humidity is 80%, sunshine duration during the rainy season varies between 8-10 hours (Oladoye et al., 2018)



**Figure 1: Map showing the study area**

Data Collection

Twenty plots of 2 m by 2 m quadrant were laid randomly on each of the plantations (*Cedrela odorata* and *Pinus caribaea*  plantation). Species present in each of the quadrant were counted and identified. Species that could not be identified on the field were collected and taken to the herbarium of The University of Agriculture and Forestry Research Institute of Nigeria for proper identification.

**Data Analysis**

Density, relative density, important value index was calculated according to the formulae of Dumbos-Muller and Ellenberg, 1974, Oladoye, 2013, 2014, using the corresponding equations below:

Density = …………………………………………...Equation (1)

Frequency = x 100 …………………Equation (2)

Relative density (RD) = x 100 …………………….....Equation (3)

Relative frequency = x 100 …………………….…...Equation (4)

Important value index (IVI) = (Relative density + Relative frequency) ……..Equation (5)

Density/Ha = x 100 …………………………………….….. Equation (6)

Species diversity analysis

Simpson diversity index (S) =

Where n = total number of species

Data were analysed using Microsoft Excel and PAST (version 3) software.

RESULTS AND DISCUSSION

The results of this study showed that both *Cedrela odorata* and *Pinus caribaea* plantations are rich in understory species, 71 and 43 species respectively were identified. This high floristic richness could be attributed partly to strong contributions coming from the natural forests around, the heterogeneous distribution pattern in species composition and might be due to favourable climatic condition, which influenced the distribution of species. (Sebashao *et al.,* 2008; Addo-Fordjour *et al*., 2009; Oladoye *et al*., 2013, 2014,). High Density/ha in *Cedrela odorata* (192,750/ha), and *Pinus caribaea* (136,000/ha) (Table 1) could be a reflection of wider range ecological adaptation and activities of dispersal agents. *Caesalpinia pulcherima* had the highest IVI of (26.08), followed by *Chromolena odorata* (21.83) in *Cedrela odorata*, however, *Erangrostis tremula* had the highest IVI (27.02) followed by *Baphia nitida* (12.93) in *Pinus caribaea.* These high IVI was a reflection of high frequency of individuals and high number (density) (Table 1). Species dominancewas higher in *Pinus caribaea* (0.05) but species diversity was higher in *Cedrela odorata.* (Table 2). This is evident when only few species dominate the population. Species that dominate the pine plantation include *Ananas comosos, Baphia nitida, Chromolena odorata, Discorea bulbifera, Erangrostis tremula.* Species common to the two plantations are *Abrus precatorius, Albizia zygia, Baphia nitida, Canthium subcordatum, Carpolobia alba, Chromolena odorata, Cnestis ferugia, Combretum platypterum,* This study shows that despite the variation in the composition of the two overstory plantations, similarities exist between the understory of communities of the two stands suggesting resilience of the occupying species to adapt and survive in any potential conditions. The abundance of species of *Leguminosae, Euphorbiaceae, Poaceae and Apocynaceae* may indicate that seedlings/saplings of these families contributed greatly to the composition of the understory in the forest floor. The presence of abundance of some species like *Cedrela odorata, Chromolena odorata, Discorea bulbifera, Baphia nitida* in nearly all the plots and their high density in the entire study area may indicate their wider range of ecological adaptation. *Cedrela odorata* plantation was typically richer in species composition than the *Pinus caribaea* plantation, this is evident in their number of species present and density/ha of the total species in each of the site (71 species; 192,750/ha) and (43 species; 136,000/ha) respectively. However, Pinus has slightly higher dominance (0.045) against 0.031 in Cedrela. In addition, the species were equally distributed under the two plantations (Table 2). High species richness recorded in the two plantations might be a display of heterogeneous nature in species composition, a function of the influence of climatic factors on species composition and distribution. In addition, it could also be a reflection of the rich soil nutrient status and composition of soil seed bank. (**Ahmed** *et al*, 2006; Oladoye *et al*., 2013 and 2014; Ahmad *et al*., 2020.)

The similarity of understory species composition between the *Cedrela odorata* and *Pinus caribaea* plantations was 0.53 (53%), indicating that about 53% of the understory species between the plantations are similar (Table 3). This suggests that about 47% of species between the two areas are completely different. The differences in species composition on the two study sites could be attributed to the interactive effects of several environmental factors and the nature of crown and extent of litter accumulation differ in the plantation stand (Asare *et al*, 2020). This result is consistent with the findings of Boakye (2012) who reported a higher composition of native plant species under Taungya plantations compared with natural and unmanaged plantation in Ghana, and Zhu and Zheng (2014) who reported species composition under open canopy plantation to be 2 to 3 times higher than plantations with a closed canopy.

In conclusion, this study has shown high species richness of understory, higher number of woody component (tree and shrub) under the two plantations may indicate the uniqueness and potentials of vegetation under these plantations for conservation of ecosystem and may act as catalyst for successful natural forest succession.

Table 1: Form, Density and Importance Value Index and Checklist of Species in *Pinus caribaea* and *Cedrela odorata* Plantations

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| - | - | - | ***Pinus caribea*** | | ***Cedrela odorata*** | |
| **Species** | **Form** | **Families** | **Density/Ha** | **IVI** | **Density/Ha** | **IVI** |
| *Raulvolfia vomitoria* | Shrub | *Apocynaceae* | *-* | - | 1750 | 3.7 |
| *Abrus precatorius* | Shrub | *Leguminosae* | 4000 | 5.94 | 875 | 1.37 |
| *Abutilon mauritianum* | Shrub | *Malvaceae* | 125 | 0.6 | 500 | 1.17 |
| *Adenai cissampeloides* | Herb | *Passifloraceae* | - | - | 750 | 0.88 |
| *Albizia zygia* | Tree | *Leguminosae* | 625 | 1.5 | 1000 | 1.43 |
| *Alframomum sceptrum* | Herb | *Zingiberaceae* | - | - | 125 | 0.56 |
| *Alstonia boonei* | Tree | *Apocynaceae* | - | - | 500 | 1.65 |
| *Amaranthus viridis* | Herb | *Amaranthaceae* | - | - | 125 | 0.75 |
| *Ananas comosus* | Herb | *Bromeliaceae* | 7125 | 12.74 | - | - |
| *Anthocleista liebrechtsiana* | Shrub | *Loganiaceae* | - | - | 1000 | 1.01 |
| *Aspilia Africana* | Herb | *Compositae* | 250 | 0.7 | - | - |
| *Baissea axillaris* | Shrub | *Apocynaceae* | 6000 | 8.41 | - | - |
| *Baphia nitida* | Tree | *Papilionaceae* | 8750 | 12.93 | 4625 | 4.69 |
| *Baphia nitida* | Tree | *Papilionaceae* | - | - | 1875 | 1.89 |
| *Baphia pubescens* | Tree | *Papilionaceae* | - | - | 125 | 0.56 |
| *Bombax brevicuspe* | Tree | *Bombaceae* | - | - | 125 | 0.56 |
| *Bombax buonopozense* | Tree | *Bombaceae* | - | - | 875 | 2.29 |
| *Bridelia micrantha* | Tree | *Euphorbiaceae* | - | - | 2500 | 3.13 |
| *Bryocarpus coccineus* | Shrub | *Connaraceae* | - | - | 39625 | 26.08 |
| *Cajanus cajan* | Shrub | *Leguminosae* | 125 | 0.6 | - | - |
| *Canthium glabriflorum* | Tree | *Rubiaceae* | - | - | 375 | 1.11 |
| *Canthium subcordatum* | Tree | *Rubiaceae* | 125 | 0.6 | 500 | 1.65 |
| *Carpolobia alba* | Shrub | *Polygalaceae* | 1375 | 3.01 | 125 | 0.56 |
| *Cassia podocarpa* | Tree | *Polygalaceae* | 2125 | 4.6 | - | - |
| *Cedrela odorata* | Tree | *Meliaceae* | - | - | 19125 | 15.92 |
| *Celtis zenkeri* | Tree | *Ulmaceae* | - | - | 250 | 1.04 |
| *Centrosema pubescens* | Herb | *Papilionaceae* | - | - | 875 | 1.85 |
| *Chenopodium ambrosioides* | Herb | *Chenopodiaceae* | - | - | 375 | 0.69 |
| *Chromolena odorata* | Shrub | *Compositae* | 23125 | 26 | 25125 | 21.83 |
| *Cleistopholia paterns* | Tree | *Annonaceae* | - | - | 125 | 0.56 |
| *Cnestis ferruginea* | Shrub | *Connaraceae* | 750 | 1.6 | 1625 | 2.68 |
| *Cocos nucifera* | Tree | *Palmae* | - | - | 125 | 0.56 |
| *Colocasia esculenta* | Herb | *Araceae* | - | - | 375 | 1.11 |
| *Combretum platypterum* | Shrub | *Combretaceae* | 125 | 0.6 | 375 | 1.59 |
| *Costus afer* | Herb | *Zingiberaceae* | - | - | 750 | 0.88 |
| *Croton lobatus* | Herb | *Euphorbiaceae* | - | - | 125 | 0.56 |
| *Cucurbita pepo* | Herb | *Cucurbitaceae* | 125 | 0.6 | - | - |
| *Culcasia scandens* | Herb | *Araceae* | - | - | 1125 | 1.5 |
| *Cylicodiscus gabunensis* | Tree | *Leguminosae* | - | - | 125 | 1.47 |
| *Cylodon dactylon* | Grass | *Poaceae* | - | - | 1125 | 2.42 |
| *Cymbopogon giganteus* | Grass | *Poaceae* | - | - | 3125 | 2.12 |
| *Cynometra megalophylla* | Tree | *Leguminosae* | - | - | 625 | 0.82 |
| *Cynometra vogelii* | Tree | *Leguminosae* | - | - | 500 | 0.75 |
| *Detarium senegalense* | Tree | *Caesalpiniaceae* | 750 | 1.6 | - | - |
| *Dichapetalum toxicarium* | Shrub | *Dichapetalaceae* | 3625 | 6.7 | - | - |
| *Dichapetalum toxicarium* | Shrub | *Dichapetalaceae* | - | - | 6625 | 8.04 |
| *Dicsorea bulbifera* | Herb | *Discoreaceae* | 7750 | 13.7 | - | - |
| Dioscorea cayanensis | Herb | *Discoreaceae* | 5500 | 8.54 | 1000 | 1.44 |
| *Discorea bulbifera* | Herb | *Discoreaceae* | - | - | 6375 | 7.91 |
| *Drynaria laurentii* | Herb | *Polypodiaceae* | - | - | 875 | 1.37 |
| *Drypetes leonensis* | Tree | *Euphorbiaceae* | - | - | 1000 | 1.02 |
| *Ehretia cymosa* | Shrub | *Boraginaceae* | - | - | 500 | 0.75 |
| *Elaeis guineensis* | Tree | *Palmae* | 2750 | 7.52 | 125 | 1.47 |
| *Elaeis guineensis* | Tree | *Palmae* | - | - | - | - |
| *Entada gigas* | Herb | *Leguminosae* | 250 | 0.7 | 875 | 1.37 |
| *Erangrostis tremula* | Grass | *Poaceae* | 30625 | 27.02 | - | - |
| *Erangrostis tremula* | Grass | *Poaceae* | - | - | 30500 | 19.05 |
| *Ficus capensis* | Shrub | *Moraceae* | - | - | 125 | 1.47 |
| *Ficus exasperata* | Shrub | *Moraceae* | 125 | 0.6 | 500 | 1.65 |
| *Funtumia elastica* | Tree | *Apocynaceae* | 250 | 1.2 | - | - |
| *Gmelina aborea* | Tree | *Verbenaceae* | 250 | 0.7 | - | - |
| *Gmelina aborea* | Tree | *Verbenaceae* | - | - | 375 | 1.59 |
| *Gongronema latifolium* | Herb | *Asclepiadaceae* | - | - | 125 | 1.47 |
| *Grewia mollis* | Shrub | *Malvaceae* | - | - | 2625 | 2.76 |
| *Guarea cedrata* | Tree | *Meliaceae* | - | - | 250 | 0.63 |
| *Hannoa klaineana* | Shrub | *Simaroubaceae* | 2250 | 4.7 | - | - |
| *Hedranthera barteri* | Shrub | *Apocynaceae* | - | - | 1000 | 1.02 |
| *Heliotropium indicum* | Herb | *Boraginaceae* | - | - | 5125 | 3.15 |
| *Hevea brasiliensis* | Tree | *Boraginaceae* | 3250 | 8.4 | 1750 | 4.14 |
| *Icacina tricantha* | Herb | *Icacinaceae* | 2000 | 4 | - | - |
| *Irvingia grandifolia* | Tree | *Irvingiaceae* | - | - | 250 | 0.63 |
| *Isolana campanulata* | Tree | *Anacardiaceae* | 500 | 0.9 | - | - |
| *Leonotis nepetifolia* | Herb | *Labiatae* | 500 | 0.9 | - | - |
| *Londetia phragmitoides* | Grass | *Poaceae* | 750 | 1.6 | - | - |
| *Macaranga barteri* | Tree | *Euphorbiaceae* | - | - | 1000 | 1.02 |
| *Maranthochloa congensis* | Shrub | *Maranthaceae* | 2750 | 4.02 | 5375 | 5.58 |
| *Massularia acuminate* | Shrub | *Rubiaceae* | - | - | 125 | 0.56 |
| *Melia azedarach* | Tree | *Meliaceae* | 1625 | 3.7 | - | - |
| *Microdesmis puberula* | Shrub | *Euphorbiaceae* | 1875 | 2.4 | - | - |
| *Milletia thonningii* | Tree | *Leguminosae* | - | - | 375 | 0.69 |
| *Morinda lucida* | Tree | *Rubiaceae* | 1125 | 1.83 | - | - |
| *Mukia maderaspatana* | Herb | *Cucurbitaceae* | - | - | 5750 | 8.51 |
| *Panicum maximus* | Grass | *Poaceae* | - | - | 250 | 1.04 |
| *Parkia clappertoniana* | Tree | *Leguminosae* | - | - | 375 | 0.69 |
| *Pausinystalia spp* | Tree | *Rubiaceae* | 2250 | 2.2 | 625 | 2.16 |
| *Piper guinense* | Herb | *Piperaceae* | 1000 | 1.24 | - | - |
| *Pseudarthria fagofolia* | Shrub | *Fabaceae* | - | - | 1125 | 3.38 |
| *Pycnanthus angolensis* | Tree | *Myristicaceae* | 1250 | 1.92 | 125 | 0.56 |
| *Rauvolfia vomitoria* | Shrub | *Apocynaceae* | 2750 | 5.02 | - | - |
| *Rhaphiostylis beninensis* | Shrub | *Icacinaceae* | 1750 | 3.8 | - | - |
| *Scottellia coriaceae* | Tree | *Flacourtiaceae* | - | - | 375 | 0.69 |
| *Setaria longiseta* | Grass | *Poaceae* | - | - | 2500 | 2.69 |
| *Smilax kraussiana* | Shrub | *Smilacaceae* | 500 | 0.9 | - | - |
| *Solenostemom monostachyus* | Herb | *Lamiaceae* | - | - | 500 | 0.75 |
| *Sphenocentrum jollyanum* | Shrub | *Menispermaceae* | 2375 | 3.8 | - | - |
| *Sphenocentrum jollyanum* | Shrub | *Menispermaceae* | - | - | 875 | 1.85 |
| *Tectona grandis* | Tree | *Verbenaceae* | - | - | 125 | 0.59 |
| *Triplochiton scleroxylon* | Tree | *Sterculiaceae* | 875 | 1.7 | - | - |
| **Total** |  |  | **136000** |  | **192750** |  |

Table 2: Diversity of Species between *Cedrela odorata* and *Pinus caribaea* Plantations.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  | | --- | --- | --- | --- | --- | |  |  |  |  |  | | ***Cedrela odorata*** | ***Pinus caribea*** |
| No of species | 71 | 43 |
| No of individuals | 1080 | 1000 |
| No of families | 37 | 30 |
| Dominance\_D | 0.03189 | 0.04575 |
| Simpson\_1-D | 0.9681 | 0.9543 |
| Evenness\_e^H/S | 0.6446 | 0.6589 |
| Equitability\_J | 0.897 | 0.8891 |

Table 3: Similarity of Species between *Cedrela Odorata* and *Pinus Caribaea* Plantations.

|  |  |  |
| --- | --- | --- |
|  | *Cedrela* | *Pine* |
| *Cedrela* | 1 |  |
| *Pine* | 0.53488 | 1 |

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## EFFECTS OF INTEGRATED NUTRIENT MANAGEMENT ON WEED INFESTATION AND YIELD OF SOYBEAN IN SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

Aliyu1\*, U., Daniya1, E., Eze2, P. C. and Osunde2, A. O.

1Department of Crop Production, Federal University of Technology, P.M.B 65, Minna.

2Department of Soil Science and Land Management, Federal University of Technology, P.M.B 65, Minna.

\*Corresponding author email: aleeu71@gmail.com

ABSTRACT

*Field trials were conducted at Lapai, Minna and Mokwa Local Governments area of Niger State, Nigeria to evaluate the effects of integrated nutrient management on weed growth and yield of soybean. The study was aimed to determine the effects of integrated nutrient management on weed infestation and yield of soybean. The treatments were: - No-input, Farmers practice (NPK only) at the rate of 200 kg/ha, Agric Lime at the rate of 0.5 tons ha-1 + NPK at 200 kg/ha, Agric Lime at the rate of 0.5 tons ha-1 + Farmyard manure at the rate of 5 tons ha-1 + NPK at the rate of 200 kg ha-1 and Farmyard manure at the rate of 5 tons ha-1 + NPK at the rate of 200 kg ha-1 arranged in a randomized complete block design (RCBD) and replicated three times. Results revealed that, the important weed species of soybeans are Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum and Commelina benghalensis. Application of No-input reduced weed infestation than in terms of weed density and dry weight. The application of combination of Agric lime + Farm Yard Manure + NPK increased the grain yield of soybean by 56.5 %, 95.3%, 80.0% and 77.4 % in Lapai, Minna, Mokwa and across the location, respectively. It is recommended that farmers in this agro-ecological zone of Nigeria should apply Agric lime + Farm Yard Manure+ NPK for higher soybean yield.*

**Keywords**: Agric lime, Farmyard manure, Integrated nutrient, Soybean, Weed species,

INTRODUCTION

Soybean [*Glycine max* (L.) Merril] is an important crop commodity widely grown and utilized as a main food source for humans, feed for livestock and as a raw material for oil production (Mamia *et al.,* 2018). At present in tropical Africa, the average seed yield of soybean is below 1 t ha-1 as against the world average of 2.7 t ha-1 (FAO, 2016). General low yields of food crops in the tropics have been attributed to low soil fertility status, weed infestation, rising cost of agrochemicals, low purchasing power of resource-constrained farmers, lack of improved crop varieties, lack of access to necessary inputs, poor management practices among others (Zerihun and Haile, 2017).

Weeds are a unique group of plants species that infest and thrive in intensively disturbed habitats. In farmlands, weeds compete with crops for most abiotic resources such as nutrients, light and water, and their presence usually results in drastic decline in crop yield and quality. The magnitude of crop yield reduction can be influenced by the weed density, types of weed species present in the field, as well as the weed species persistence and the type of cultural practices in use in the farmland (Kaur and Verma, 2016).

The continuous application of inorganic fertilizer is known to decrease the water holding capacity, organic matter and nutrient content, and the soil microbe population which in turn can decrease the quality of soil fertility (Zerihun and Haile, 2017). Declining soil fertility is one main reason for the slow growth in food production in Sub-Saharan Africa (Zerihun and Haile, 2017). In the same vein, the productivity of soybean is limited due to poor soil and crop management practices. As a result, smallholder farmer yield for the crop is far below the potential production.

However, use of organic manure alone or in combination with chemical fertilizer can improve the physical and chemical properties of the soils; which in turn can provide a good substrate for the growth of microorganisms, and in maintaining a favourable nutritional balance (Gautam and Pathak, 2014). One of such strategy to maintain soil fertility for sustainable soybean production is through the judicious use of fertilizers for higher crop yield (Mamia *et al*., 2018). It has also been reported that the application of combination of inorganic and organic fertilizers increased soybean yield by 3.5 t ha-1 (Yamika and Ikawati, 2012). In order to optimize and maintain healthier soil and achieve sustainable soybean production, we suggest the integration of ameliorant (organic manure and lime) and inorganic fertilizers. Therefore, the objective of this study was to determine the effects of combining NPK fertilizer, agric lime and farmyard manure on weed growth and yield of soybean.

MATERIALS AND METHODS

On farm study was conducted in Lapai, Minna and Mokwa Local Government of Niger State, located in the Guinea savannah zone of Nigeria. The treatments were (No-input, Farmers practice (NPK only) at rate of 200 kg/ha, Agric Lime at the rate of 0.5 tons ha-1 + NPK at 200 kg/ha, Agric Lime at the of 0.5 tons ha-1 + Farmyard manure at the rate of 5 tons ha-1 + NPK at the rate of 200 kg ha-1 and Farmyard manure at the rate of 5 tons ha-1 + NPK at the rate of 200 kg ha-1) arranged in a randomized complete block design (RCBD) and replicated three times. The soybean seed variety TGX 1987-6f was sourced from the National Cereals Research Institute (NCRI) Badeggi, Niger State. This variety is early maturing and high yielding. Farm yard manure and Agric. lime were sourced in Minna, Niger State and NPK cherifien des- phosphate (OCP) fertilizer was sourced from Morocco where it is manufactured. Lime and manure were applied one week before planting by incorporating them into the soil according to the treatment combinations. Manual weeding was done at 3 and 6 WAS. The NPK fertilizer was applied at 3 WAS by side placement 5 cm away from the plant stands. Soybean was sown at 3 seeds per hole and later thinned to 2 plants per stand at 14 days after planting. The parameters measured were weed importance value index (IVI), weed density and weed dry weight at 9 WAS, number of pods per plant and grain yield. Data collected were subjected to analysis of variance (ANOVA) using the Statistical Analysis System (SAS) version 9.2 software. The Least Significant Difference (LSD) test was used to separate the treatment means at 5% level of significance.

RESULTS AND DISCUSSION

Fourteen, thirteen and eight weed species from 10 different families were identified in soybean across the integrated nutrient management at 9 WAS in Lapai, Minna and Mokwa, respectively (Table 1). Based on the importance value index (IVI), the prevalent weed species infesting soybean field in all the locations were *Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum* and *Commelina benghalensis* (Table 1). Similarly, weed species such as *Sida acuta, Cyperus rotundus, Vernonia galamensis, Dactyloctenum aegyptium* and *Kyllinga pumila* were predominant in Lapai and Minna only than the other weed species (Table1). In general, five weed species, *Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobicula-tum* and *Commelina benghalensis* were the most important and prevalent in soybeans in our study. This suggests the ecological importance of these weed species and their ability to compete favourably with soybeans for growth resources. Our observations also suggest that the variation in the number of weed species identified during the sampling period might be attributed to the fact that weed species and crops are site specific over a wide range of habitat (Dada *et al*., 2017).

Weed density differed significantly among the integrated nutrient management at Lapai, Mokwa and the mean (Table 2). Plots with No-input produced the lowest weed density than all the other plots. The application of Agric lime + Farm Yard Manure + NPK produced higher weed density across the locations and the mean. Weed dry weight differed significantly among the integrated nutrient management in Lapai, Minna, Mokwa and the mean (Table 2). The plots with No-input had lighter weed dry weight than all the other plots. Plots with the combined application of Agric lime + Farm Yard Manure + NPK produced heavier weeds in each location and the mean.

Table 1: Weed species composition and their importance value index average across the integrated nutrient management at 9 WAS in Lapai, Minna and Mokwa

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  |  | **Important value index** | | |
| **Weed species** |  | **Family** | **Lapai** | **Minna** | **Mokwa** |
| *Sida acuta* Burm.f. |  | Malvaceae | 10.92 | 14.97 | - |
| *Cyperus rotundus* L. |  | Cyperaceae | 10.75 | 42.70 | - |
| *Hyptis suaveolens* Poit. |  | Lamiaceae | 27.78 | 18.77 | 36.33 |
| *Tridax procumbens* L. |  | Asteraceae | 25.35 | 54.80 | 60.61 |
| *Digitaria horizontalis* Willd. |  | Poaceae | 31.36 | 20.59 | 62.05 |
| *Paspalum scrobiculatum L.* |  | Poaceae | 28.56 | 14.97 | 31.18 |
| *Commelina benghalensis* L. |  | Commelinaceae | 18.39 | 45.77 | 25.13 |
| *Vernonia galamensis* (Cass.) Less |  | Asteraceae | 11.34 | 12.04 | - |
| *Dactyloctenum aegyptium* (L.) P. Beauv |  | Poaceae | 12.77 | 14.97 | - |
| *Kyllinga pumila* Michx. |  | Cyperaceae | 47.44 | 14.97 | - |
| *Panicum maximum* Jacq. |  | Poaceae | 49.46 | - | - |
| *Calopogonium mucunoides* Desv. |  | Papilionoideae | 8.62 | - | 25.70 |
| *Cynodon dactylon* (L.) Pers |  | Poaceae | 8.62 | - | - |
| *Mitracarpus villosus* (Sw.) DC. |  | Rubiaceae | 8.62 | - | - |
| *Pennieitum pedicellatum* Trin. |  | Poaceae | - | - | 31.18 |
| *Daniellia oliveri* (Rolfe) Hutch. & Dalz. |  | Fabaceae | - | - | 27.92 |
| *Senna occidentalis* (L.) Link |  | Fabaceae | - | 14.97 | - |
| *Ageratum conyzoides* Linn. |  | Asteraceae | - | 15.45 | - |
| *Ludwigia decurrens* Walt. |  | Onagraceae | - | 14.97 | - |

**Table 2: Weed density and dry weight at 9 WAS in soybean as affected by integrated nutrient management in 2021 rainy season at**

**Lapai, Minna and Mokwa**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Weed density (no. m-2)** | | | |  | **Weed dry weight (g m-2)** | | | |
| **Treatment** |  | **Lapai** | **Minna** | **Mokwa** | **Mean** |  | **Lapai** | **Minna** | **Mokwa** | **Mean** |
| No-Input |  | 6.0c | 5.0a | 0.48b | 4.0d |  | 1.03d | 1.13b | 2.00b | 1.40d |
| NPK only |  | 9.0bc | 5.0a | 0.57a | 5.0cd |  | 1.50c | 1.80ab | 5.33a | 2.90bc |
| Agric lime + NPK |  | 13.0bc | 7.0a | 0.57a | 7.0bc |  | 2.47b | 2.50a | 5.33a | 3.34ab |
| Agric lime + Farmyard manure + NPK |  | 21.0a | 7.0a | 0.57a | 10.0a |  | 3.20a | 2.72a | 5.67a | 3.90a |
| Farmyard manure + NPK |  | 16.0ab | 7.0a | 0.56a | 8.0ab |  | 2.42b | 2.14a | 4.33a | 2.10cd |
| LSD (0.05) |  | 7.81 | 2.97 | 0.53 | 2.61 |  | 0.40 | 0.99 | 2.28 | 0.80 |

Means with the same letter(s) within the same column are not significantly different from each other using the least significant difference (LSD) test at P≤ 0.05

**Table 3: Number of pods and grain yield of soybean as affected by integrated nutrient management in 2021 rainy season at**

**Lapai, Minna and Mokwa**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **Number of pods per plant** | | | |  |  | | **Grain yield (kg ha-1)** | | | | | | |
| **Treatment** |  | **Lapai** | **Minna** | **Mokwa** | **Mean** |  | | **Lapai** | | **Minna** | | **Mokwa** | | | **Mean** | |
| No-Input |  | 176.0c | 273.0c | 230.0c | 226.0c |  | 833.33b | | 92.27e | | 361.10d | | | 430.23e | |
| NPK only |  | 263.0c | 347.0c | 367.0c | 326.0c |  | 1037.03b | | 979.20d | | 962.93c | | | 990.72d | |
| Agric lime + NPK |  | 480.0b | 659.0ab | 574.0b | 571.0b |  | 1509.27a | | 1361.10c | | 1268.58bc | | | 1379.62c | |
| Agric lime + Farmyard manure + NPK |  | 745.0a | 786.0a | 812.0a | 781.0a |  | 1916.67a | | 1981.50a | | 1805.53a | | | 1901.23a | |
| Farmyard manure + NPK |  | 526.0b | 587.0b | 669.0ab | 594.0b |  | 1638.87a | | 1685.20b | | 1574.10ab | | | 1632.72b | |
| LSD (0.05) |  | 141.21 | 182.86 | 159.92 | 181.51 |  | 466.55 | | 252.47 | | 358.93 | | 179.22 | | |

Means with the same letter(s) within the same column are not significantly different from each other using the least significant

difference (LSD) test at P≤ 0.05

The higher weed density and heavier weeds recorded with the application of Agric lime + FYM + NPK could be attributed to the availability of nutrients in sufficient quantity, and as at when required to support the growth and development of the weeds. This finding is in line with the work of Lukangila (2016) who reported that the application of mineral and organic fertilizers can increase weed pressure either by strengthening the growth of weed seedlings present at the time of the fertilizer application or by stimulating seed germination from seed stock of the past growing season.

Number of pods per plant were significantly different among the integrated nutrient management in this study (Table 3). The application of Agric lime + Farm Yard Manure + NPK significantly produced more pods per plant compared to the other plots. Plots with No-input produced the least pods per plant in each location and mean. Soybean grain yield differed significantly among the integrated nutrient management in all the locations and the mean (Table 3). Plots with the application of Agric lime + Farm Yard Manure + NPK produced the highest grain yield than all the other plots. The plot with No-input had the lowest grain yield in this study.The production of more pods per plant and higher grain yield by the application of Agric lime + FYM + NPK might be attributed to the improvement of the soil physical and chemical properties by the soil amendment and organic manure in providing a favourable medium for the uptake of inorganic fertilizer which in turn supported the increase in the yield and yield characters of soybean. This finding is in conformity with the work of Mamia *et al*. (2018) who reported maximum number of pods per plant, number of seeds per pod, pod length and seed yield of soybean due to adequate supply of nutrient element at the right time from organic and inorganic sources and consequently increased the yield and yield attributes of soybean.

CONCLUSION

From the results of this study, it is concluded that weed species associated with soybean include *Hyptis suaveolens, Tridax procumbens, Digitaria horizontalis, Paspalum scrobiculatum* and *Commelina benghalensis*. Application of combination of Agric lime + Farm Yard Manure + NPK resulted in the production of highest grain yield of soybean and therefore recommended to soybean farmers in this zone of Nigeria.

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## EFFECT OF MILLED GROUNDNUT SHELL AS A NUTRIENT SOURCE ON THE NUTRITIONAL QUALITY OF PEPPER IN COMPARISON WITH OTHER NUTRIENT SOURCES

\*E.A. Asubiaro and O.A. Adesina

Department of Crop Production, Federal University of Technology Minna, Nigeria.

\*Corresponding author; adolwak@yahoo.com

ABSTRACT

*Many nutrient sources have been introduced into agriculture such as poultry manure, cow dung, NPK, urea etc. in order to improve vegetable production. Groundnut shell which is known as an agricultural waste has not been explored to see if it could serve any use to the agriculture industry. The aim of this study was to evaluate the potential of milled groundnut shell as a nutrient source on the nutritional quality of pepper fruits, and the nutrient uptake by pepper plants in comparison with other nutrient sources. Five treatments were used in this experiment, namely: control, poultry manure, milled groundnut shell, milled groundnut shell in combination with poultry manure and NPK 15:15:15. Proximate analysis was carried out on the pepper fruits from each treatment to check the nutritional composition and tissue analysis was carried out on the pepper stems from each treatment to check the nutrient uptake by the plant. Post- planting soil analysis was also carried out to determine the nutrient residue in the soil. The results from each analysis was subject to data analysis using Statistical Analysis System (SAS) and the means separated using Duncan Multiple Range Test at 5% level of probability. The results from the proximate analysis showed that pepper fruits treated with Poultry manure had higher nutritional composition followed by pepper fruits treated with poultry manure + groundnut shell. The lowest was observed in fruit from NPK 15:15:15. The results from the tissue analysis showed that the pepper plants treated with poultry manure + groundnut shell had higher nutrient uptake while plants treated with NPK 15:15:15 had the lowest nutrient uptake. The results from the post-planting soil analysis showed that soils treated with milled groundnut shell had higher nutrient residue. While soils treated with NPK 15:15:15 had lower nutrient residue. From this study, it can be concluded that groundnut shell possesses nutritional qualities and it can be considered, as a nutrient source. It is recommended that further research work be conducted on the rate of application of milled groundnut shell as a nutrient source and possibly the addition of organic or inorganic nutrient supplements should be considered.*

**Keywords:** Groundnut shell; Organic fertilizer; Inorganic Fertilizer; tissue analysis; nutrient analysis;

INTRODUCTION

Pepper (*Capsicum* sp) is an economically important crop belonging to the family *Solanaceae.* It originated from South and Central America where it is still under cultivation (Pickersgill, 1997). Peppers are commonly divided into three groups; bell peppers, sweet peppers and hot pepper (Grubben, 2004). Most popular pepper varieties are seen belonging to one of these categories or as a cross pollination between them.

Groundnut *Arachis hypogaea*, is a nutritious leguminous crop grown mainly for oil and seed worldwide. Groundnut shells are the leftover product obtained after the removal of groundnut seed from its pod (Pham Anh Duc, 2019) which are most times burnt, buried or left to litter the environment resulting in environmental contamination. Groundnut shell contains various bioactive and functional components which are beneficial for mankind; commercially it is used in bio-filter carriers etc. (Pham Anh Duc, 2019). However, little is known about its use as organic fertilizer, it is therefore important to ask if this waste can be converted into a form which can add value to the environment and possibly the economy at large.

Aim of the study

The aim of this study is to determine the potential for the utilization of groundnut shell as a nutrient source in the agricultural industry

Objectives of the study

1. To determine the effect of milled groundnut shell in comparison with other nutrient sources on the fruit quality of pepper, and see it’s suitability and as the best alternative in curbing agricultural waste problems and reducing waste management costs.

2. To determine the level of nutrient uptake of the pepper plants in the tissue.

MATERIALS AND METHOD

Description of the study site

The research was carried out at the department of Crop Production screen-house and laboratory, Federal University of Technology Minna, Niger state.

Treatments and Experimental Design

A local variety of pepper called “Dan-Zaria” were obtained from local market. The experiment consisted of five treatments viz: control, NPK 15:15:15, poultry manure, milled groundnut shell, milled groundnut shell + poultry manure. These were replicated five times and arranged in Completely Randomized Design (CRD). .

Determination of Nutritional Composition

Proximate analysis was carried out on the fruits of the plant. Five samples were used for the analysis by selecting at random replicates from each treatment. Proximate composition (%) of the samples in terms of moisture, ash, fat, crude protein and fibre content were determined using methods described by (Nwinuka N, 2005).

Tissue Analysis

Tissue analysis was carried out on the stems of the plants to determine the nutrient composition in the stem. Five plants were chosen at random from each treatment and replicate for this analysis. The stems of these plants were used to determine the Nitrogen (N), Potassium (K), Phosphorus (P), Calcium (Ca) and Magnesium (Mg) uptake in the plant tissue.

Post-planting Soil Analysis

Soil analysis was carried out on the soil used to plant the pepper to determine residue of nutrient composition left in the soil. The soil analyzed was taken from all the pots used to plants, 6 weeks after harvest (i.e, from each treatment and replicate).

**Data Analysis**

The data collected were subjected to Analysis of Variance (ANOVA) using SAS statistical package. The treatments means were separated using Duncan Multiple Range Test at 5% level of probability.

**RESULTS**

Tables 1 –3 shows the result for proximate composition of the pepper fruits, tissue analysis on the stem of the pepper plant and post planting soil analysis respectively.

Table 1 shows that there was no significant difference in the moisture content (MC), ash, crude fibre and crude protein content of the different treatments. Milled groundnut shell (MGS) had the higher value of MC while poultry manure + milled groundnut shell (PM+MGS) had a lower MC.

A significant difference was noted in the fat content of the pepper fruits. Fruits from PM are observed having higher fat content, while the lowest was observed in MGS

Table 1: Proximate Analysis on Pepper fruits as Affected by Different Nutrient Sources

|  |
| --- |
| Treatment MC% ASH% FAT% CF% CP% |
| Control (T1) 3.08a 2.29a 1.46cd 8.05a 5.83a  PM (T2) 3.29a 2.49a 4.00a 7.23a 6.16a  MGS (T3) 3.37a 2.37a 1.03d 7.88a 5.32a  PM + MGS (T4) 2.29a 1.59a 2.90b 8.10a 5.69a |
| NPK :15:15:15 (T5) 2.46a 2.04a 2.13bc 7.93a 5.83a  SE ± 0.42 0.26 0.32 0.90 0.37 |

Means with the same letter(s) in the column are not significantly different at 5% level of probability.

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. MC- moisture content, CF- crude fibre, CP- crude protein.

In Table 2 the stem nutrient compositions of K and Ca were significantly influenced by the applied treatments. While, TON and P were significantly improved by control, PM, MGS and PM + MGS compared to NPK: 15:15:15.

**Table 2: Tissue Analysis carried out on the stem of Pepper Plant, as Affected by Different Nutrient Source**

|  |
| --- |
| Treatment TON K P Ca Mg |
| Control (T1) 1.15ab 268.80a 112.40ab 189.20ab 111.20a |
| PM (T2) 1.39ab 269.00a 122.60ab 136.80ab 94.00a  MGS (T3) 1.35ab 260.60a 134.80a 180.60ab 105.40a  PM + MGS (T4) 1.61a 303.60a 137.40a 212.20a 117.40a  NPK :15:15:15 (T5) 0.95b 192.80a 84.00b 116.80a 50.80b  SE ± 0.17 35.58 15.48 23.79 10.24 |

Means with the same letter(s) in the column are not significantly different at 5% level of probability.

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. TON- total nitrogen, K- potassium, P- phosphorus, Ca- calcium, Mg- magnesium.

In Table 3, the soil’s pH level was significant in Control, Poultry Manure (PM), MGS and PM+ MGS. Although the highest value was recorded at control but there was no significant difference between them. The lowest value was observed in NPK: 15:15:15 treated soil.

The soil’s Electrical Conductivity (EC) and Exchangeable Cation (Exc) parameter increased in MGS and PM respectively while a decrease of these parameters was observed in NPK: 15:15:15. The Ca content of the soil was higher in control but lower in NPK 15:15:15.

The OC and OM contents of the soil were improved by MGS and PM + MGS, although the highest values were observed in NPK 15:15:15.

The highest TN content in the soil was determined with the application of PM +MGS. However, there was no significant difference between all of the treatments. Soil treated with MGS had the highest Na content. It is also observed that the application of NPK 15:15:15 to the soil, only exerted significant effects on the concentration of Mg and PO4

**Table 3: Post-planting Soil Analysis as Affected by Different nutrient Sources**

|  |
| --- |
| Treatment Ph EC Ca Mg OC OM TN Na K PO4 Exc cat |
| Control (T1) 7.25a 253.20b 3.52a 0.69a 0.87b 1.53b 0.58a 1.37b 0.29a 10.54a 0.02a |
| PM (T2) 7.07a 271.20b 2.44bc 1.53a 0.93b 1.60b 0.18a 0.67b 0.29a 11.16a 0.03a  MGS (T3) 6.97a 363.60a 2.82ab 1.44a 1.34a 2.31a 0.20a 3.29a 0.39a 8.27a 0.02a  PM + MGS (T4) 7.03a 242.00b 1.80cd 2.51a 1.36a 2.35a 0.21a 0.66b 0.22a 12.85a 0.02a  NPK :15:15:15 (T5) 4.29b 112.20c 1.30d 36.92a 0.59b 1.02b 0.13a 0.60b 0.21a 16.00a 0.01a  SE ± 0.78 30.58 0.29 15.99 0.13 0.22 0.16 0.45 0.07 3.35 0.00 |

PM- poultry manure, MGS- milled groundnut shell, PM + MGS- poultry manure + groundnut shell, NPK- Nitrogen, Phosphorus and Potassium, SE- standard error. Ec - electrical conductivity, Ca- calcium, Mg- magnesium, OC- organic carbon, OM- organic matter, TN- total nitrogen, Na- sodium, K- potassium, PO4- phosphorus, Exc.- Exchangeable cations.

DISCUSSION

In this study we observed that an optimum amount of organic manure is advantageous for higher nutritional content. The results from this research indicates that there was significant amount of ash from all the treatments however, the application of PM gave a higher composition of ash in the peppers. The ash content is an indication of the level of minerals present in the peppers. Consumption of foods rich in minerals helps the human body in maintaining water balance as well as play some useful role in the bone and body (Akintola *et al.,* 2015). The mineral elements present (Ca, P, Mg, Na etc.) in ash were analyzed in the stems of the plants; PM + MGS had the highest composition.

From the proximate analysis, it is noted that pepper fruits from plants treated with PM contained higher fat content. According to (Akintola *et al.,* 2015), fat content in the food is important because it’s serves as means of storage and transport of metabolic fuel in the human body. It also serves as electrical insulators for subcutaneous tissues and emulsifier for drug preparations. The results clearly shows that all the treatments supplied rich amounts of crude fibre to the peppers with the highest composition coming from plants treated with PM + MGS. Fibre is considered an essential nutrient for humans because of its role in lowering constipation, diabetes and high blood pressure as well as reduces the risks of developing cardiovascular disease and cancer (Akintola *et al.,* 2015). There was a significant amount of crude protein in pepper fruits from all the treatments, with plants from PM treatment having a higher concentration than the others. Protein have amino acid as its building blocks and it is the only macronutrient in food that contains nitrogen.

The results revealed that the moisture content of the peppers from all the treatments are low with NPK 15:15:15 having the lowest moisture content. Generally, the moisture content of food gives an indication of its susceptibility to microbial spoilage (Effiong *et al*., 2018). The low moisture content of the peppers from the treatments in this study suggests that they are not easily degraded by microorganisms thereby extending the shelf life of the fruits.

According to Botir (2018), organically amended soil is generally reflected in the enhanced nutrient content of the plant vegetative parts. The results from the proximate, tissue and soil analysis from this study agrees with the above statement. In this study, it shows that an increment in the fruit nutrient values were in response to the improved soil quality by the input of poultry manure and Milled groundnut shell to the soil as a nutrient source to pepper. These results show that incorporating organic manure in the soil improves the growth and nutrient attributes of the plants.

CONCLUSION

This research has shown that milled groundnut shell which is considered an agricultural waste possesses nutritional quality and can serve as a nutrient source in the fertilization of pepper. The milled groundnut shell on pepper exhibited a significant response in the nutritional composition of pepper. Among the five (5) treatments, milled groundnut shell, poultry manure and the combination of poultry manure and milled groundnut shell (PM+ MGS) were observed to have significant impact on the proximate composition of the pepper fruits, nutritional status of the pepper stems lastly, the soil’s nutritional composition as compared to NPK :15:15:15.

RECOMMENDATION

Based on this research, it is observed that the addition of milled groundnut shell as a nutrient source could improve the nutritional value in foods. Although the use of milled groundnut shell as a nutrient source has not yet been fully exploited, therefore the following recommendations are suggested;

* Different application rates of milled groundnut shell should be considered for further research.
* Nutrient supplements either organic or inorganic should be added to milled groundnut shell for further research.

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## REACTION OF RICE VARIETIES TO RICE BLAST - AN INSIGHT INTO UNDERSTANDING OF RICE RESILIENCE TO CLIMATE INDUCED RICE DISEASES

**Bolajoko, M. H. 1, Gana, A. S. 2, Salaudeen, M. T. 2, Tolorunse, K. D. 3**

Department of Crop Production

Federal University of Technology Minna, Niger State

Corresponding email: [muhammed.bolajoko@futminna.edu.ng](mailto:muhammed.bolajoko@futminna.edu.ng) 07067676267

**ABSTRACT**

*This study is aimed at identifying the reaction in rice (Oryza sativa L.) varieties to loss in yield due to blast which is a climate induced rice disease. The experiment was carried out at hydromorphic fields of National Cereals Research Institute Badeggi, Southern Guinea Savanna of Nigeria in 2016. The treatments comprised of ten rice varieties arranged in a randomized complete block design with three replicates. Data were collected on morpho-agronomic traits, 100 grain weight, harvested stool count, number of lesions, and diseases progression. Data collected were subjected to analysis of variance using general linear model procedure of SAS 2008. Results of disease progression showed that FARO 19 and ART16-16-11-25-1-B-1-B-11 had lowest disease progression rate. The results showed no significant differences in grain yield. However, the grain yield showed a range of 4242kgha-1 – 1212kgha-1. FARO 19 and ART16-16-11-25-1-B-1-B-11 reactions to blast infestation showed that, they could be used to manage blast in endemic areas. It was concluded that all the varieties of rice can be cultivated with substantial level of yield production based on different levels of control measures. The study showed that differences in climatic environment, morpho-agronomic traits and plant nutrients content particularly silicon, phosphorus and nitrogen confer mechanism of resistance in rice varieties to blast disease infection.*

**Keywords:** Reaction, Rice Blast, Resilience, Diseases, Climate

INTRODUCTION

Rice is the world’s most important food cereal crop and a main food source for more than a third of the world’s population (Gana *et al.,* 2013). It is grown on 11 % of the world’s cultivated land (Dogara *et al*., 2014). There is hardly any country in the world where rice is not utilized in one form or the other. It is one of the few food items whose consumption has no cultural, religious, ethnic or geographical boundary (Isa *et al.,* 2013).

Rice pests are any organisms or microbes with the potential to reduce the yield or value of rice crop. Rice pests include weeds, pathogens, insects, rodents and birds. A variety of factors can contribute to pest outbreaks, including the over use of pesticides and high rate of nitrogen fertilizer application (Jahn *et al*., 2005). Climatic condition also contributes to pests outbreaks. Rice gall midge and army worm outbreak tend to follow high rainfall in the wet season, while thrips outbreak is associated with drought (Douanghoupha *et al*., 2006). Rice diseases include rice ragged stunt, sheath blight, tungro and blast.

Developing disease resistant varieties is the best approach to crop management of rice. The two major diseases that affect rice production are rice blast and sheath blight (Otto, 2015). Outbreaks of these diseases have always proven to be disastrous (NCRI, 2002). Disease control by materials with low environmental effects is most desired (El-Kazzaz *et al*., 2015).

The use of chemical fungicides to control disease has longed been viewed as a last resort for disease management (Hajime, 2001). The use of seed treatment to prevent infection of seedlings after germination and use of fungicide to prevent infection of leaves and panicles during the growing season only attempt to reduce the incidence of blast disease on rice (Gohel and Chauhan, 2015). The objectives of the study was to evaluate the reaction of rice to blast disease and identify rice cultivars with slow blast disease progression rate in relation to the climate.

MATERIALS AND METHODS

This research work was carried out on the hydromorphic rice fields of National Cereals Research Institute (NCRI) Badeggi, Nigeria. Surface soil (0-15 cm) sample was collected from the hydromorphic field of NCRI Badeggi, using a hand trowel. The sample was air dried, gently crushed, passed through a 2 mm sieve and thoroughly mixed together to analyze for the physical and chemical properties.A sample of the soil was further passed through a 0.5 mm sieve to determine the total nitrogen using the micro kjehdal method.

Treatments and Experimental design

The Ten varieties (FARO 52, NERICA 7, FARO 16, FARO 19, ART16-16-11-25-1-B-1-B-11, FARO 49, ART16-9-29-12-1-1-B-1, NERICA 4, ART16-9-6-21-1-2-2-B-B-1 and FARO 38)of rice used for the experiment were collected from NCRI Badeggi due to their reactions to blast. . The treatments are the ten rice varieties which are arranged in a randomized complete block design with three replications.

Procedure

The pathogens collected were isolated from lesions on infected rice leaves in the central laboratory of NCRI, Badeggi using conidial isolation technique (Singh *et al*., 2000). The infected leaves were washed in sterile distilled water before cutting into pieces of 3 cm long. The cuttings were then surface-sterilised in 1 % mercury chloride for 15 seconds, then washed three times with sterile distilled water. They were then plated on moist sterilized filter papers placed in 9 cm petri dishes and treated with 3-5 mls of antibacterial (tetracycline) to avoid bacterial contamination and incubated at 290C for 24 hours.

Blast scoring was determined using WARDA, (1999) visual disease evaluation scale of 0, 1, 3, 5, 7, and 9, to determine the degree of infection on each variety. This was done at 1, 2, 3, 4, 5, and 6 weeks after inoculation (WAI) for leaf blast, and at 3 weeks after heading for panicle blast.

Disease incidence was determined based on the number of plants leaves infected, lesions and sizes of lesion on the leaves, neck and panicle infected based on WARDA, 2009protocols. This was used to calculate disease progression, (Vander Plank, 1963).



Where: r= rate of disease incidence

t₁= period of first assessment in days

t₂= period of second assessment in days

X₁= initial amount of disease

X₂= amount of disease at second assessment

The results were expressed as percentages increase of the initial values.

Where A is the initial value and X is the difference between the initial and second value.

Other Data taken includes:

**Morpho-Agronomic Traits:** The data taken are; emergence percentage, days to 50% flowering, leaf area, plant height, tiller count, days to maturity, panicle number and panicle length.

**Grain Yield:** Data taken are; biomass weight, weight of panicle, harvested stool count, weight before winnowing, grain weight.

**Plant Sampling:** Rice leaves were sampled on each plot. The plant samples were oven dried at 60oC for three days and milled. The total nitrogen, total phosphorus and silicon concentrations were determined using standard methods as outlined by (Agbenin, 1995).

**Data Analysis**

Data collected were subjected to Analysis of Variance (ANOVA) using General Linear Model (GLM) procedure of SAS (SAS, 2008). Means were separated using Duncan Multiple Range Test at 5 % level of probability where treatment means shows significant difference. Pearson correlation was used to determine the relationships between the mineral nutrients in the leaves of the rice varieties and level of blast disease infestation on the rice varieties.

RESULTS

Table 1 revealed that there was no significant difference between the varieties nutrient composition. Result of tiller count revealed that FARO 19 had the highest tiller count with significant difference to ART 16-16-11-25-1-B-1-B-11 but was not significantly different from other varieties. Number of days to maturity varied from 123 days (NERICA 4) to 128 days (ART16-16-11-25-1-B-1-B-11, FARO 38 and FARO 52).

**Table 1: Mineral nutrients of the leaves**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **VARIETY** |  | **NC**  **(gkg-1)** |  | **PC**  **(mgkg-1)** |  | **ABSC**  **(gkg-1)** |  | **SC**  **(gkg-1)** |
| FARO 52 |  | 0.9a |  | 23.0a |  | 0.03ab |  | 10.3ab |
| NERICA 7 |  | 1.0a |  | 22.2a |  | 0.03ab |  | 7.9ab |
| FARO 16 |  | 0.94a |  | 23.2a |  | 0.03ab |  | 9.6ab |
| FARO 19 |  | 0.9a |  | 24.5a |  | 0.017b |  | 5.6ab |
| ART 16-16-11-25-1-B-1-B-11 |  | 0.92a |  | 23.1a |  | 0.03ab |  | 11.7ab |
| FARO 49 |  | 0.9a |  | 23.3a |  | 0.03ab |  | 7.0ab |
| ART16-9-29-12-1-1-1-B-1 |  | 0.94a |  | 23.3a |  | 0.04a |  | 13.2a |
| NERICA 4 |  | 1.0a |  | 23.0a |  | 0.03ab |  | 8.73ab |
| ART 16-9-6-21-1-2-2-B-B-1 |  | 0.93a |  | 23.1a |  | 0.04a |  | 8.9ab |
| FARO 38 |  | 0.9a |  | 23.8a |  | 0.023ab |  | 11.2ab |
| Mean |  | 0.93 |  | 23.25 |  | 0.03 |  | 9.413 |
| ±SE |  | 0.038 |  | 0.591 |  | 0.007 |  | 2.284 |
| p-value |  | 0.9284 |  | 0.6158 |  | 0.5439 |  | 0.5933 |

Values are presented in mean of four replicates. Values with the same superscript alphabets within the column are not significantly different at (*p* = 0.05) by Duncan Multiple Range Test. KEY: NC: Nitrogen content, PC: Phosphorus content, ABSC: Absorbed silicon, SC: Silicon content.

For days to maturity in Table 2, ART 16-16-11-25-1-B-1-B-11, was significantly different from all other varieties. FARO 52 gave the highest panicle number (16) while NERICA 4 had the lowest Panicle number (6.2). FARO 52 was significantly different (p = 0.05) from all varieties except ART 16-9-6-21-1-2-2-B-B-1. For panicle blast, FARO 19 had the highest panicle length of 22.9cm while FARO16 had the lowest panicle length of 16.8cm. FARO 19 was significantly different from FARO 16 and ART 16-9-29-12-1-1-1-B-1.

**Table 2: Morpho-agronomic traits of rice varieties**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **VARIETY** | **EP (%)** | **D50%F(days)** | **LA(cm2)** | **PH(cm)** | **TC** | **DTM(days)** | **PN** | **PL(cm)** |
| FARO 52 | 71.5ab | 70.3cde | 33.6cd | 51.9def | 14.7abc | 125.0bc | 16.0a | 19.5ab |
| NERICA 7 | 49.1ab | 72.7bcd | 47.2bdc | 80.6ab | 14.3abc | 125.0bc | 9.2bc | 22.8a |
| FARO 16 | 38.8ab | 77.3ab | 33.7cd | 55.2cdef | 15.9abc | 124.0bc | 10.3bc | 16.8b |
| FARO 19 | 49.7ab | 77.0abc | 38.7cd | 84.7a | 14.0abc | 124bc | 9.6bc | 22.9a |
| ART 16-16-11-25-1-B-1-B-11 | 86.1a | 66.0ef | 54.8abc | 63.2bcde | 15.8abc | 128.0a | 8.7bc | 19.5ab |
| FARO 49 | 74.6ab | 77.7ab | 28.2d | 60cdef | 15.4abc | 124.7bc | 8.7bc | 18.2ab |
| ART 16-9-29-12-1-1-1-B-1 | 68.9ab | 75.0abc | 42.1bcd | 42.3ef | 14.9abc | 125.3bc | 9.2bc | 17.3b |
| NERICA 4 | 42.4b | 82.0a | 52.3abc | 69.4abcd | 10.3c | 123.0c | 6.2bc | 19.5ab |
| ART 16-9-6-21-1-2-2-B-B-1 | 75.2ab | 77.0abc | 54.6abc | 52.7dcef | 16.8ab | 124.3bc | 11.7ab | 18.8ab |
| FARO 38 | 77.0ab | 75.7abc | 33.3cd | 42.7ef | 13.9abc | 125.0bc | 6.3bc | 19.5ab |
| Mean | 63.330 | 75.070 | 41.850 | 60.270 | 14.600 | 124.830 | 9.590 | 19.480 |
| ±SE | 16.664 | 4.452 | 9.843 | 14.479 | 1.768 | 1.307 | 2.794 | 2.021 |
| p-value | 0.2629 | 0.0001 | 0.0019 | 0.3957 | 0.1702 | 0.0018 | 0.0724 | 0.3647 |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at (*p* = 0.05) by Duncan Multiple Range Test. KEY: EP: Emergence percentage, D50%F: Days to 50 % flowering, LA: Leaf area, PH: Plant height, TC: Tiller count, DTM: Days to maturity, PN: Panicle number, PL: Panicle length.

Result of yield parameters are presented in Table 3. Harvested stool count ranged from 47.3 (ART 16-16-11-25-1-B-1-B-11) to 23.7 (NERICA 7) There was no significant difference among the varieties apart from NERICA 7 which was significantly different from ART 16-16-11-25-1-B-1-B-11. The result of the biomass weight revealed that FARO 49 had the highest biomass weight (379g) while FARO 16 (122g) had the lowest biomass weight. In respect to weight of rice before winnowing, NERICA 7 recorded highest (169g) while FARO 16 was the least (70g). NERICA 7 recorded the highest (11.7g) panicle weight while NERICA 4 recorded the least panicle weight of (5g).

**Table 3: Grain yield and its components traits for the ten rice varieties**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **VARIETY** |  | **HSC** |  | **BW(g)** |  | **WRBW(g)** |  | **W5P(g)** |  | **100GW(g)** |  | **GYH(kgha‑1)** |
| FARO 52 |  | 39.3ab |  | 326.3abc |  | 114.3ab |  | 9.7abc |  | 6.7a |  | 1212.0a |
| NERICA 7 |  | 23.7b |  | 294.0abc |  | 169.0ab |  | 11.7a |  | 13.3a |  | 2424.0a |
| FARO 16 |  | 29.0ab |  | 122.7c |  | 70.0b |  | 8.7abcde |  | 20.0a |  | 2424.0a |
| FARO 19 |  | 38.7ab |  | 303.0abc |  | 72.0b |  | 8.3abcde |  | 16.7a |  | 3030.0a |
| ART 16-16-11-25-1-B-1-B-11 |  | 47.3a |  | 315.0abc |  | 131.7ab |  | 8.7abcde |  | 20.0a |  | 3636.0a |
| FARO 49 |  | 45.7ab |  | 379.3abc |  | 117.0ab |  | 7.3cde |  | 13.3a |  | 2424.0a |
| ART16-9-29-12-1-1-1-B-1 |  | 39.0ab |  | 283.3abcs |  | 102.0ab |  | 9.7abcd |  | 23.4a |  | 4242.0a |
| NERICA 4 |  | 26.7ab |  | 150.7bc |  | 153.7ab |  | 5.0e |  | 16.7a |  | 4242.0a |
| ART 16-9-6-21-1-2-2-B-B-1 |  | 41.3ab |  | 325.7abc |  | 114.0b |  | 8.3abcde |  | 16.7a |  | 3030.0a |
| FARO 38 |  | 42.3ab |  | 261.7abc |  | 83.0ab |  | 8.7abcde |  | 26.7a |  | 3030.0a |
| Mean |  | 37.300 |  | 275.378 |  | 112.670 |  | 8.610 |  | 17.350 |  | 2969.400 |
| ±SE |  | 8.073 |  | 84.887 |  | 32.848 |  | 1.728 |  | 5.633 |  | 923.474 |
| p-value |  | 0.1794 |  | 0.0971 |  | 0.4603 |  | 0.0395 |  | 0.6635 |  | 0.66 |

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at (*p* = 0.05) by Duncan Multiple Range Test. KEY: HSC: Harvested stool count, BW: Biomass weight, WRBW: Weight of rice before winnowing, W5P: Weight of five panicles, 100GW: 100gram weight, GYH: Grain yield per hectare.

NERICA 7 was not significantly different from most varieties but was significantly different from NERICA 4 and FARO 52. 100 seed weight ranged from 6.7g to 26.7g. FARO 52 had the lowest 100 seed weight while FARO 38 recorded the highest 100 seed weight. There was no significant difference among the varieties. The seed yield per hectare had no significant difference among the varieties. The result in Table 4 shows that there was a significant difference among the varieties with respect to number of lesions. FARO 52 (9.1) had the highest while FARO 16 (3.9) gave the lowest. FARO 52 was significantly different from FARO 16 but showed no significant difference from other varieties. The disease progression varied significantly from 60.3 (NERICA 7) to 6.5 (ART 16-16-11-25-1-B-1-B-11). NERICA 7 was significantly different from most varieties but was not significantly different from FARO 16 and NERICA 4. Leaf blast ranged from 3.0 - 4.3. There was no significant difference (p = 0.05) among the rice varieties to leaf blast. Result of panicle blast showed that ART 16-9-29-12-1-1-B-1 was most affected (8.3). It was only significantly different from FARO 52.

**Table 4: Reaction of rice varieties to blast disease**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **VARIETY** | **NL** |  | **DPGN** |  | **LB** |  | **PB** |
| FARO 52 | 9.1a |  | 15.7fgh |  | 3.0a |  | 4.3b |
| NERICA 7 | 7.2ab |  | 60.3a |  | 3.0a |  | 6.3ab |
| FARO 16 | 3.9bc |  | 49.1abc |  | 3.7a |  | 7.7a |
| FARO 19 | 4.8abc |  | 9.1gh |  | 3.7a |  | 7.7a |
| ART 16-16-11-25-1-B-1-B-11 | 5.9abc |  | 6.5h |  | 3.0a |  | 7.0ab |
| FARO 49 | 7.6ab |  | 18.7efgh |  | 3.7a |  | 7.7a |
| ART16-9-29-12-1-1-1-B-1 | 8.0ab |  | 26.9defgh |  | 3.0a |  | 8.3a |
| NERICA 4 | 5.2abc |  | 52.0ab |  | 3.0a |  | 7.0ab |
| ART 16-9-6-21-1-2-2-B-B-1 | 7.2abc |  | 33.2bcdef |  | 3.0a |  | 7.7a |
| FARO 38 | 8.0ab |  | 26.9defgh |  | 4.3a |  | 7.7a |
| Mean | 6.43 |  | 32.66 |  | 3.43 |  | 7.13 |
| ±SE | 1.46 |  | 6.39 |  | 1.38 |  | 0.92 |
| p-value | 0.2838 |  | 0.0001 |  | 0.9999 |  | 0.4512 |

Values are presented in mean of three replicates. Values with the same superscript alphabets within the column are not significantly different at (*p* = 0.05) by Duncan Multiple Range Test. KEY: NL: Number of lesions, DPGN: Disease progression, LB: Leaf blast, PB: Panicle blast but was not significantly different from other varieties.

**Correlation Analysis**

Result of correlation coefficient in Table 5 showed that all parameters were not significantly correlated with blast infestation except for number of lesions and nitrogen content (r = 0.4\*). Similarly, there was no significant correlation among the plant nutrients except for silicon and phosphorus content with negative but significant correlation and phosphorus and nitrogen content which showed the strongest relationship (r = 0.8\*\*).

**Table 5: Correlation analysis**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **NL** | **DP** | **LB** | **PB** | **NC** | **PC** | **ABS** | **SC** |
| **NL** | 1 | -0.309ns | 0.029ns | -0.26ns | 0.384\* | 0.289ns | 0.269ns | -0.23ns |
| **DP** |  | 1 | -0.003ns | -0.05ns | 0.042ns | 0.210ns | -0.14ns | -0.38ns |
| **LB** |  |  | 1 | 0.365ns | -0.01ns | -0.125ns | -0.08ns | 0.132ns |
| **PB** |  |  |  | 1 | -0.20ns | -0.199ns | 0.167ns | 0.138ns |
| **NC** |  |  |  |  | 1 | 0.768\*\* | 0.312ns | -0.27ns |
| **PC** |  |  |  |  |  | 1 | 0.189ns | -0.511\* |
| **ABS** |  |  |  |  |  |  | 1 | 0.066ns |
| **SC** |  |  |  |  |  |  |  | 1 |

KEY: ns: Not significant, \*: Significant, \*\*: Very significant, NL: Number of lesions, DP: Disease progression, LB: Leaf blast, PB: Panicle blast, NC: Nitrogen content, PC: Phosphorus content, ABS: Absorbed silicon content, SC: Silicon content.

**DISCUSSION**

This paper showed that blast disease greatly affects the agronomic traits of the rice varieties, which leads to variations in plant height, leaf area, tiller number, panicle length, panicle number, biomass weight, and grain yield. The results however, showed that leaf and panicle blast had no effect on the grain yield. This agrees with the findings of Koutroubas *et al.,* (2015), Who reported that inoculation of rice varieties with blast isolates affected immensely the overall agronomic traits of rice but had negative correlation to grain yield. At low humidity, varieties with high above average grain yield were characterized with average height, late flowering, wider leaves, fewer tillers, higher above ground biomass, late maturity and there was higher silicon and phosphorus content in their leaves. This corroborates with the report of Vange and Obi (2006), who reported that agronomic traits and cultural practice affects blast disease effects on seed yield. Similarly, varieties with low yield under the effect of high rainfall had; tiny leaves flowered earlier, more tillers, average height, reached maturity earlier and high rate of disease progression, which supports the works of Ishihara *et al.* (2014) who states that there is no significant difference between panicle and leaf blast under high humidity. Tiller count had significant variation which could be as a result of phosphorus level in the varieties. This supports the report of Alan *et al.* (2009) statement that tiller productions were highly responsive to phosphorus levels.

Experimental result showed that, some varieties (FARO 38, ART 16-9-6-21-1-2-2-B-B-1 and ART 16-9-29-12-1-1-1-B-1) had average rate of disease progression, high level of leaf silicon and nitrogen content and above average nitrogen content. This could be a reflection of late maturing, wide leaves, fewer tillers, average height and delayed maturing qualities they possessed, which is in line with the report of Huang *et al.* (2010), who reported that phenotypic variance is an evidence of resistance to rice climatic induced blast disease. From the experimental results all the varieties did not show any significant difference in respect to leaf and panicle blast, they however varied in terms of disease progression and seed yield with relations to the climate of the environment and silicon, phosphorus and nitrogen contents in the plant. This is similar with the works of Ashraf *et al.* (2017), which states that mechanism of resistance to blast is influenced by the climate of the environment and mineral nutrients of the plant. The result of the nutrient correlation of this research suggests that phosphorus uptake by rice plant tissue is a major determinant in the ability of its ability to resist blast infestations in relation to its individual early crop maturity aided by nitrogen uptake. Similarly, silicon positively aids rice resistance to blast at lower concentration of nitrogen (Mayamulla *et al.,* 2017), in line with this, the research also suggests that higher levels of silicon aids the regulation of nitrogen uptake in plant tissues which help to reduce the number of lesions, hence prevents blast infestation.

The experiment showed that grain yield showed no variation among the varieties with relations to the climatic condition. This could be as a result of the varietal yield potential differences and nutrient content level of the varieties in consent to the reports of Smith *et al.* (2012) who reported that grain yield showed no significant differences with respect to good management practices under high humid conditions. Similarly, effect of climate change on nutrients of the rice varieties is suggested to be a measure of the resistance mechanism in the rice varieties (Ashraf, *et al.,* 2017).

CONCLUSION

It was concluded that two varieties; NERICA 4 and ART16-9-29-12-1-1-1-B-1, gave the best reaction to blast infection under the Badeggi Hydromorphic climate conditions. Also, two varieties expressed slow disease progression rate effectively; FARO 19 and ART16-16-11-25-1-B-1-B-11. With the result of this study all the varieties of rice can be cultivated with substantial level of yield production based on different levels of control measures. The study showed that differences in climatic environment, morpho-agronomic traits and plant nutrients content particularly silicon, phosphorus and nitrogen confer mechanism of resistance in rice varieties to blast disease infection.

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## ALLELOPATHIC EFFECT OF MINTWEED (*Hyptis suaveolens* (L.) Poit) GREEN AND BROWN LEAVES AQUEOUS EXTRACT ON SEED GERMINATION AND SEEDLING GROWTH OF COWPEA

Aguwa, N., Daniya, E. and Mamudu, A. Y.

Department of Crop Production, School of Agriculture and Agricultural Technology.

Federal University of Technology, P.M.B 65, Minna, Niger State, Nigeria.

\*Corresponding Author`s Email: nnamdiaguwa4eck@gmail.com

Mobile: 07063056463

ABSTRACT

*Hyptis suaveolens is an invasive weed that has negative effects on native plant communities and impedes the growth of vulnerable or threatened species growing near it. This study revealed the allelopathic effect of the aqueous extract of the green and brown leaves of Hyptis suaveolens on seed germination and seedling growth of cowpea at different concentration (0 %, 2.5 %, 5 %, 7.5 % and 10 %) in a laboratory – based experiment. The treatments were arranged as a 2 x 5 factorial in a Completely Randomized Design (CRD) in four replications. Results revealed that irrespective of the leaf type, there was no significant difference in the allelopathic potential on the seed germination and seedling growth of cowpea. In contrast, the concentration of the extracts had a significant allelopathic effect on cowpea seed germination and seedling growth, such that the inhibition was concentration dependent. The inhibition of the seed germination and seedling growth increased with the increase in the concentration from 0 to 10 %. The highest concentration (10%) of H. suaveolens leaf extract significantly reduced the germination percentage, germination index, mean germination time, radicle and plumule lengths by 61.5 %, 63.9 %, 61.7 %, 54.2 % and 62.5 %, respectively. It was apparent that the 10% concentration had more inhibitory (-61.5%) effect on the germination and seedling growth of cowpea relative to the control. This weed must therefore be controlled in the cowpea field at their initial growth.*

**Keywords:** Allelopathy, Germination, Seedling growth, Concentration and Cowpea

INTRODUCTION

Hyptis suaveolens (L.) Poit, which is commonly known as Mintweed, is an important invader of the tropical and sub-tropical regions of the world (Afreen *et al.,* 2017). Hyptis possesses several characteristics common to other invasive species, such as allelochemicals that help in its survival and spread. This species has wide ecological amplitude, high plasticity and reproductive capacity because it is able to grow on a variety of soil types, land uses and land cover type ([Padalia et al., 2013)](javascript:;). Hyptis possesses faster growth rate, massive seed production, high proliferation rate, dual mode of reproduction (from perennating root-stocks as well as seed). Higher resistance against pathogens due to allelochemicals and essential oil (Raizada, 2006).

The growth and establishment of other plant species near the clumps of *H.suaveolens* is quite restricted (Raizada *et al*., 2006) but the specific reasons that lead to the dominance of *H. suaveolens* still remain unclear. One of the plausible reasons for such interference could be due to the presence of allelochemicals in this plant. Allelochemical activities of aqueous methanol extract of *H. suaveolens* on the germination and seedling growth of several weeds and crop species have been reported by Momimul-Islam *et al.* (2013) and Daniya *et al.* (2014).

Allelopathy refers to the effect of one plant species on another through the release of chemical compounds known as allelochemicals into the environment (Weih *et al*., 2008), which may either be promoting (synergistic) or inhibiting (antagonistic) depending on the compounds released and target plants. The potential use of allelopathy as a natural means for weed suppression in Agro ecosystems has attracted the interest of researchers for a long time (Yongqing *et al.,* 2014).

Cowpea (*Vigna unguiculata* (L.) Walp) is an important pulse crop widely cultivated in the tropics. The pods are highly nutritive and are a good source of digestible protein, dietary fiber and vitamin A and C. In addition to these the pods also contain Ca, P, Na, K, Mg, Fe, Zn, Mn and Cu (Gerrano *et al*., 2017). However, it is sensitive to weed competition especially at the early stage of crop development and the period from 14 to 40 days after sowing (DAS) has been considered critical for the weed competition (Osipitan *et al.,* 2016). Weed infestation has been reported to be more severe during the rainy season and causes severe yield reduction (Gupta *et al.,* 2016). The impact of weed interference on cowpea yield depends on the duration and stage at which the crop-weed interference takes place. The season-long competition has resulted in 53 to 76 percent yield reduction in cowpea (Gupta *et al.,* 2016).

The aim of the study was to assess the allelopathic effect of aqueous extracts of green and brown leaves of *H. suaveolens* at varying concentrations on germination and seedling growth of cowpea.

MATERIALS AND METHODS

A set of experiments was carried out to assess the allelopathic effect of *H. suaveolens* on germination and seedling growth of cowpea in a laboratory at Department of Crop Production, Federal University of Technology, Minna, Niger State. Green and Brown leaves of *H. suaveolens* were collected at flowering stage from farmlands within the Federal University of Technology Gidan Kwano Campus, Minna, Niger State during the rainy season of 2022. The two leaves were separated, air dried under the shade for four weeks and later oven dried at 70oC to a constant weight. The powder of each plant part was soaked in distilled water for 24 hours in a ratio of 1:20 (w/v) at room temperature. The water extracts of each plant part were filtered through a Whatman No. 1 filter paper to obtain the pure aqueous extracts without impurities. The extracts prepared in this manner were used as stock solutions with concentration of 10 % (w/v), and further dilutions to 2.5 % (w/v) of extracts of green and brown leaves of *H. suaveolens* were made by adding distilled water to the stock solution for carrying out the experiment at varying concentrations: - 0%, 2.5% (1:40 w/v), 5% (1:20 w/v), 7.5% (1: 15 w/v) and 10% (1: 10 w/v) against cowpea in a laboratory condition. Ten cowpea seeds were placed on a filter paper in 9 cm diameter petri dishes, separately. In each petri dish, 10 ml of green or brown leave aqueous extracts at 2.5%, 5%, 7.5% and 10% and distilled water was poured as per the treatments. Distilled water was used as control for comparison. The temperature during the growing period of cowpea ranged from 29.0 to 31.8oc. The experiment was observed for 16 days. Petri dishes were kept moistened during the whole period of study. The number of seeds germinated was counted on a daily basis. Germination percentage, germination index, mean germination time and germination energy were determined using the formulae shown below: -

1. Germination percentage (GP)

GP= x 100 as described by the Association of Official Seed Analysts (AOSA, 1990).

1. Mean germination time (MGT)

MGT= Ellis Roberts as described by Safder *et al*. (2021)

Where n = number of germinated/emerged seeds on day `D` and `D` equal days of count

1. Germination Index (GI)

GI= + as described by AOSA (1990)

1. Radicle and Plumule length: This were measured using a centimetre rule.

(e) Percentage Inhibition/Stimulation: -

Inhibition (-) or Stimulation (+) = x 100

The data collected were subjected to the analysis of variance (ANOVA) using the Statistical Analysis System (SAS) software package version 9.0. Differences between the treatments means were separated by the Least Significant Difference (LSD) at 5% level of probability.

**RESULTS AND DISCUSSION**

**Germination Indices of Cowpea**

The allelopathic effect of green and brown leaves extracts of *H. suaveolens* on germination indices of cowpea are hown in Table 1. The germination percentage, germination index and mean germination time was not significantly affected by either green or brown leaves of *H. suaveolens* (Table 1). In contrast, the germination indices were significantly reduced by the concentrations of the aqueous extract of the leaves (Table 1). Furthermore, the germination percentage, germination index and mean germination time were significantly reduced as the concentration of the extract was increased from 0 % to 10 %. The highest concentration of 10 % consistently and significantly reduced the germination percentage, germination index and mean germination time compared to the control. The allelopathic inhibition of germination in cowpea could be attributed to the presence of allelochemicals at varying concentrations in the water extracts of the *H. suaveolens* leaves. Oraon and Mondal (2021) demonstrated that *H. suaveolens* inhibited the seed germination, though in rice. Furthermore, Oraon and Mondal (2021) substantiated that allelopathic activity depends on the concentration and varies from species to species.

**Seedling Growth of Cowpea**

The allelopathic effect of extracts of *H. suaveolens* on seedling growth of cowpea is shown in Table 2. The radicle and plumule lengths were not significantly affected by either green or brown leaves of *H. suaveolens*. In contrast, the radicle and plumule length were significantly reduced by the concentrations of the aqueous extract of the *H. suaveolens* (Table 2). Both radicle and plumule lengths were significantly reduced as the concentration of the extract was increased from 0 % to 10 %. Maximum reduction in radicle and plumule lengths were recorded with the highest concentration (10 %) in this study. Increasing the concentrations of aqueous leaf extracts increased the inhibitory effect of the radicle and plumule lengths of cowpea. Oraon and Mondal (2021) also reported that the germination and seedling growth of several crops are affected by the allelopathic influence of *H. suaveolens.*

**Table 1: Allelopathic effect of water extract of green and brown leaves of *Hyptis suaveolens* at varying concentration on germination indices of cowpea**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment | Germination  Percentage | Germination  Index | Mean Germination Time |  |
| Leaf type (L) |  |  |  |  |
| Green | 54.0a | 2.4a | 5.4a |  |
| Brown | 63.0a | 2.7a | 6.3a |  |
| LSD (0.05) | 11.6 | 0.5 | 1.2 |  |
| Concentration(C) (%) |  |  |  |  |
| 0 | 81.3a | 3.6a | 8.1a |  |
| 2.5 | 70.0ab | 3.1ab | 7.0ab |  |
| 5.0 | 58.8bc | 2.6bc | 5.9bc |  |
| 7.5 | 51.3c | 2.2cd | 5.1c |  |
| 10 | 31.3d | 1.3d | 3.1d |  |
| LSD (0.05) | 18.3 | 0.8 | 1.8 |  |
| Interaction |  |  |  |  |
| L x C | NS | NS | NS |  |

Means with different letters from each other differ significantly at p≤0.05: NS = Not significant.

**Table 2: Allelopathic effect of water extract of green and brown leaves of *Hyptis suaveolens* at varying concentration on radicle length, plumule length, stimulation and inhibition of cowpea**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatment | Radicle length  (cm) | Plumule length  (cm) | Stimulation and inhibition (%) |
| **Leaf (L)** |  |  |  |
| Green | 2.8a | 6.7a | -28.8a |
| Brown | 3.1a | 7.6a | -25.6a |
| LSD (0.05) | 0.5 | 1.0 | 16.0 |
| **Concentration (C )** |  |  |  |
| 0 | 3.5a | 9.6a | 0.0a |
| 2.5 | 3.5a | 8.0b | -12.7ab |
| 5.0 | 3.0a | 7.3b | -26.6b |
| 7.5 | 3.0a | 7.0b | -35.2b |
| 10 | 1.6b | 3.6c | -61.5c |
| LSD (0.05) | 0.8 | 1.5 | 25.27 |
| **Interaction** |  |  |  |
| L x C | NS | NS | NS |

Means with different letters from each other differ significantly at p≤0.05: NS = Not significant: negative values represent inhibition

CONCLUSION

It can be concluded in this study that irrespective of the type of leaves of *H. suaveolens*, the aqueous extract of the leaves had a strong allelopathic potential to fully inhibit the germination and seedling growth of cowpea. The 10 % concentration of aqueous extract of the *H. suaveolens* leaves strongly inhibited the germination and seedling growth of cowpea.

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## FUNGI ASSOCIATED WITH MILLET GROWN IN ZONE A AGRO-GEOGRAPHICAL ZONE OF NIGER STATE NORTH CENTRAL NIGERIA

Abdullahi, K. K. (1\*), Adebola, M. O. (\*),Hussaini, A. M. (\*1) and Ismail, M. B. (\*)

1\*Department of Plant Biology Federal University of Technology, Minna, Niger State, Nigeria

\*Department of Biochemistry Federal University of Technology, Minna, Niger State, Nigeria

Corresponding Author: Abdullahi, Khadijat. Kubura

E-mail: khadreez@gmail.com

ABSTARCT

*Millet production is affected by fungi which are their significant destroyers from production to storage thereby making them unfit for human consumption by reducing their nutritional composition and some often even produce mycotoxins. The occurrences of these fungi organisms which vary from region to region might be due to climatic differences. Hence, these research looks at possible fungi associated with millet grown in Zone A agro-geographical Zone of Niger State. Millet Samples were collected across nine villages from three selected Local Government Areas(LGAs) located in the zone, associated fungi were isolated from the samples using direct plating on Potato Dextrose Agar adjusted with chloramphenicol as bacteriostatic after which the plates were incubated at 28 ± 20 for a period of 5-7 days. Pure isolates of fungi were obtained through sub-culturing. Eight fungi isolates were isolated from the millet grains collected across the zone consisting of four species of Aspergillus, Alternaria spp, Curvularia spp, Fusarium verticilliodes and Mucor spp. A. flavus was observed to have an occurrence rate of 100 % in both Gbako and Lapai LGAs while Mokwa LGA recorded 33. 33 % occurrence rate, Mokwa had 100 % occurrence of Alternaria spp while Gbako and Lapai LGAs recorded 66.67 % and 33.33 % respectively. Mucor spp was recorded only in Lapai LGA at 33.33 %, while both Gbako and Mokwa had no Mucor occurrence. This research thereby serves as a baseline data for fungi organisms found in millet grown in Zone A agro-geographical zone of Niger State, Nigeria.*

**Keywords:** *Aspergillus* *spp*, Fungi, Millet, Zone A, Niger State

INTRODUCTION

Millets and their derivatives are important nutrient sources for mankind world-wide, they are one of the most important forms of dietary food for most of Africans populations (Riba *et al*., 2014), and also major source of calories and proteins for the people of Nigeria especially the Northern part (Sultan *et al*., 2022). It is one of the major cereal crop cultivated in Nigeria amongst sorghum, rice and maize. Ogi (the fermented cereal porridge) commonly called akamu in Northern Nigeria and Niger State inclusive is the major product of millet which is consumed mainly as breakfast with some other delicacies like akara (bean cake), kuli-kuli (groundnut cake) and many others, The production of millet is mostly concentrated in the drier parts of the region owing to its drought tolerance (FAO, 2002).

Fungi Mycro-flora are significant destroyers of grains especially millet from production to storage thereby making them unfit for human consumption by reducing their nutritional composition and some often even produce mycotoxins. Pandey and Trivedi, (2008) have in the past submitted various reports showing yield losses of up to 67% resulting from fungi damaging grains in several ways; they reduce the germinability, produce undesirable odour and kernel discolouration, depletion in seeds viability, hardness, colour, size and shape, grain weight and various biochemical parameters; protein, carbohydrate and vitamins decrease the food value and can also lead to production of toxins injurious to human health (Matthew *et al*., 2010).

Niger State is one of the major producers and consumers of millet crop. The State which is the Largest in land mass in Nigeria comprises of twenty-five local government area which is divided into three agro-geographical zones base on rainfall (Zone A, Zone B, Zone C). The Zone A which is the Southern region of the state consists of eight LGAs (Agaie, Bida, Edati, Gbako, Katcha, Lavun and Mokwa), the Zone B the Eastern part has nine LGAs (Agwara, Borgu, Magama, Mashegu, Mariga, Kontagora, Rijau and Wushishi) and the Zone C the Northern part which has eight LGAs (Bosso, Chanchaga, Gurara, Munya, Paikoro, Shiroro, Suljeja and Rafi) Yatswako and Alhaji, (2017). This research was designed to study the occurrence of fungi associated with Millets grown in the Zone A agro-geographical Zone selecting three LGAs (Gbako, Lapai and Mokwa).

MATERIALS AND METHODS

Millet samples (1kg) were collected from three villages from the three selected LGAs in Zone A agro-geographical zone of Niger State, Nigeria. The Local Governments includes Gbako (Edozhigi, Gusadi and Lemuta), Lapai (Cheche, Lenfa and Muye) and Mokwa (Bokani, Dukun and Rabba) in sterile polythene bags and were transported to the microbiological lab Step-B Federal University of Technology for fungi isolation and identification. The Maps below gives an insight of the sample sights and the rainfall activities of the year 2021 in which the research was carried out. The samples were collected between the months of November and December harvesting season of the year 2021 from farmers across the selected LGAs.

Isolation of Fungi from Millet Samples

Fungi were isolated from the samples using direct plating method where the millet samples collected were washed with tap water and disinfected with sodium hypochlorite (0.5 %) for 2 minutes, then rinsed thoroughly with sterile distilled water to remove the remaining sodium hypochlorite, and later dried with whatman No. 1 filter paper to remove excess moisture (Abdullahi *et al*., 2018). The washed and dried samples (10 grains) were then evenly plated on petri-dishes containing Potato Dextrose Agar which was adjusted with chloramphenicle to outdo the growth of bacteria organisms, the plates were then incubated at 28 ± 20 for a period of 7 days for eventual growth of fungi (Abdel-Hafez et al., 2017), and for each of the samples three replicates were maintained.



Identification and Characterization of Fungal Associated with Millets

Colony appearance of fungi on each plate were counted and recorded while pure isolates of the fungi were obtained through sub-culturing. The frequency of occurrence (%) was calculated using the formula described by Bamkifa *et al*., (2019) with little modifications.

Frequency of occurrence (%) = the presence of an isolate in the village x 100

Total number of villages

Microscopy

Wet mount method of slide preparation was used to prepare the slides for microscopy, a thin slice of the various pure culture were separately cut and placed on a clean dry slides using a sterile needle, a drop of water was added to the samples on the slides using a dropper and were cover with coverslip at a 45-degree angle with one edge touching the water and let go to evenly spread the sample which were held in place by surface tension avoiding air bubbles. The slides were then placed under the microscope with a magnification power of X4 where the morphological characters of each of the isolates were viewed and photomicrographed to be compared with those described by standards manual of fungi identification by Barnett and Hunter, (2003).

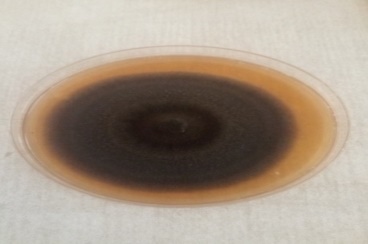
Data analysis

The data obtained from the experiment were analyzed using Microsoft excel sheet where two-way Analysis of Variance (ANOVA) was conducted to check where there are differences between the three LGAs sampling sites (Gbako, Mokwa and Lapai) on the various fungal isolates at 5 % Level of significance.

RESULTS AND DISCUSSION

Eight different fungi isolates comprising of four *Aspergillus* *species* (*A*. *flavus*, *A*. *niger*, *A*. *fumigatus* and *A*. *terreus*), *Alternaria* *spp*, *Curvularia* *spp*, *Fusarium* *verticilliodes* and *Mucor* *spp* were isolated from the millet samples collected across the Zone A agro-ecological zone of Niger State. These results are similar to the reports of Sultan *et al*., (2022) who reported the presence of six fungi isolates (*A*. *flavus*, *A*. *niger*, *Alternaria*, *Cladosporium*, *Fusarium* and *Rhizospus*) from Maize, Millet and sorghum collected from two Markets in Kano State, Nigeria, Makun *et al*., (2007) also reported the presence of 5 species of *Aspergillus*, 3 species of *Fusarium*, 1 species of *Helminthosporium, Penicillium, Penicillium, Phoma, Mucor, Rhizopus, and Syncephalastrum spp*.

The cultural characteristics of *Alternaria* *spp* grew rapidly with a colony size reaching a diameter to 3- 9 cm following 7 days incubation period at 25-28 0 ± 2 o C on PDA, it had a flat colony with short aerial hyphae with initial greyish white at the beginning of the growth that later turned greyish black or with a light border and the reverse side is typically brown to black. The microscopic view shows septation with brown hypae, they had also brown septated conidiophores which are arranged in a zigzag form (Plate I **A** and **B)** this corresponds with what is obtainable the book of Larone (1995). The *Curvularia spp* cultural features ranges from rapid growth colony with a whitish to pinkish grey which later turns to brown or black as its grows older and the reverse side is usually dark brown to black. The microscopic image of *Curvularia spp* similarly revealed a brown hyphae, brown conidiophores that are simple, branched, or bent at the origin of the conidia. The central cell looked typically darker and enlarged as compared to the end cells in the conidium and there is a visible swell in the central cell which gives the conidium a curved shape (Plate I **C** Aand **D**), this is however related to the features explained by De Hoog *et al*., (2000).

 **P**

**D**

**C**

**B**

**A**

**Plate I: A** shows the cultural character, **B** shows the photomicrograph of *Alternaria* *spp***, C** shows the cultural character, **D** shows the photomicrograph of *Curvularia* *spp*.

**Table 1:** Showing the presence and absence of fungi isolates in the three LGAs with each of the villages, + presence of isolate, - absence of isolate.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| S/no. | Name of Isolates | Local Government Areas and Villages | | | | | | | | |
|  |  | Gbako | | | Lapai | | | Mokwa | | |
| Edozhigi | Gusadi | Lemuta | Cheche | Lenfa | Muye | Bokani | Dukun | Rabba |
| 1 | *A. flavus* | + | + | + | + | + | + | - | - | + |
| 2 | *A. niger* | - | + | - | - | - | + | + | + | + |
| 3 | *A. fumigatus* | + | + | - | + | + | + | + | + | - |
| 4 | *A. parasiticus* | - | - | - | - | - | + | + | - | - |
| 5 | *A. terreus* | - | - | - | - | - | - | - | - | - |
| 6 | *Alternaria spp* | + | - | + | - | + | - | + | + | + |
| 7 | *Curvularia spp* | + | - | - | - | + | + | - | + | - |
| 8 | *Fusarium verticillioides* | + | - | - | - | + | + | + | - | -- |
| 9 | *Mucor spp* | - | - | - | + | - | - | - | - | - |

Generally, *Aspergillus flavus* had the highest frequency of occurrence to be 77.78 % in all the LGAs with Mucor having the least occurrence rate which was 11.11 %, as seen in table 3, this is in line with the work of Bamkefa *et al*., (2019) who reported the occurrence of *Mucor spp* to be 2.4 % as compared to the 25 % occurrence rate of *A*. *fumigatus*,. Similarly, Hadiza *et al*., (2019) also reported the highest occurrence rate of fungi isolated from Maize in Niger State to be *A*. *niger* at 75 %, followed by A. flavus with 68 % and the least was at 12 % for the fungi *Penicillium* *sp.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | |  |  |  |  | | --- | --- | --- | --- | | **Isolates** | **LGAs**  **Gbako Mokwa Lapai** | | | | *A*.     *flavus* | 100 | 33.33 | 100 | | *A*.     *niger* | 33.33 | 66.67 | 33.33 | | *A*.     *fumigatus* | 66.67 | 33.33 | 100 | | *A*.     *terreus* | 33.33 | 66.67 | 33.33 | | *Alternaria* *spp* | 66.67 | 100 | 33.33 | | *Curvularia* *spp* | 33.33 | 33.33 | 66.67 | | *Fusarium* *Verticilloides* | 33.33 | 33.33 | 66.67 | | *Mucor* *spp* | 0 | 0 | 33.33 |   **Table 2: Showing Isolates and their % occurrence in each of the LGAs** |  |  | | |  |  |  | | --- | --- | --- | |  |  |  | | **Graph: Showing Isolates and their % occurrence in each of the LGAs** |  |  | |  |  |  | |  |  | |  |  |  | |  |

**Table 3:** General frequency of occurrence of isolates in the study LGAs.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Gbako** | **Mokwa** | **Lapai** | **Total** | **Frequency of Occurrence (%)** |
| *A*.     *flavus* | 3 | 1 | 3 | 7 | 77.77778 |
| *A.*     *niger* | 1 | 2 | 1 | 4 | 44.44444 |
| *A*.     *fumigatus* | 2 | 1 | 3 | 6 | 66.66667 |
| *A*.     *terreus* | 1 | 2 | 1 | 4 | 44.44444 |
| *Alternaria* *spp* | 2 | 3 | 1 | 6 | 66.66667 |
| *Curvularia* *spp* | 1 | 1 | 2 | 4 | 44.44444 |
| *Fusarium* *Verticilloides* | 1 | 1 | 2 | 4 | 44.44444 |
| *Mucor* *spp* | 0 | 0 | 1 | 1 | 11.11111 |

CONCLUSION

Rainfall could be a great determinant of the presence of fungi organism in a particular environment as it’s determines the moisture content and temperature conditions of crops, (in this regard Millet) in which organisms could thrive. This factor ranges from region to region and hence can affect the presence or absence of fungi organisms in Zone A agro-geographical area of Niger State, Nigeria as compared to other regions of the state and similarly other parts of the Country at large.

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# FOOD SCIENCE

## PROXIMATE AND SENSORY ASSESSMENT OF *AADUN* PRODUCED FROM MAIZE AND GROUNDNUT PASTE

Atteh Bamidele Olaiya and Orhevba Bosede Adelola

Department of Agricultural and Bioresources Engineering, Federal University of Technology Minna. Niger State, Nigeria.

Corresponding author: Atteh Bamidele Olaiya, +2348036638942 bamidele.atteh@yahoo.com

ABSTRACT

*The effect of partially substituting roasted whole maize (Zea may) flour with groundnut (Arachis hypogaea) paste in the production of aadun and its acceptability was investigated. Formulations of aadun from different combination levels of maize flour (60 - 78%), groundnut paste (5 - 20%) and palm oil (10 - 20%) were generated using a constrained D-optimal mixture-process experimental design while salt and pepper remained constant at 0.5% and 1.5% respectively. Maize-based snack, aadun was produced from the resulting composite blends. Proximate and sensory properties of the samples were determined using standard procedures. Results obtained showed a considerable significant increase (P≥0.05) in the amount of protein with increase in the level of substitution with groundnut paste, ranging respectively from 6.71 to 16.81%. While similar trends were observed concerning the fat contents, the levels of ash, and crude fibre while carbohydrates and calories showed a significant (P≥0.05) decrease.*

**Keywords:** *Aadun*, Maize, Groundnut, Snacks, Proximate

INTRODUCTION

*Aadun* is an indigenous staple food commonly consumed by the Yoruba ethnic group of south-western Nigeria, it is usually reddish and often moulded into balls. It is a snack food prepared from dried maize grain which constitutes nearly 80% of the entire snack (Jonathan *et al.,* 2015). It is characterized by its fine texture, ease of digestion and sweetness and is traditionally served during ceremonial events such as marriage and naming ceremonies and had found acceptability in the past by warriors, women, children and people of all ages (Adedokun, 2006). According to Adedokun (2006), *aadun* is an excellent source of energy with phosphorus and magnesium being its chief mineral but low in crude protein.

It is necessary to improve the nutritional quality and flavour of *aadun* and develop a single product which will have an improved nutritional content and also the flavour which ordinarily would have been obtained from the consumption of two different food items. The objective of this study is therefore to produce nutritionally enhanced *aadun* from maize and groundnut paste and to assess the effects of groundnut paste inclusion on the nutrient and acceptability of *aadun*.

MATERIALS AND METHODS

Materials

Samples of freshly harvested white maize-TZL Comp 4C2 (commonly used by indigenous manufacturers) and unshelled groundnut seed, palm oil, pepper and salt were obtained from *Kasuwa Gwari* (a local market) in Minna, Niger State, Nigeria. The control was produced according to Adedokun (2006).

Production of *Aadun* Snacks

The laboratory-prepared *aadun* was produced using the method of Adedokun (2006). Maize grains were first cleaned, roasted with the aid of an electric hot plate for fifteen minutes and milled. The maize powder and milled pepper were mixed thoroughly and the mixture was later sieved (<0.4mm) to obtain a fine powder. The sieved powdered mixture was later mixed with palm oil and salt to make a paste. The paste was moulded into balls.

Dried Maize

Cleaning

Roasting (150-280oC) for 15minutes

Pepper

Milling (stone/disk mill)

Mixing

Sieving (0.40mm)

***AADUN***

Salt

Palm oil

Figure 3: Flow chart for the production of indigenous *aadun* (Adedokun, 2006).

Formulation of *Aadun* supplemented with Groundnut Paste

Formulations of *aadun* from different combination levels of maize flour (60 - 78%), groundnut paste (5 - 20%) and palm oil (10 - 20%) were generated using a constrained D-optimal mixture-process experimental design of Design Expert (version 11, Stat - Ease Inc., USA) while salt and pepper remained constant at 0.5% and 1.5% respectively. There were seventeen runs (treatments) in all with the control (78% maize, 20% oil, 1.57% pepper and 0.34% salt).

Proximate analysis

The proximate composition of the samples was assessed using Association of Analytical Chemists, AOAC (2005) procedures. Moisture content, ash, fibre, fat, protein and carbohydrate were all determined. The Atwater component was used to determine the energy content.

Sensory evaluation

A twenty-man panellist comprising of staff and students of the Federal University of Technology, Minna, Niger State was used for the sensory evaluation and selection was made based on their familiarity with "*aadun*”. The samples were presented to the panellists in a randomised order and were evaluated for appearance, taste, aroma, texture and overall acceptability using a 9-point hedonic scale.

Statistical analysis

Data was generated in triplicate and analysis was done using one-way Analysis of Variance (ANOVA) of the Statistical Package for Social Sciences (SPSS version 20.0 for windows) and the means were separated using Duncan’s Multiple Range test.

RESULTS AND DISCUSSION

Table 1 and 2 show the results of the proximate composition and sensory evaluation of the *aadun* samples.

Table 1: Proximate composition of the *aadun* samples

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Runs | Moisture | Protein | Fibre | Ash | Fat | CHO | Energy(K/ca) | |
| Control | 5.28±0.20b | 6.71±0.28a | 2.83±0.12a | 2.29±0.10a | 17.85±0.19h | 65.04±0.34f | | 447.65±1.63g |
| 1 | 9.12±0.20ef | 7.33±0.12b | 3.31±0.20b | 2.81±0.08b | 14.32±0.15g | 63.11±0.5e | | 410.64±1.87d |
| 2 | 3.50±0.39a | 16.81±0.19i | 6.06±0.12h | 4.45±0.13gh | 18.01±0.32h | 51.17±1.07b | | 434.01±1.50f |
| 3 | 6.32±0.25c | 8.73±0.19c | 3.69±0.08c | 2.91±0.16b | 11.21±0.40c | 67.14±0.94g | | 404.37±1.93c |
| 4 | 5.59±0.38b | 14.72±0.16h | 5.93±0.13h | 4.27±0.17fg | 23.50±0.22i | 45.99±1.01a | | 454.34±1.95h |
| 5 | 8.15±0.38d | 13.51±0.21f | 5.51±0.14g | 4.05±0.10ef | 13.75±0.15f | 55.03±0.53c | | 397.91±2.91b |
| 6 | 5.53±0.16b | 14.98±0.28h | 5.42±0.10g | 4.62±0.14h | 18.22±0.15h | 51.23±0.26b | | 428.82±1.48e |
| 7 | 7.98±0.23d | 9.25±0.22d | 3.02±0.11a | 2.73±0.21b | 11.78±0.16d | 65.24±0.37f | | 403.98±0.33c |
| 8 | 9.14±0.26ef | 13.71±0.31f | 4.25±0.13e | 3.87±0.11e | 13.24±0.20e | 55.79±0.86c | | 397.16±0.77b |
| 9 | 5.53±0.16b | 14.98±0.28h | 5.42±0.10g | 4.62±0.14h | 18.22±0.15h | 51.23±0.26b | | 428.82±1.48e |
| 10 | 10.52±0.11g | 8.40±0.12c | 3.84±0.15cd | 3.22±0.19c | 10.34±0.18a | 63.68±0.26e | | 381.38±2.07a |
| 11 | 9.12±0.20ef | 7.33±0.12b | 3.31±0.20b | 2.81±0.08b | 14.32±0.15g | 63.11±0.58e | | 410.64±1.87d |
| 12 | 9.03±0.19e | 10.09±0.17e | 4.04±0.17de | 3.85±0.12e | 14.50±0.16g | 58.49±0.54d | | 404.82±0.36c |
| 13 | 10.52±0.11g | 8.40±0.12c | 3.84±0.15cd | 3.22±0.19c | 10.34±0.18a | 63.68±0.26e | | 381.38±2.07a |
| 14 | 9.56±0.16f | 14.05±0.14g | 4.52±0.16f | 3.54±0.12d | 10.86±0.21b | 57.47±0.41d | | 383.82±1.54a |
| 15 | 5.59±0.38b | 14.72±0.16h | 5.93±0.13h | 4.27±0.17fg | 23.50±0.22i | 45.99±1.01a | | 454.34±1.95h |
| 16 | 7.98±0.23d | 9.25±0.22d | 3.02±0.11a | 2.73±0.21b | 11.78±0.16d | 65.24±0.37f | | 403.98±0.33c |

\* Values represent mean ± standard error of triplicate determinations and values with same superscript along same column are not significantly different (P≥0.05).

Moisture content, which is one of the remarkable qualities and a commonly used factor in the processing and testing of food qualities was seen to range from 3.04% - 11.32% in the supplemented samples compared to the control (5.28%). High moisture content may affect the storability and the quality of the product. The moisture content obtained was within the range indicated by Idowu *et al*. (2012) who reported that street *aadun* contains 2.42 to 10.59% moisture.

The protein content of the snacks significantly (P≥0.05) increased from 6.71% - 16.81% with an increase in the percentage of groundnut paste. Ibitoye *et al*. (2020) also recorded an increase in protein content (5.71% - 6.16%) by supplementing *aadun* with plantain. A similar pattern was noticed by Otunola *et al*. (2012) who indicated a substantial increase in the level of protein from 12.33% - 23.77% after supplementing *Kokoro* with defatted groundnut paste.

The values of fibre (3.02% - 6.06%) and ash content (2.81-4.62) in samples of *Aadun* supplemented with the various constituent of groundnut paste were higher than the values of the control sample 2.83 for fibre and 2.29 for ash content. The reports of Akinola and Enujiugha (2017) were lower values (1.85% - 2.44%) for ash and 2.12 - 2.42% for fibre content after supplementing *aadun* with defatted African oil bean seed flour. The higher ash content of the *aadun* supplemented with groundnut indicates that there may be more minerals present in the supplemented *aadun* than in the plain (control).

The fat ranged from 10.86% - 23.50%. The level of fat in the *aadun* samples may be linked to the palm oil as well as the oil from the groundnut used in the production of the products. The higher fat observed in some of the samples of the supplemented *aadun* may be due to the ability of the maize flour to absorb more oil due to its dryness. Idowu and Adedokun (2011) and Idowu *et al*. (2012) reported higher ranges (30.06% - 52.54%) and (24.87% - 46.11%) after collecting samples from different locations.

The carbohydrate values (45.99% - 67.14%) obtained in this work were greatly higher than the values of 26.18-36.32% reported by Adepoju *et al*. (2020). The energy content of the samples (381.38 - 454.34 kcal/100g) is lower than the values (447.05 - 556.90 kcal/100g) obtained by Idowu *et al*. (2012). The reduction in the calorie content of the supplemented samples may be attributed to the reduction in the added palm oil and carbohydrate content.

Table 2: Sensory evaluation of the sample

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Runs | Appearance | Taste | Texture | Aroma | Overall Acceptability |
| CONTROL | 7.70±0.92b | 5.90±1.02a | 6.05±0.89a | 5.85±0.93a | 6.15±0.75a |
| 1 | 7.35±0.93ab | 6.05±0.88a | 6.10±0.72a | 6.10±0.79ab | 6.30±0.80ab |
| 2 | 7.15±0.93ab | 7.50±0.61cd | 7.35±0.88bc | 7.45±0.76d | 7.40±0.50efg |
| 3 | 7.05±0.76ab | 6.35±0.67a | 6.20±0.77a | 6.15±0.81ab | 6.50±0.69abc |
| 4 | 6.90±0.97ab | 6.95±0.89bc | 7.05±0.83b | 7.25±0.91cd | 7.35±0.81efg |
| 5 | 6.75±1.07a | 7.00±0.86bc | 7.80±0.77c | 7.10±0.85cd | 7.80±0.70g |
| 6 | 7.00±1.17ab | 7.60±1.00d | 7.70±0.87c | 7.20±0.83cd | 7.30±0.87defg |
| 7 | 6.95±1.23ab | 6.25±0.72a | 6.25±0.72a | 6.00±0.86a | 6.30±0.73ab |
| 8 | 6.75±1.16a | 7.20±0.89cd | 7.50±0.89bc | 6.95±0.76cd | 7.50±0.51fg |
| 9 | 7.00±1.17ab | 7.60±1.00d | 7.70±0.87c | 7.20±0.83cd | 7.30±0.86defg |
| 10 | 7.30±1.03ab | 6.50±0.83ab | 6.25±0.79a | 6.65±0.88bc | 6.90±0.72cde |
| 11 | 7.35±0.93ab | 6.05±0.89a | 6.10±0.72a | 6.10±0.79ab | 6.30±0.80ab |
| 12 | 7.25±1.25ab | 6.20±0.70a | 6.15±0.75a | 6.80±0.77c | 6.80±0.62bcd |
| 13 | 7.30±1.03ab | 6.50±0.83ab | 6.25±0.79a | 6.65±0.88bc | 6.90±0.72cde |
| 14 | 7.10±0.97ab | 7.45±0.69cd | 7.35±0.67bc | 7.00±0.73cd | 7.00±0.80cdef |
| 15 | 6.90±0.97ab | 6.95±0.89bc | 7.05±0.83b | 7.25±0.91cd | 7.35±0.81efg |
| 16 | 6.95±1.23ab | 6.25±0.72a | 6.25±0.72a | 6.00±0.86a | 6.30±0.80ab |

\* Values represent mean ± standard error of triplicate determinations and values with same superscript along same column are not significantly different (P≥0.05).

The appearance varies significantly (p≥0.05), and ratings ranged from 6.75% - 7.70%. The control (78% maize: 20% palm oil) had the highest rating of 7.70 while run 5 (68.75% maize: groundnut 16.50%: 12.75% palm oil) and run 8 (73% maize: 15% groundnut paste: 10% palm oil) has the least appearance rating of 6.75. The oil produced by the groundnut paste is responsible for the variation in appearance. The taste, texture, aroma and overall acceptability of the supplemented *aadun* were scored higher than the control sample. The rating increased with an increase in the substitution of groundnut paste. Runs 6 and 9 (68% maize: groundnut 20%: 10% palm oil) have the highest rating for taste and run 2 (64% maize: 20% groundnut paste: 14% palm oil) obtained the highest score for aroma, while run 5 for texture and overall acceptability. Snacks containing roasted groundnuts have high consumer acceptance due to their unique roasted groundnut flavour (Eke-Ejiofor *et al*.,2012).

CONCLUSION

Based on the findings of this study, it can be concluded that groundnut paste can be used to supplement maize flour. The proximate analysis conducted on the different samples reveals an increase in the quality of the nutrients with increasing groundnut paste compared to the plain *aadun* (control). The supplemented samples were acceptable to the panellists. However, the most acceptable sample based on the overall acceptability score was run 5 (68.75% maize: groundnut 16.50%: 12.75% palm oil). Supplementing maize in the production of *aadun* with groundnut paste will therefore increase the snack nutrients and acceptability.

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## MICROBIOLOGICAL QUALITY OF OVEN ROASTED PLANTAIN (*Musa Parasidiaca*)

Tavershima Dzenda and Femi F.A

Department of Food Science and Technology, Federal University of Technology, Minna, Niger State, Nigeria

[tavershimadzenda5@gmail.com](mailto:tavershimadzenda5@gmail.com), 08146431613

ABSTRACT

*In this study, the microbiological quality of oven roasted plantain was investigated and compared with open charcoal roasted roadside sold plantain purchased from Tunga market, Minna, Niger State (Control). The Total Viable Count (TVC), Total Plate Count (TPC), Total E. coli Count (TEC) and Total Staphylococcus Count (TSC) were accessed by inoculating into different selective media using MacConkey agar, Nutrient agar and Mannitol salt agar for day 0, day 5 and day 10 after production. TVC ranged from 1.0 × 106 to 2.0 × 107 cfu/g while TPC ranged from 1.0 × 106 to 2.40 × 107 cfu/g. The TEC recorded no growth for day 0 to day 5. However, the growth became visible at day 10 in CU10 (3.0 × 106 cfu/g) and OP10 (1.5 × 106 cfu/g) while TSC ranged from no growth on day 1 to 2.1 × 107 cfu/g on day 5. The level of contamination of oven roasted plantain and charcoal roasted boli were high and above the International Commission for Microbiological Specification for Foods (ICMSF) standards for ready to eat foods. Therefore, there is need to create more awareness among the vendors as well as the consumers of the roasted product as it is exposed to various sources of contamination such as polycyclic aromatic hydrocarbons, dusts etc. to avoid any associated health implications.*

**Key words:** Microbiological quality, Roasting, Plantain, Inoculation, Selective media.

INTRODUCTION

In Nigeria, plantain is eaten in many forms such as boiled, fried or even snacks i.e. the famous roasted, delicacy called ‘*boli*’. In china, plantain is processed into durable flour for subsequent usages. (Oluwalana *et al*., 2011). Matured plantains from which *boli* is made are a very rich source of nutrients such as 60% water, 32% carbohydrates, 1% proteins, 0.02% fats and some vitamins and minerals elements (Oluwalana and Oluwamukomi, 2010).

Roasted plantain or *boli* is a Nigerian native dish especially to the Yoruba people. It is referred to as either “*boli*” or “*bole*” and eaten with groundnut or fish in southern Nigeria.

The Nigerian conventional method of processing *boli* used by roadside food vendors involves open charcoal roasting which exposes the product to various sources of contamination such as polycyclic aromatic hydrocarbons (PAHs), dust, fumes and flies etc. posing a risk of food contamination to consumers especially as the local snack is gaining a high consumption rate due to the increasing urbanization in Nigerian cities such as Minna, Niger State. Most food vendors in the developing countries like Nigeria and Minna precisely are not adequately informed on good manufacturing practices and basic food sanitary measures and practices. Consequently, these street foods are most times subjected to various contamination sources at different levels of handling (Rane, 2011). Hence, it is necessary to maintain personal hygiene, as well as good manufacturing practices to ensure product safety of such foods.

There is need to process plantain in an oven and compare the microbiological quality with the open charcoal roadside sold ones.

MATERIALS AND METHODS

**Source of Raw Material:** Not too ripe plantain and charcoal roasted plantain (*boli*) were bought from Tunga market, Minna, Niger state.

**Preparation of oven roasted plantain:** The plantains were thoroughly sorted and cleaned using clean running water in order to remove foreign materials such as sand, glue and dirt etc. The plantains were thereafter weighed using an electronic weighing balance in order to ascertain their weights before and after production. Crown Star electric roaster oven (Model: MC – 1985K) was preheated at 190˚C for 15 minutes, and then roasting was done at 200˚C for 30 minutes for peeled plantain while for unpeeled plantain, roasting was carried out at 200˚C for 40 minutes.

**Microbial Analysis:** Microbial analysis was carried out using the method of Ojokoh (2006), which involved preparation of media, diluents, serial dilution, inoculation, incubation, subculture, gram stain.Test tubes were washed and rinsed with clean running water in order to remove contaminants and filled with 9 mL of clean water prior to sterilization.Test tubes alongside with culture media (nutrient agar, MacConkey agar and manitol salt agar) were sterilized in an YX – 280A model autoclave at 121˚C for 15 minutes in order to destroy all potential microbes. The test tubes and culture media were cooled to 45˚C to avoid the heat from destroying the nutrients and microbes present in the samples before analysis.

Inoculation was carried for 1g of each sample. Serial dilution was carried out after inoculation using a new sterile syringe. Thereafter, 1 mL of the sample was transferred into petri dishes. Beakers containing agars were sterilized using open flame. The agars were then added into the petri dishes and stirred gently. The samples were left to gel or solidify for 20 – 25 minutes and incubated for 24 hours in a Gallentant (Model: 1971s) electronic incubator at 37˚C. This process was carried out for day 0, day 5 and day 10 and the total microorganisms were counted and recorded.

RESULTS AND DISCUSSION

Table 1: Microbial analysis of roasted plantain (charcoal, oven, peeled and unpeeled)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| SAMPLE | TVC (cfu/g) | TPC(cfu/g) | TEC(cfu/g) | TSC(cfu/g) |
| CP0 | 1.0×106 | 1.0×106 | NG | NG |
| CU0 | 3.0×106 | 9.0×106 | NG | NG |
| OP0 | 1.6×107 | 2.1×107 | NG | NG |
| OU0 | 1.4×107 | 1.8×107 | NG | NG |
|  |  |  |  |  |
| CP5 | 5.0×106 | 1.9×107 | NG | 2.1×107 |
| CU5 | 1.7×107 | 2.7×107 | NG | NG |
| OP5 | 9.0×106 | 3.9×107 | NG | NG |
| OU5 | 6.0×106 | 1.5×107 | NG | NG |
|  |  |  |  |  |
| CP10 | 2.8×106 | 3.0×107 | NG | 8.0×106 |
| CU10 | 2.0×107 | 2.40×107 | 3.0×106 | 3.16×106 |
| OP10 | 7.0×106 | 7.1×106 | 1.5×106 | 4.3×106 |
| OU10 | 9.8×106 | 1.12×107 | NG | 9.2×106 |

KEY: TVC = Total Viable Count. TPC = Total Plate Count, TEC = Total *E.coli* Count, TSA =Total *Staphylococcus aureus* Count, CU = Charcoal Unpeeled, CP = Charcoal Peeled, OU = Oven Unpeeled, OP = Oven Peeled, NG = No Growth, 0 = Day 0, 5 = Day 5 and 10 = Day 10.

**Day 0 Microbial Quality:** Table 1 showed the microbial quality of oven roasted and charcoal roasted plantain (peeled and unpeeled) on day 0 of production. The total viable count for oven peeled sample recorded the highest count (1.6 × 107 cfu/g) while charcoal peeled recorded the lowest (1.0 × 106 cfu/g). The values were low compared to the ones gotten from various streets of Accra, Ghana (Maxwell *et al.*, 2000). The total plate count ranged from 1.0 × 106 to 2.1 × 107 cfu/g. The high counts of TVC and TPC indicate improper processing or cross contamination as well as post process recontamination with dirty utensils and handlers etc. as well as improper storage which result into high multiplication and spread of toxigenic and pathogenic organisms (Vedesh and Neel, 2017).

**Day 5 Microbial Quality:** Table 1 showed the microbial quality for oven roasted and charcoal roasted (peeled and unpeeled) on day 5 after production. For TVC, charcoal peeled count recorded the lowest (5.0 × 106 cfu/g) while charcoal unpeeled count recorded the highest (1.7 × 107 cfu/g). This high count could be as a result of the infested plantain skin with microorganisms because certain microbes such as Penicillums spp, Bacillus subtilis, etc. are associated with the supply chain of plantains (Fajinmi *et al*, 2011). The presence of Staphylococcus aureus was 2.1 × 107 cfu/g from charcoal peeled sample. The presence of Staphylococcus aureus signifies respiratory contamination from the food handler as this microorganism is introduced into street vended foods during handling and vending (Sandel and Mckillip, 2004).

**Day 10 Microbial Quality:** Table 1 showed the microbial quality of oven roasted and charcoal roasted (peeled and unpeeled) plantain after 10 days of production. There was no growth of *E. coli* in charcoal peeled and oven unpeeled samples. However, its growth was observed in the charcoal unpeeled and oven peeled samples. Staphylococcus aureus indicated growth for all the days. The appearance of *E. coli* in food samples indicates the use of unhygienic practices, poor water quality used in washing the raw plantains (Rasmi *et* *al*., 2012). This also indicated improper hygienic practices especially in the location of the food environment (Suneetha *et al*., 2011). This is in line with an experiment which was done in Lokoja streets by Madueke *et al.* (2014) and reported that the food samples harbored microorganisms such as *E. coli*, *Staphylococcus aureus* etc.

CONCLUSION

The microbial analysis showed the level of contamination of oven roasted and charcoal roasted plantains (*boli*) were high. It is noted that the total viable count, total plate count, total Staphylococcus count and total *E. coli* counts were more than the recommended reference level. The International Commission for Microbiological Specification for Food (ICMSF, 1996) stated that ready to eat foods between the values of 103 are acceptable, 104 to 105 tolerable. However, 106 and above are unacceptable hence the eating of the ready to eat foods such as roasted plantain (*boli*) is an avenue to increase the risk of food borne diseases. In the present study, the microbial counts of the analyzed microorganisms (TVC, TPC, TEC and TSA) all exceed the recommended levels as prescribed by the ICMSF and are harmful to our health

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## FUNCTIONAL PROPERTIES OF CASSAVA SEED PROTEIN CONCENTRATE

Gana, B.K1\*,Akanya, H.O1 and Egwim E.C1, 2.,

1Department of Biochemistry, Federal University of Technology, P.M.B 65, Minna, Nigeria.

2Global Institute of Bio-Exploration (GIBEX), Federal University of Technology, Minna Nigeria

\*Corresponding Author Email: ganablessingkaka@gmail.com. +2347061837907

ABSTRACT

Cassava seed is protein-rich; however, it is underutilized because it is less known, has high cyanide level and its functional properties are not studied. Functional properties are invaluable to the application of protein concentrate obtained from protein-rich seeds. The functional properties of cassava seed protein concentrate are reported in this work. The protein concentrate was prepared from defatted cassava seed flour samples using isoelectric precipitation extraction method. The proximate analysis and functional properties of the seed flour and the protein concentrate were carried out using standard methods. For proximate analysis, carbohydrate content was the highest and ash content was the lowest. The protein yield was 26.67%. The functional properties showed that water absorption capacity (WAC), oil, absorption capacity (OAC) and swelling capacity were higher than solubility index, least gelation capacity, and foaming capacity. Bulk density and viscosity are similar to results obtained from other seeds. The findings in this study showed that cassava seed protein concentrate may be relevant in the formulation of complementary foods, they may serve as good ingredient in sausage production industries where protein usually bridges the fat and water to obtain good products. Cassava seed would also be useful in dish washing liquids formulation industries and baking industries.

**Keywords**: cassava seed, protein concentrate, functional properties, proximate analysis, protein yield.

INTRODUCTION

Cassava is a major staple food in developing world and many sub-Saharan African countries (FAO, 2019). Cassava can be multiplied vegetatively from stem, meristem, leaf-bud and root-tip cuttings, or sexually from botanical seed (Hedge *et al*., 2016). Besides, cassava seeds are protein rich and thus, protein concentrates can be obtained from them. Protein concentrates are high protein content, obtained when non-protein components are eliminated from food through solvent extraction (Sibt-e-Abbas *et al*., 2015). Protein concentrate can be added to existing food products, markedly improving the nutritional quality without significantly altering other characteristics, moreover, in some instances, the addition appears to improve the shelf life of final products. In many developing countries, the supply of animal protein cannot adequately meet the protein needs of the rapidly growing population. Increase in cost of animal protein sources have accelerated research on food properties and potential utilization of alternative plant protein from locally available crops at a lower cost of production (Cheng *et al*., 2019). Since the values of cassava seeds are unknown, this research was carried out to investigate the potential of cassava seed protein concentrate as a food supplement through analysis of its nutritive value and function properties.

OBJECTIVE

To determine the proximate composition of cassava seed and functional properties of cassava seed protein concentrate.

MATERIALS AND METHODS

Source of Material

Cassava seeds were purchased from IITA Ibadan, Oyo State.

Determination of Proximate Composition

Moisture content, total ash content, crude lipid content, and crude protein content were determined using AOAC methods (AOAC, 2012).

Preparation of Protein Concentrate

The method of Chandi & Sogi (2007) was adopted in the preparation of cassava seed protein concentrate. The obtained protein isolate was then freeze-dried and packaged for further analysis.

Determination of Functional properties

Bulk density, swelling capacity and solubility index, Water and oil absorption capacity, gelation capacity, Viscosity, foaming capacity were determined using the method described by Onwuka (2005).

Statistical Analysis

Statistical analysis was performed using SPSS version 22.0. T-test and one-way analysis of variance (ANOVA) tools were used where required. All data was analyzed at 95% confidence interval and values were considered statistically significant at p ≤ 0.05.

RESULTS AND DISCUSSION

The proximate compositions of cassava seed flour (Table 1) indicates that carbohydrate content of cassava seed flour was the highest compared to moisture, ash, crude fiber, crude protein and oil content. The lower moisture contents observed in raw cassava seed flour (Table 1) may enhance the shelf stability of the cassava seed flour by preventing the growth of microorganisms during storage (Godswill, 2019). The high ash content of cassava seed suggests that cassava seed may be a good source of minerals. Cassava seed flour has high crude fibers, which may improve bowel function and enhance faecal bulk digestion. The high crude fibre contents may be due to the presence of the hulls (DePeters *et al.*, 2020). Cassava seeds contain appreciable level of oil (Adunni, 2017), suggesting that they can be exploited as source of vegetable oil like the peanuts and soybean seeds. However, the oil content in cassava seed flour falls within the range (12.40-21.60%) of oil contents of conventional oilseed crops. the crude protein content is within the normal range of protein content of legumes (20 - 25%) reported by Erbersdobler *et al.*, (2017) and Maphosa and Jideani, (2017) thus, it may potentiate the use of cassava seed flour as source of protein in some food formulations. carbohydrate was the highest macro nutrient in cassava seed. The high content of cassava obtained in this study makes it an energy giving source; providing accessible fuel for physical performance and other body functions. Figure 1 shows the percentage protein yield and recovery. The result shows that the percentage protein yield and recovery were 26.67% and 84.31% respectively.

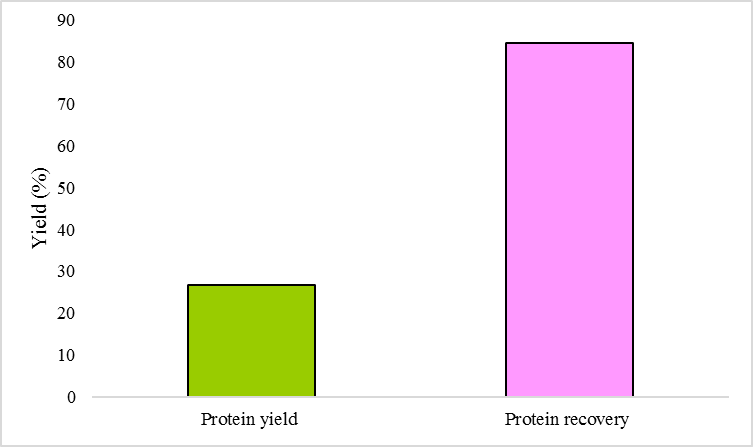
Table 2 shows that the water absorption capacity (WAC), oil, absorption capacity (OAC) and swelling capacity were higher than bulk density, solubility index, viscosity, least gelation capacity, and foaming capacity. Low bulk density is important in the formulation of complementary foods for infants feeding to enhance digestibility (Fasuan *et al.,* 2017). Therefore, the low value of bulk density obtained from this study makes the samples suitable for formulation of complementary foods. The result showed that CSPC, has high values of water absorption capacity (WAC) and oil absorption capacity (OAC). high water absorption capacity (WAC) and oil absorption capacity (OAC) of cassava seed protein concentrate (CSPC) give it amphipathic properties which would make it a good ingredient in cold meat industry, particularly for sausages, where the protein usually bridges the fat and water to obtain good products (Jain *et al.,* 2019). The low foaming capacity was probably due to low solubility, since high protein solubility is a prerequisite for achieving better foaming capacity (Dhanabalan *et al*. 2020). The low foaming capacity of Cassava seed protein concentrate obtained in this study would be useful in product formulation requiring low product foaming like dish washing liquids for machines (Toedt *et al*., 2005 Clendennen and Boaz, 2019). The low solubility of CSPC could be attributed to the fact that, it was extracted at the product’s isoelectric point (James *et al*., 2016). Therefore, the pH or other solubility enhancing properties of CSPC can be further modified to improve its solubility and enhanced application in the food industry. The low level of least gel capacity obtained in this study would be useful as a substitute to other proteins in food applications and in new product development to form gels and provide a structured matrix for holding water, flavors, sugars and food ingredients, thereby providing an added dimension to protein functionality (Lin *et al*., 2020). High viscosity obtained in this study, can be due to the high-water absorption capacity of CSPC as shown in (Table 2) Therefore, for cassava seed protein concentrate, high viscosity will be necessary for foaming stability, especially as it has low foaming capacity.

Table 1: Proximate compositions of flours from raw and defatted cassava seeds

|  |  |
| --- | --- |
| **Proximate constituents** | **Cassava seed flour composition (%)** |
| Moisture | 9.89 ± 0.16 |
| Ash | 4.20 ± 0.23 |
| Oil | 20.75 ±2.66 |
| Crude protein | 16.64 ± 0.46 |
| Crude fiber | 11.94 ± 2.10 |
| Carbohydrate | 35.03 ± 5.73 |

Values are means of triplicate determinations ± SD.

Values along rows with different superscripts are significantly (p≤0.05) different.



**Figure 1**: Protein Yield and Recovery from Cassava Seed Flour

Table 2: Functional properties of cassava seed protein concentrate.

|  |  |
| --- | --- |
| **Parameter** | **Functional properties** |
| Bulk density (g/ml) | 0.75 ± 0.78 |
| Water absorption capacity (%) | 250.77 ± 16.90 |
| Oil absorption capacity (%) | 209.81 ± 4.64 |
| Swelling capacity (%) | 277.18 ± 16.97 |
| Solubility index (%) | 6.68 ± 1.04 |
| Least gel capacity (%) | 17.00 ± 1.15 |
| Foaming capacity (%) | 5.50 ± 2.12 |
| Viscosity (mpa.s) | 56.25 ± 4.65 |

Values are means of triplicate determinations ± SD.

CONCLUSION

Cassava seed was found to be rich in protein. In addition, the functional properties of cassava seed protein concentrate can lead its possible relevance in food formulation industries.

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## INFLUENCE OF TEMPERATURE AND AIR VELOCITY ON THE MOISTURE DIFFUSIVITY AND ACTIVATION ENERGY IN DRYING OF AFRICAN YAM BEAN (*Sphenostylis stenocarpa*) TUBER

Ugwu Innocent Chukwuebuka, Peter Aba Idah and Atteh Bamidele Olaiya

Department of Agricultural and Bioresources Engineering, Federal University of Technology Minna. Niger State, Nigeria.

Ugwu Innocent Chukwuebuka

+2347036006957

jsphinnocent25@gmail.com

ABSTRACT

The aim of this paper is to report African yam bean tuber moisture diffusivity data determined and activation energy from experimental drying kinetics. The thin-layer drying experiments were carried out under three air temperatures of 50, 60 and 70 ºC, two air velocity 1.2, and 1.8 m/s at constant length thickness of 3 mm. It was observed that drying took place in the falling rate period. Effective moisture diffusivity values varied from 2.55 × 10-9 m2s-1 to 4.92 × 10-9 m2s-1 for the range of temperatures considered. The values of activation energy ranged between 10.0059 and 8.098 kJ/mol were obtained at different velocities of air.

**Keywords**: African yam bean tuber, Drying, Effective moisture diffusivity, Activation energy

INTRODUCTION

African yam bean (AYB*; Sphenostylis stenocarpa*) is a tuberous legume which belongs to the family Fabaceae. It is also known as *Okpududu* and *Azanma* (Igbo, Nigeria), *Girigiri* (Hausa, Nigeria) and *Sese* (Yoruba, Nigeria). Nigeria is more prominent for AYB production, as it is extensively cultivated in the western, eastern, southern and northern states of the country (Saka *et al*., 2004). AYB is mostly cultivated as a mixed crop with cassava, vegetables, yam and rice.

Generally, African yam bean is grown for tubers in certain areas and for seeds in other locations, and evidence that yield of seeds and tubers are inversely related (Ene-Obong and Okoye, 1992).

The edible tubers look like elongated sweet potatoes are harvested from 150 to 240 days after sowing (Ezueh, 1984).

African yam bean is one of the under-utilize African crop species that has immense advantages, especially its high nutritional value (it has a total carbohydrate of 61.6%, 19.1% crude protein, 0.5% crude fat, 5.2% crude fibre and 2.4% total ash (Amoatey et al., 2000).

The tuber of AYB has a protein content that is more than twice that obtainable in sweet potato or Irish potato (NRC, 2007). It is also higher than those in yam and cassava (Amoatey, 2000).

Drying is one of the oldest method of preserving food (Krzysztof *et al.*, 2020). Maxwell and Zantoph (2002) define drying as a mass transfer process consisting of the removal of moisture from a solid, semi-solid or a liquid. It is also a method of food preservation that works by removing water from the food, which inhibits deterioration (Zantoph and Schuster, 2004). It helps in reducing the water activity of the produce to a level below which deterioration does not occur for a definite duration. Drying of moist materials is a complicated process involving simultaneous heat and mass transfer. Many researches have attempted food product drying process especially perishable crops. Mathematical modelling of drying process is a good way to analyse and describe the products drying treatment.

Many authors have studied the drying behaviour of food materials and several mathematical models have been proposed. There appears to be little information in the literature on the drying characteristics of AYB tuber and the combined effects of temperature and air velocity.

The knowledge of the moisture diﬀusivity and activation energy under diﬀerent drying conditions is essential in optimizing the process of drying food and agricultural materials. This study therefore, investigated the eﬀects of temperature and air velocity on the eﬀective moisture diﬀusivity and activation energy during the drying of African yam bean tuber.

MATERIALS AND METHODS

AYB tuber were purchased from a local market in Minna, Niger State, washed with water, manually peeled, re-washed and sliced into chips 3mm thickness) using sharp stainless steel knife.

Drying experiments were performed using three different temperature levels (50, 60 and 70oC) at 1.2ms-1 and 1.8ms-1 drying air velocity in a ﬂuidized bed dryer at laboratory scale. During drying experiments, the weight of the sample was measured with a digital balance and recorded at thirty minutes interval for all temperature range selected for this study until no further changes in their mass were observed (constant weight). The digital top pan balance was kept very close to the drying unit (within 1 m). Each process of weight measurement lasted about 9.55±0.31 seconds. Moisture contents of the samples at each weighing intervals were determined according to standard method by AOAC, 2005. Drying experiment for each temperature was conducted in triplicate, and mean values were reported.

Mathematical modelling of AYB tuber

The moisture ratio (MR) of AYB tuber during the drying process was obtained following Equation 1.

(1)

Where Mt, Mo and Me are moisture content at each measurement time, initial moisture content, and equilibrium moisture content (kg water/kg dry matter) respectively. However, the drying varied continuously during the drying experiments, the relative moisture content of drying air is simplified into Equation 2 (Akpinar et al., 2003):

(2)

Determination of the effective moisture diffusivity (Deff)

The AYB was assumed as a slab because the thickness of sample was much less than its diameter. The effective moisture diffusivity was calculated by the following equation:

*MR* ) (3)

Many researchers demonstrated that for long drying period, Equation 3 can be further simplified to the first term of series as follows (Tutuncu and Labuza, 1996):

*MR* ) (4)

Equation 4 can be arranged in a logarithmic form as follows

ln*MR*  (5)

The effective moisture diffusivities are typically determined by plotting experimental drying data in terms of ln(MR) versus time t.

Diffusivities are typically determined by plotting experimental drying data in terms of ln MR versus drying time (t), because the plot gives a straight line with a slope as follows:

Slope = t (6)

where t is the time (s), Deff is the effective diffusivity (m2s-1) and L is the half thickness of samples (m).

Calculation of activation energy

The temperature dependence of the eﬀective diﬀusivity may be described by an Arrhenius-type relationship (Wang et al., 2007) as follows:

D*eff* (7)

where D0 is the pre-exponential factor of the Arrhenius equation (m2s-1), Ea the activation energy (kJ/mol), R the universal gas constant (kJ/mol K) and T the absolute temperature (K).

Slope = (8)

From the slope of the straight line of ln Deﬀ versus reciprocal of T, described by the Arrhenius equation, the activation energy, Ea, could be calculated.

Results AND DISCUSSION

Table 1: Eﬀective moisture diﬀusivity and activation energy for AYB tuber slices

|  |  |  |  |
| --- | --- | --- | --- |
| Dry air velocity (ms-1) | Temperature (oC) | Eﬀective moisture diﬀusivity(×10-9 m2s-1) | Activation energy(kJmol-1) |
| 1.2 | 50 | 2.55 | 10.0059 |
|  | 60 | 2.74 |  |
|  | 70 | 3.01 |  |
| 1.8 | 50 | 4.01 | 8.098 |
|  | 60 | 4.47 |  |
|  | 70 | 4.92 |  |

The effective moisture diffusivity of a food material characterizes its intrinsic moisture mass transport property that includes molecular diffusion, liquid diffusion, vapour diffusion, hydrodynamic flow and other possible mass transport mechanisms (Karathanos *et al*., 1990). The effective moisture diffusivity was calculated using Equation 7. The minimum value of the moisture diffusivity was 2.55 × 10-9 m2s-1 at the air velocity of 1.2 ms-1 and air temperature of 50°C while the maximum value of the moisture diffusivity was 4.92 × 10-9 m2s-1 at the air velocity of 1.8 ms-1 and air temperature of 70°C. These values are in good agreement with the most recent reported values of 2.03×10-9 to 1.71×10-9 m2s-1 for olive-waste cake (Vega-Galvez et al., 2010). 1.7×10-10 to 1.15×10-9m2s-1 for apricots (Mirzaee et al., 2009). Generally, the value of effective moisture diffusivity changes in the range of 10-11 to 10-9 m2s-1 for food materials (Babalis and Belessiotis, 2004).

**Figure 1**: Relationship between effective coefficient moisture diffusivity and temperature for 1.2 and 1.8 m/s2 air velocity.

Figure 1 shows the relations between the natural logarithm of Deff and the reciprocal of absolute temperature for drying of the sliced AYB tuber. The results showed a linear relationship derived from the Arrhenius-type equation. According to the slopes of two straight lines, the values of activation energy were 10.0059 and 8.098 kJ/mol for 1.2 and 1.8 m/s2 drying air velocity. The values obtained is however lower when compared with the value (16.98 kJ/mol) reported by Tai *et al*. (2021) for banana. The differences observed could have resulted from the higher temperature used in their study.

Conclusion

The eﬀects of temperature and drying air velocity on the eﬀective moisture diﬀusivity and activation energy of AYB tuber have been investigated in this study. Variations in temperature and drying air velocity levels had signiﬁcant eﬀect on the eﬀective moisture diﬀusivity and activation energy of AYB tuber. Effective moisture diffusivity values varied from 2.55 × 10-9 m2s-1 to 4.92 × 10-9 m2s-1, which increased with increase in temperature and drying air velocity. The values of activation energy ranged between 10.0059 and 8.098 kJ/mol. Ea values were found to decreased slightly with increase in drying air velocity.

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## EVALUATION OF SINGLE AND MIXED VIRUS-INOCULATED BAMBARA GROUNDNUT LANDRACES FOR NODULATION AND NITROGEN FIXATION

A. J. Salaudeen1\*, M.T. Salaudeen1, L.Y. Bello1 and A.O. Uzoma2

1Department of Crop Production, Federal University of Technology, Minna, Nigeria.

2Department of Soil and Land Management, Federal University of Technology, Minna, Nigeria

\*Corresponding author: [salaudeenamina135@gmail.com](mailto:salaudeenamina135@gmail.com), +2347066032274

ABSTRACT

*Bambara groundnut (Vigna subterranea [L.] Verdc) enriches soils by forming a symbiotic relationship with nitrogen-fixing and stem-nodulating bacteria. Virus infections, however, limit the plant's ability to fix nitrogen. The study evaluated the nodulation and nitrogen-fixing ability of Bambara groundnut landraces (Vg 01, Vg 02, Vg 03, Vg 04, and Vg 05) under single and mixed virus infections of Blackeye cowpea mosaic virus (BlCMV; Potyvirus), Cowpea mild mottle virus (CPMMV; Carlavirus), BlCMV+CPMMV, and CPMMV+BlCMV. The experiment was conducted under screenhouse conditions, using a completely randomised design with three replications. The results showed that the landraces varied significantly (p<0.05) in their nodulation and symbiotic effectiveness (SE). The highest number of nodules (7 per plant) was observed in Vg\_04 followed by Vg\_05 (6 per plant), and Vg\_01 had the lowest of 5 nodules per plant. The highest reduction in the number of nodules per plant was 54.1 %, dry weight of shoot 48.6 % and root 43.8 %; length of shoot and root reduced by 43.1 % and 59.3 %, respectively in BlCMV+CPMMV treated plants. Nitrogen-fixing efficiency of the landraces varied from ineffective (IE), in BlCMV (SE = 29.1 %) and BlCMV+CPMMV (SE = 32.0 %) to poorly effective (PE) for CPMMV (SE = 35.6 %) and CPMMV+BlCMV (SE = 36.4 %) while the control treatment was effective with average percentage SE of 70.7 %. These results suggest the need to protect plants from virus infections to guarantee desirable yield and food security.*

**Keywords:** Bambara groundnut, Landraces, Nitrogen Fixation, Nodulation, Virus

INTRODUCTION

Bambara groundnut (*Vigna subterranea*(L.) Verdc) is an indigenous legume of Africa; cultivated across the Sub-Saharan and Semi-Arid region of Africa, Southeast Asia in regions of Indonesia and Thailand (Mayes *et al*., 2019). The crop is the third most important food legume in Africa after groundnut and cowpea, both in consumption and land area under cultivation (Puozaa *et al*., 2017). It is a hardy, drought-tolerant legume which thrives well in nutrient deficient soils largely due to its ability to form effective root nodules with compatible soil rhizobia that convert atmospheric nitrogen (N) to Ammonia for bacterial and plant use, thereby contributing to soil fertility (Mbosso *et al*., 2020). However, the ability of a plant to form nodules along with the subsequent capacity of fixing nitrogen (symbiotic effectiveness, SE) could be hampered when infected with a virus, resulting in significant yield reductions. Also, systemic virus infections of grain legumes severely hamper N2 fixation and the effectiveness of the symbiosis by controlling the plant cellular machinery for replication (López *et al*., 2017). Among the viruses infecting Bambara groundnut on the fields in Nigeria *Blackeye Cowpea mosaic virus* (BICMV) *Potyvirus*and *Cowpea mild mottle virus* (CPMMV) *Carlavirus*have emerged in the past two decades as an important threat ravaging the crop. The exploitation of the genetic variation in the available landraces of Bambara groundnut for multiple virus resistance with high nodulation and nitrogen-fixing ability could contribute to the improvement of the crop and selection of elite genotypes against the viruses. Also, the availability of seeds of cultivars with a high level of multiple virus resistance could aid in the effective management of virus diseases. Hence, this study was carried out to determine the effects of single and mixed infections on nodulation and nitrogen fixation in virus-inoculated Bambara groundnut plants.

MATERIALS AND METHODS

Source of experimental materials and virus isolates

The five Bambara groundnut landraces used were obtained from the local farmers in Minna, Niger State and the nitrogen fertilizer was obtained from a reputable Agro-chemical Store in Minna. The isolates of BlCMV and CPMMV were obtained from the stock in the Department of Crop Production, Federal University of Technology (FUT), Minna, maintained and multiplied on cowpea plants (Ife Brown) to ensure sufficient inoculum.

Virus multiplication

Multiplication of the viruses was done with three plastic pots (30 cm diameter and 30 cm deep) at the rate of two seedlings per pot. The collected virus inoculum in the infected leaf tissues was extracted by grinding the isolate in an extraction buffer (pH 7.2) (0.1M sodium phosphate dibasic, 0.1M potassium phosphate monobasic, 0.01M ethylene diamine tetraacetic acid and 0.001M L-cysteine per litre of distilled water) at the rate of 1 g/mL. One microlitre of β-mercaptoethanol was dispensed into the extract just before being used. Before inoculation, the plants were dusted with carborundum powder (600 mesh) to facilitate the entry of the virus into the hosts. Inoculation was done mechanically by using a pestle to rub sap over the upper leaf surface from base to top of the leaf and incubated at screenhouse temperatures of 23 – 32° C.

Experimental site and design

The experiment was conducted under screenhouse conditions at the Teaching and Research Farm (9.51752o N, 6.4419o E and altitude 203 masl), FUT, Minna. Top loamy soil (0–15 cm) was collected from the Teaching and Research Farm, bulked together and thoroughly mixed to form a composite. A sub-sample (10 g) of the homogeneous composite soil was air-dried and passed through a 2 mm diameter sieve for physical and chemical analysis. Soil analysis was carried out according to the procedures described by Okalebo *et al*. (2002).The set-up for the assessment of nodulation and nitrogen fixation in Bambara groundnut landraces inoculated with the virus treatment combinations consisted of five landraces of Bambara groundnut, two different viruses (BlCMV and CPMMV) in 4 virus treatment combinations and control, 2 Nitrogen levels (starter N and without starter N) with each replicated two times (5 × 5 × 2 × 2) making a total of 100 experimental bags arranged in a completely randomised design (CRD).

Sowing and seedling inoculation

A total of 100 experimental bags (30 cm diameter and 30 cm deep) were filled with 20 kg of soil and labelled properly based on the treatment. Seeds of the landrace were sown in the bags at the rate of three seeds per bag and seedlings thinned to one plant per bag a week after emergence. After thinning of samples, 1.75 g of nitrate fertilizer was applied to the soil of each N starter treatment sample. The seedlings were then mechanically inoculated with respective virus treatment at 2 and 3 weeks after emergence as presented below: i) Single virus inoculation: The landraces were inoculated singly with each virus BICMV and CPMMV; ii) Mixed virus inoculation: For mixed virus treatments a set of the landraces were first pre-inoculated with one of the viruses singly and 7 days later with the second and vice-versa (Nsa and Kareem, 2015). The plants were irrigated daily with 500 mL and observed for symptom development.

Data collection and analysis

At 45 days after inoculation, the plants were carefully uprooted and rinsed under running tap water through a 40-mesh screen to remove all traces of soil. The number of nodules per plant was counted and the dry weight of the root and the shoot were recorded after drying at 70 ºC for 48 hours (Kabede *et al*., 2020). Data collected were subjected to analysis of variance (ANOVA) using the statistical analysis system (SAS, 2008). Symbiotic effectiveness percentage (SE %) was calculated by comparing the inoculated plant with the N-fertilized positive control (Purcino *et al*., 2000). Nitrogen-fixing efficiency (NFE) was classified as highly effective (SE %> 80%), effective (SE % = 50-80%), poorly effective (SE % = 35-50% and ineffective (SE % <35%).

RESULTS

Symptomatically, all the inoculated plants exhibited varying degrees of foliar symptoms of both single and mixed virus infections. The mixed infection had high effects on the morphological indices and nodulation when compared to the single inoculated plant. Significant (*p*<0.05) lowest dry weight of shoot (0.57 g) and root (0.09 g) were obtained in BICMV+CPMMV treated plants with parentage reduction of 48.6 and 43.8, respectively (Table 1). Similarly, the shortest shoot (10.61 cm) and root (6.15 cm) length was recorded in BICMV+CPMMV.

The highest average number of nodules (9 per plant) was obtained in the control plant, followed by 6.2 nodules per plant in CPMMV and the lowest of 4.13 nodules per plant in BICMV+CPMMV. However, the lowest nodules per plant were not significantly different (*p*>0.05) from the values of CPMMV+BICMV (4.8 per plant) and BICMV (4.87 per plant (Table 1). Significant (*p*<0.05) differences were observed among the landraces for all the morphological parameters and number of nodules per plant with Vg\_05 having the highest dry weight (0.89 g), length of the shoot (15.25 cm) and root (11.92 cm) while Vg\_04 had the highest average number of nodules per plant with the value of 6.93 followed by 6.13 in Vg\_05. However, there were no significant differences (*p*>0.05) among Vg\_01, Vg\_02 and Vg\_03 with values of 5, 5.33 and 5.6, respectively (Table 1).

The mean Nitrogen-fixing efficiency varied from ineffective (SE< 35 %) in BICMV and BICMV+CPMMV to poorly effective (SE = 35-50 %) in CPMMV and CPMMV+BICMV (Table 2). *Blackeye cowpea mosaic virus* exhibited considerable deleterious effects on symbiotic activities of Vg\_01 (26.05 %) and Vg\_02 (25.91 %) while CPMMV had a higher negative effect on Vg\_03 and Vg\_04 with a percentage symbiotic effectiveness value of 22.13 % and 25.25 %, respectively. Percentage symbiotic effectiveness for BICMV+CPMMV and CPMMV+BICMV infected plants ranged from 24.21 – 43.96 % and 25.10 – 46.48 %, respectively (Table 2). However, the percentage of symbiotic effectiveness of the control plots varied from 56.42 % in Vg\_01 (Effective, SE = 50-80 %) to 91.22 in Vg\_05 (Highly effective, SE>80 %).

Table 1: Growth indices and nodulation of Bambara groundnut infected with single and mixed *Blackeye cowpea mosaic virus* (BlCMV) and *Cowpea mild mottle virus* (CPMMV)

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Factor** |  |  | Dry Weight | |  |  | Length | | | |  | Number of Nodules |
|  | Shoot  (g) | % Red | Root  (g) | % Red |  | Shoot  (cm) | % Red | Root  (cm) | % Red |  |
| **Treatment** |  |  |  |  |  |  |  |  |  |  |  |  |
| BICMV |  | 0.83b | 25.2 | 0.11c | 31.3 |  | 11.38d | 38.9 | 7.65b | 49.3 |  | 4.87c |
| CPMMV |  | 0.62c | 44.1 | 0.15b | 06.3 |  | 16.97b | 09.0 | 14.63a | 03.1 |  | 6.20b |
| BICMV+CPMMV |  | 0.57c | 48.6 | 0.09c | 43.8 |  | 10.61d | 43.1 | 6.15c | 59.3 |  | 4.13c |
| CPMMV+BICMV |  | 0.59c | 46.8 | 0.14b | 12.5 |  | 12.55c | 32.7 | 8.82b | 41.6 |  | 4.80c |
| Control |  | 1.11a | - | 0.16a | - |  | 18.64a | - | 15.10a | - |  | 9.00a |
| SEM |  | 0.06 |  | 0.01 |  |  | 0.38 |  | 0.51 |  |  | 0.36 |
| **Landrace** |  |  |  |  |  |  |  |  |  |  |  |  |
| Vg\_01 |  | 0.76a |  | 0.16a |  |  | 13.77bc |  | 7.82c |  |  | 5.00b |
| Vg\_02 |  | 0.55b |  | 0.14ab |  |  | 14.51ab |  | 11.67a |  |  | 5.33b |
| Vg\_03 |  | 0.68ab |  | 0.13ab |  |  | 13.84bc |  | 9.73b |  |  | 5.60b |
| Vg\_04 |  | 0.79a |  | 0.09c |  |  | 12.79c |  | 11.21a |  |  | 6.93a |
| Vg\_05 |  | 0.89a |  | 0.12b |  |  | 15.25a |  | 11.92a |  |  | 6.13ab |
| SEM |  | 0.06 |  | 0.01 |  |  | 0.38 |  | 0.51 |  |  | 0.36 |

Means followed by similar alphabet letters are not significantly different by Student-Newman-Keuls (SNK); % Red = Percentage reduction

Table 2: Symbiotic effectiveness of Bambara groundnut infected with single and mixed *Blackeye cowpea mosaic virus* (BlCMV) and *Cowpea mild mottle virus* (CPMMV)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment** | Vg\_01 | Vg\_02 | Vg\_03 | Vg\_04 | Vg\_05 | Mean | NFE |
| BICMV | 26.05 | 25.91 | 33.02 | 34.50 | 26.00 | 29.10 | IE |
| CPMMV | 45.92 | 36.91 | 22.13 | 25.25 | 47.59 | 35.56 | PE |
| BICMV+CPMMV | 37.68 | 28.27 | 43.96 | 26.07 | 24.21 | 32.04 | IE |
| CPMMV+BICMV | 45.16 | 46.48 | 25.10 | 25.32 | 39.88 | 36.39 | PE |
| Control | 56.42 | 68.23 | 70.35 | 67.44 | 91.22 | 70.73 | E |
| Mean | 42.25 | 41.16 | 38.91 | 35.72 | 45.78 | 40.76 |  |

NFE = Nitrogen fixing efficiency, HE = Highly effective, E = Effective, PE = Poorly effective, IE = Ineffective. Highly effective (SE>80 %), Effective (SE= 50-80 %), Poorly effective (SE = 35-50 % and Ineffective (SE<35 %)

DISCUSSION

The expression of typical foliar symptoms of BICMV, CPMMV or both viruses by all the inoculated plants indicated that none of the Bambara groundnut landraces was immune to the disease. The low growth (weight and length of shoot and root) parameters values and the number of nodules recorded in the inoculated plants of this study could be attributed to the proliferation of particles from replicating virus (es), resulting in alteration of growth pathways. In support of this assertion, Salaudeen and Aguguom (2014) reported that a series of physiological changes are triggered as soon as a virus is introduced into a host plant depending largely on the genetic composition of the infected plant. Similar to this result, López *et al*. (2017)who worked on the plants pre-infected with *Southern bean mosaic virus* (SBMV) attributed the greater magnitude of the deleterious effects on growth masses to the virus’ presence in the radicles. The authors further ascribed this to the virus hampering the catabolism of ureides in the leaves.

The N2 fixation by bacteroids within the nodules has great importance in agriculture since leguminous crop yields are highly enhanced in Rhizobium-nodulated plants grown in low nutrient soils (Mabrouk and Belhadj, 2016). The ability of a plant to form nodules along with the subsequent capacity to fix nitrogen (symbiotic effectiveness) is widely used as means of evaluating the inherent links between rhizobia and respective hosts (Osei *et al*., 2018). In conformity with the result of this study, a drastic reduction in root nodulation of virus-infected plants had been reported by López *et al*. (2017). The variation in the number of nodules among the landraces indicated that responses to nodule efficiency differed from one landrace to another. The high number of nodules recorded in the control plants as well as Vg\_04 and Vg\_05 indicated sufficiently establishment of the Rhizobium–host relationship for nodulation. The poor to ineffectiveness in symbiotic activities of all the landraces when inoculated with either or both viruses could be attributed to an alteration in symbiotic signalling molecules.

CONCLUSION

The study confirmed that all tested viruses reduced growth indices and nodulation of the infected plans. It was also found that either BICM and CPMMV or their combination decreased nitrogen fixation with greater deleterious effects exerted by the mixed viruses. Though the landraces showed different symbiotic characteristics, Vg\_05 had proven to be more effective among the landraces and could be explored further to determine its potential for crop improvement.

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# SOIL SCIENCE/ENVIRONMENTAL MANAGEMENT

## EFFECT OF BIOCHAR AND NANOPARTICLES ON THE MICROBIAL DEGRADATION OF CRUDE OIL CONTAMINATED SOIL

Abdullahi Aminu1\*, M.U Garba2, E.C Evans3

Department of Chemical Engineering, Federal University of Technology Minna, Nigeria.

Correspondence\*: [*Elameen07@gmail.com*](mailto:Elameen07@gmail.com) Tel:08163743860

ABSTRACT

*Oil spill in the Niger Delta region of Nigeria had caused substantial problems to the inhabitants of this region such as pollution of surface water, ground water, farmland and human health. The aim of this research is to study the effects of biochar, nanoparticles and microbial organism in remediating a crude oil contaminated soil. Analysis such as ash content, volatile matter, fixed carbon, thermo gravimetric analysis, organic carbon, nitrogen and synthesis of Nanoparticles were carried out during this study. Materials such as mortar and pistol, oven, thermogravimetric analyzer, pyrolizer, centrifuge, desiccator, incubator, miller and glass wares were used. Result shows that, the biomass had high volatile matter and low ash content in the proximate analysis while ultimate analysis showed high carbon and oxygen composition but low nitrogen and Sulphur contents, the amount of crude oil remaining in the treated sample was about 8.9% while the control sample was around 81%, this decrease in the control sample can be attributed to natural attenuation through the action of existing indigenous microorganisms.*

**Keywords:** Biochar, Pyrolysis, Nanoparticles, Proximate analysis, Ultimate analysis.

INTRODUCTION

Crude oil is a yellowish-black viscous liquid that ensues naturally in geological formations under the earth's surface and is composed of hydrocarbon deposits and other organic materials. A type of fossil fuel, crude oil is refined to produce usable products including gasoline, diesel, and various other forms of petrochemicals (James, 2021). Crude oil was initially discovered in profitable amount in the Niger Delta region of Nigeria at Oloibiri (present day Bayelsa state) in 1956, more discoveries were made in other locations after that of Oloibiri and exploitation began almost 2years after the initial discovery. Soil pollution refers to the presence of a chemical or substance out of place and/ or present at a higher-than-normal concentrationthat has adverse effects on any non-targeted organism (FAO and ITPS, 2015). Although the majority of pollutants have anthropogenic origins, some contaminants can occur naturally in soils as components of minerals and can be toxic at high concentrations. Soil pollution often cannot be directly assessed or visually perceived, making it a hidden danger. Biological remediation uses microorganisms to degrade hazardous substances or complex organic contaminants into less toxic or non-toxic compounds (Li, 2007).

Groundnut or peanut is notably called “poor man’s nut” (Ansari *et al.,* 2015). Today, it is an important oilseed and food crop globally (FAOSTA, 2018). This plant is one of the most popular crops in Nigeria and has never been found uncultivated. Groundnut shells have about 20% of the dried peanut pod by weight, that is, there is a significant amount of shell residual left over after groundnut processing (Zheng *et al.,* 2013). Petroleum hydrocarbon are products of crude oil which are commonly used by humans for many purposes such as heating, power generation and transportation (Snape *et al.,* 2001; Aislabie *et al.,* 2006). Widespread pollution from petroleum hydrocarbon can be due to infrastructure failure, human fault, or natural cause (Snape *et al.,* 2008). This raises an alarm on both local and global scale as petroleum hydrocarbon can have tremendous adverse effects on human and ecological health. Petroleum hydrocarbons are naturally occurring substance; hence, microorganisms which are capable of remediating these hydrocarbon compounds are in existence in the environment.

Biochar is a soil amendment which appeared in recent years as a great option which can act both as a carbon sink and as an amendment improving soil quality, increasing water retaining capacity, and fertility, thus eliminating risks for soil contamination (IPPC, 2019). Biochar production is achieved via a thermochemical process known as pyrolysis. Pyrolysis is termed as the thermal decomposition of biomass at elevated temperature (2000C-10000C) under very low concentration of oxygen or no oxygen at all, and accompanied by the production of three by-products: biochar (solid), bio-oil (liquid) and syngas (Gibbins-matham *et al.,* 1998). Pyrolysis consists of a large family of processes and reactor technologies. Heating rates and temperature characterize different types of pyrolysis, which yield different mixtures of the three products (Patel *et al.,* 2016; Tripathi *et al.,* 2016). Report by (Brennan *et al.,* 2014) shows that biochar could alter the physical and chemical properties of soil. For instance (Mukherjee *et al.,*2014; Schmidt *et al.,* 2014) found that biochar produced from Oak could increase the soil pH, improve the water holding capacity of the soil (Yao *et al.,*2012; Evangelou *et al.,*2014), increase the fertility of the soil (Steinbeiss *et al.,*2009; Mia *et al.,*2014), decrease leaching of soluble macro nutrients (Quilliam *et al.,*2013; Lucchini *et al.,*2014), and heighten carbon sequestration (Mendez *et al.,*2012; Bastos *et al.,* 2014). Nano composites are high performance materials which reveal rare properties. Nanocomposites have an estimated annual growth rate of 25% and fastest demand to be in engineering plastics and elastomers (Sajad *et al.,* 2019). Nanoparticles are a wide class of materials which include particulate substances. Nano particles have very large surface area which makes them more efficient to bind with various molecules. In the last few decades, nano particles have been developed for treatment of soil and waste water.

MATERIALS AND METHODS

The equipment used in this research work are; Mortar and Pistol, Oven, Thermogravimetric analyser, Pyrolyser, Centrifuge, Desiccator, GC-MS Analyzer, Incubator, Miller, Glass wares (beakers, testubes, measuring cylinder, crucibles, Petri dishes and syringes), and Calorimeter, Other materials include groundnut shell, crude oil and flavonoid extract.

Sample Collection and Preparation

Soil sampling site is located at Federal University of Technology Bosso Campus, Minna (9o32’5”N, 6o26’25”E, At-2ft). It was sieved using a mesh in order to remove the unwanted particles such as sticks and stones.

Method

Soil samples of 300g each were weighed in six different plates of same sizes. 30ml of crude oil was added to each of the samples to contaminate them and the set up were labeled A, B, C, D, E and Control as shown in Table 1.

Table 1: Experimental Design

|  |  |  |  |
| --- | --- | --- | --- |
| Sample | Biochar (g) | Pseudomonas (ml) | Nano Particle (g) |
| A | 10 | 30 | 0.2 |
| B | 20 | 60 | 0.4 |
| C | 30 | 90 | 0.6 |
| D | 40 | 120 | 0.8 |
| E | 50 | 150 | 1.0 |
| Control | - | - | - |

NB: all samples contain 30ml of crude oil in 300g of soil.

Streaking method was used in order to isolate the microorganisms and kept in an incubator for culturing. Steps followed in order to degrade the crude oil contained in the soil are highlighted in Fig.1 below.

Groundnut shell characterization (tga), proximate and ultimate analysis

Size reduction

Groundnut shell sourcing

Groundnut shell preparation

Drying

Sieving

Pure isolation of *Pseudomonas aeruginosa*

Culture of *Pseudomonas aeruginosa* for 2 weeks

Biochar

Characterization

BIOREMEDIATED SOIL

Slow pyrolysis of g/nut shell @4000C for 20mins

Simulated crude oil contaminated soil

Synthesized nano particle

*Fig. 1: Block diagram showing steps involved in degradation of crude contaminated soil.*

RESULT AND DISCUSSION

The proximate analysis of the biomass showed high volatile matter and low ash content as shown in Table 2**.** While the ultimate analysis results showed high carbon and oxygen composition, but low nitrogen and Sulphur contents as shown below.

Table 2: Proximate and Ultimate Analysis of Groundnut Shell (Biomass)

|  |
| --- |
| Proximate Analysis Ultimate Analysis  Element Composition (wt%) Element Composition (wt%) |

Ash content 2.5 Carbon 50.98

Moisture content 8.5 Hydrogen 7.13

Fixed carbon 11.2 Nitrogen 0.59

Volatile matter 77.8 Oxygen 40.10

Sulphur 0.22

The soil contaminated with crude oil showed some changes in the physical and chemical properties as shown in Table 3. The decrease in the values of pH and nitrogen in the contaminated soil is attributed to the **INTRODUCTION** of crude oil, while the increase in the phosphorus and organic carbon is also due to the same reason. Furthermore, it can be seen from Table 3 that the soil treatment with biochar, microorganisms and nanoparticles altered the properties in a desirable way.

Table 3: Properties of the Soil After Seven Weeks of Treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Properties | Uncontaminated soil | Contaminated soil | Treated soil (with GB+N+P) | Control after 7 weeks |
| pH | 6.43 | 5.7 | 6.38 | 5.97 |
| Nitrogen(g/kg) | 0.10 | 0.06 | 0.07 | 0.05 |
| Phosphorus(mg/kg) | 1.06 | 2.0 | 1.15 | 2.05 |
| Organic Carbon(g/kg) | 2.4 | 4.4 | 2.92 | 4.21 |

\*GB- Groundnut shell Biochar \*N- Nano particle \*P- Pseudomonas

At the end of this research, the amount of crude oil left in the soil samples are shown in Fig. 2. Sample E had the lowest crude oil concentration after 7 weeks of treatment which can be ascribed to the high concentration of amendments in it, while the control sample had very little reduction in crude oil concentration due to it not having any amendments.

The hydrocarbon utilizing bacteria population increased rapidly after two weeks of amendment in all samples except for samples A and Control which can be attributed to the low concentration of amendment in sample A and lack of amendments in Control. Subsequently, there was a decline in the microbial count until there were no bacteria present in week five for samples D and E, and week six for samples B and C. Sample A had its highest bacteria population after 4 weeks of treatment. While the Control sample showed no significant increase in hydrocarbon utilizing bacteria throughout the treatment period of seven weeks as seen in Fig 3.

*Fig. 2: Rate of Degradation of Crude Oil*

*Fig. 3: Population of Microorganisms during Amendment.*

CONCLUSION

The present study reports the use of biochar combined with nano particles and pseudomonas aeruginosa exhibited tremendous impact in degradation of crude oil in contaminated soil. However, concentration of soil amendments plays a vital role in the degradation rate and time. Higher concentration of the three amendments enhanced degradation faster compared to lower concentration of amendments in contaminated soil.

It is therefore recommended that, the application of these three soil amendments combined in the bioremediation of crude oil contaminated soil should be conducted in the field at a larger scale to check its effectiveness.

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## **ASSESSMENT OF FERTILITY STATUS OF SOME FADAMA SOILS IN BIDA LOCAL GOVERNMENT AREA OF NIGER STATE, NIGERIA**

1Mohammed, I., 1Saba, M. A., 1Shehu, A. K., 2Panatami, S. A., 3Adamu, M.

1Department of Agricultural Technology, Federal Polytechnic Bida, Niger State, Nigeria\* 2Department of Soil science, Bayero University Kano, Kano\* 3 Department of Chemistry, Nigerian Army University, Biu Borno State, Nigeria

\*Corresponding Author’s Email: [ibrahimndanusa512@gmail.com](mailto:ibrahimndanusa512@gmail.com).

*Phone number: +234* 8035894078*.*

ABSTRACT

*Declined in soil fertility have capitulated decreased in food production. The study was conducted to evaluate the fertility status of some Fadama soils in Bida Local Government Area of Niger state, Nigeria. Five (5) locations of Fadama soils (Fadama) were selected around Bida metropolis, namely Banyagi, Nasarafu, Daracita, Film-Ta and Bangaie. Twenty (20) representative Fadama soil samples were collected randomly from a depth of 0-20 cm at each of the locations, bulked together to form a composite sample for each of the location. The samples were subjected to laboratory analysis using standard procedures. The data obtained were subjected to simple descriptive statistics including coefficient of variation (CV) to test for dispersion of the data. Results obtained show that the soils were mostly sandy loam and sandy clay loam in texture. The pH was strongly acidic. Total nitrogen, available P, Organic carbon, Calcium, K and CEC were very low. Magnesium and sodium varied from medium to high. Percentage base saturation was medium. The incorporation of crop residues, application of organic manure and inorganic fertilizers to the soils will play an important role in nutrient availability of these soils for sustainable crop production in the study area.*

**Keywords**: Assessment, fertility potentials, Fadama soils, sustainable crop production, Bida.

INTRODUCTION

Soil is a complex system comprising of minerals, soil organic matter (SOM), water, and air. The physical and chemical properties of soils play important roles in plant growth and development. Soil quality includes mutually interactive attribute of physical, chemical and biological properties, which affect many processes in the soil that make it suitable for agricultural practice and other purpose (Adamu *et al*., 2019). Nigeria is characterized by chronic food deficit caused by fast population growth rate and slowest pace of food production (Onyekwere, 2013). Fadama is a Hausa term used to qualify low-lying areas on depressions, or adjacent to a river or stream otherwise known as wetlands. Fadamas are rich agricultural areas and contain land and water resources that could easily be developed for irrigated farming (Singh, 1997). Over four million hectares of land scattered along the river systems of Nigeria have been identified as Fadama area, capable of supporting intensive cultivation and grazing. Fadama ecosystem has potential for all season agricultural production (Lawal *et al*., 2012).

Owing to the rapid increase in population and the realization or the need to feed the ever increasing human and animal populations, attention is now focused on the utilization of Fadama lands that were previously neglected. Factors limiting the agricultural development in Nigeria include lack of much information on soils physico-chemical characteristics (Kparmwang, 1996). The Fadama farm in Bida over the years has mainly been used for rice, vegetable and sugar cane production under rain fed condition and irrigation systems. Therefore, the aim of this study is to evaluate the fertility status of Fadama soils in Bida metropolis.

MATERIALS AND METHODS

Study Areas, Soil sampling and Laboratory analysis

The study area was Bida, a major town in Niger state, Nigeria. The area lies between Latitude: 9o.06′N and Longitude 6o.01′E with an elevation of 150 m above sea level. Bida lies under sedimentary formation dominated by Nupe Sandstone. Five (5) locations of Fadama soils were selected around Bida metropolis, namely Banyagi, Nasarafu, Daracita, Film-Ta and Bangaie. The study locations are free from flooding even during the peak of rainfall. Twenty (20) representative Fadama soil samples were collected randomly from a depth of 0-20 cm at each of the locations, bulked together to form a composite sample for each of the location. The soil samples were air-dried, ground and passed through a 2-mm sieve to obtain the fine earth fractions for determination of physical and chemical soil properties following standard laboratory procedures. Particle size analysis was determined by Bouyoucos hydrometer method. The pH was determined using 1:2.5 soil water ratio. Total nitrogen and available phosphorus was determined by the macro-kjeldahl digestion and Bray-1 method. The Soil Organic carbon was analysed using the Walkley-Black procedure. Exchangeable bases, calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) were extracted with 1N NH4OAC. Calcium and Mg in the extract was determined using atomic absorption spectrophotometer (AAS) while K and Na were determined by flame photometry. The cation exchange capacity was computed by summation, effective cation exchange capacity (ECEC) was determined by summing the total exchangeable bases plus exchangeable acidity as described by Udol *et al*., (2009).While Percentage Base Saturation was calculated by dividing the total sum of exchangeable bases by ECEC and multiplying by 100 (Udol *et al.,* 2009).

Data Analysis

The data obtained were subjected to simple descriptive statistics including coefficient of variation (CV) to test for dispersion of the data.

RESULTS AND DISCUSSIONS

Physical and Chemical Properties of Soils of the study area.

The results of particle size fractions of surface depth (0-20cm) are presented in Table-1. The result of the study showed that the fadama soils around Bida metropolis are sandy loam and sandy clay loam in texture with average sand content of 605.6 g kg-1 and a CV of 10.04%. The silt and clay content has a CV of 0.22 and 0.30%. The soils were low in both clay and silt with average values of 156.5 g kg-1 and 237.9 g kg-1 respectively. Sand content across all the sampling sites ranged between 528 g kg-1 and 712.0 g kg-1 .Silt content ranged between 184 g kg-1 and 310 g kg-1 while clay content ranged between 100 g kg-1and 206 g kg-1.The results are similar to the findings of Alarima *et al*., (2018) for soils of Nasarafu and Banyagi in Bida been sandy loam.

Soil reaction was strongly acidic to moderately acidic with pH values ranging from 4.57 to 5.48 (Table 1). The pH was low in all locations with average values of 5.08 (strongly acidic). The low CV (6.26%) shows that the soils around bida metropolis are uniformly acidic. The pH of the study soils may imply high level of leaching of non acid cations. The low pH may affect availability of other essential plant nutrient (Lawal *et al*., 2014). The available P content of the soils was the low ranging from 4.35 - 14.41 mg kg-1 with a mean value of 6.20 mg kg-1 and a CV of 26.89%. This result corroborates with the findings of Onyekwere (2013) for Fadama soils in Barikin Sale, minna. Brady and Weil, (2002) stated that the lower level of available phosphorus, particularly in fadama soils could be due to phosphorus fixation into unavailable forms such as calcium phosphate, which could be attributed to large quantities of calcium deposited in the farm through irrigation water and flooding water. The N content ranges from 0.05-0.68 g kg-1 and a CV of 30.34%. N was generally low with a mean value of 0.40 g kg-1 based on soil fertility ratings scale given by Esu (1991) for Nigerian soils. The low total N content in the soils may be attributed to removal of crop residue on farmlands and low application of organic residues for crop cultivation coupled with low vegetative cover for returning organic matter to the soil. There is therefore the urgent need to improve total N in the soil through the addition of organic and inorganic fertilizers. The low amount of N in the soils is a reflection of the organic carbon content in the soils (Onyekwere *et al*., 2009). This results is agrees with the findings of Alarima *et al*., (2018) for soils of Nasarafu in Bida and Obalum (2012) for soils of Shaba Maliki and Ejeti in Lavun Local Government Area of Niger State. The organic carbon of the soil at all locations is low with a mean value of 3.18g kg-1(low). The low organic carbon content in all the assessed soils could be attributed to the low natural organic matter returns and other human factors such as burning and removal of crop residue (Ahmed, 1995). This could be further attributed to rapid mineralization of the organic matter by micro organism which is active throughout the year as a result of the prevailing high temperature and low amount of clay fraction of the soil (Raji *et al.,* 2001). The O.C contents in soils were not uniform with a CV of 37.16%. Calcium ranged between 1.27 to 2.61 cmol kg-1 with an average value of 1.83 cmol kg-1 (low) and Mg ranged between 0.35 to 1.01 cmol kg-1 with an average value of 1.83 cmol kg-1 (medium). The low CEC could be due to the low value of exchangeable Ca and medium value of Mg.

Generally the low CEC values of soils of the study area could be as a result of the dominance of Kaolinite in the fine earth fraction (Ojanuga and Awujoola 1981). Exchangeable acidity and effective cation exchange capacity has a mean value of 1.53 cmol kg-1 and 4.89cmol kg-1 respectively. Percentage base saturation was medium with a mean value of 66.37 %. This results corroborates with the finding of Lawal *et al.,* (2012) were base saturation was average across study area in Katcha. The result implies that leaching was moderate and the dominance of basic cations in the exchange complex in the study location.

CONCLUSION AND RECOMMENDATION

From the results obtained in this study it can be concluded that the Fadama soils in the study area are dominantly sandy loams, low in pH, N, phosphorus, O.C, Ca, K and CEC, the values of Mg and Na are medium. Most soil chemical properties and the major fertility indices show low values which implies a deficiency in the nutrients. Liming may be necessary to reduce soil acidity, enhance P availability. Management practices such as application of organic manure and inorganic fertilizer would to improve the soil N status. Soil evaluation is necessary for sustainability and increase of crop production for economic development in the study area.

Table 1. Physical and chemical properties of soils of the study area.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Locations | Sand  g kg-1 | Silt  g kg-1 | Clay  g kg-1 | Textural Class | pH (H20) | Av.P  mg kg-1 | N g kg-1 | O.C g kg-1 | Exchangeable bases (CEC) cmolkg-1 | | | | CEC cmolkg-1 | EA cmolkg-1 | ECEC cmolkg-1 | % BS |
| Ca | Mg | K | Na |
| Banyagi F1 | 610 | 184 | 206 | SCL | 4.57 | 12.61 | 0.07 | 1.91 | 1.27 | 0.35 | 0.09 | 0.16 | 1.87 | 2.71 | 4.65 | 56.67 |
| Banyagi F2 | 597 | 203 | 200 | SCL | 4.61 | 12.81 | 0.05 | 1.33 | 1.63 | 0.41 | 0.1 | 0.24 | 56.67 | 2.62 | 5.04 | 60.56 |
| Nasarafu F1 | 573 | 223 | 204 | SL | 4.69 | 14.41 | 0.48 | 4.61 | 1.85 | 0.51 | 0.09 | 0.36 | 60.56 | 2.14 | 4.85 | 56.77 |
| Nasarafu F2 | 585 | 212 | 203 | SL | 4.81 | 11.81 | 0.43 | 1.99 | 1.62 | 0.62 | 0.1 | 0.38 | 56.77 | 2.01 | 4.68 | 57.51 |
| Bangaie F1 | 712 | 184 | 104 | SL | 5.31 | 8.83 | 0.39 | 1.18 | 1.61 | 1.01 | 0.04 | 0.11 | 57.51 | 1.21 | 3.96 | 68.32 |
| Bangaie F2 | 699 | 190 | 111 | SL | 4.95 | 8.57 | 0.35 | 1.71 | 1.47 | 0.98 | 0.08 | 0.16 | 68.32 | 1.23 | 3.82 | 66.94 |
| Daracita F1 | 607 | 290 | 106 | SL | 5.22 | 5.35 | 0.61 | 1.27 | 2.61 | 1.86 | 0.11 | 0.19 | 66.94 | 1.11 | 5.86 | 77.47 |
| Daracita F2 | 614 | 283 | 100 | SL | 5.14 | 5.41 | 0.68 | 1.18 | 2.08 | 1.03 | 0.14 | 0.21 | 77.47 | 0.98 | 5.74 | 73.51 |
| Film-Ta F1 | 531 | 300 | 169 | SL | 5.46 | 4.82 | 0.49 | 2.22 | 2.13 | 1.63 | 0.13 | 0.31 | 73.51 | 1.21 | 5.24 | 72.56 |
| Film-Ta F2 | 528 | 310 | 162 | SL | 5.48 | 4.75 | 0.51 | 2.1 | 2.07 | 1.43 | 0.12 | 0.44 | 72.56 | 1.23 | 5.03 | 73.38 |
| Min | 528 | 184 | 100 |  | 4.57 | 4.75 | 0.05 | 1.18 | 1.27 | 0.35 | 0.04 | 0.11 | 73.38 | 0.98 | 3.82 | 56.67 |
| Max | 712 | 310 | 206 |  | 5.48 | 14.41 | 0.68 | 4.61 | 2.61 | 1.86 | 0.14 | 0.44 | 62.75 | 2.71 | 5.86 | 77.5 |
| **Mean** | **605.6** | **237.9** | **156.5** | **SL** | **5.08** | **6.2** | **0.4** | **3.18** | **1.83** | **0.66** | **0.1** | **0.26** | **64.69** | **1.53** | **4.89** | **66.37** |
| SD | 6.08 | 5.17 | 4.66 |  | 0.32 | 1.67 | 0.12 | 1.18 | 0.39 | 0.2 | 0.03 | 0.11 | 66.63 | 0.53 | 0.66 | 7.92 |
| CV% | 10.04 | 0.22 | 0.3 |  | 6.26 | 26.89 | 30.34 | 37.16 | 21.46 | 30.72 | 28.28 | 43.08 | 61.08 | 34.47 | 13.54 | 11.93 |

F1= farm one, F2= farm two, SL= sandy loam, SCL= sandy clay loam.

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## ASSESSMENT OF SELECTED SOIL FERTILITY PARAMETERS ALONG A TOPOSEQUENCE UNDER INTENSIVE CROP PRODUCTION AND IMPLICATIONS FOR SUSTAINABLE MANAGEMENT

\*T. Mohammed1, B.A. Lawal2, M.K.A. Adeboye2, and P.A. Tsado2

1Department of Crop Production Technology, College of Agriculture, Mokwa, Niger State, Nigeria

2Department of Soil Science and Land Management, Federal University of Technology, PMB 65, Minna, Nigeria

\*Corresponding Author’s email: tetengi4me@gmail.com

ABSTRACT

This study assessed the effect of topography on distribution and status of soil organic carbon (SOC), total nitrogen (N), available phosphorus (P) and potassium (K) in soil under intensive crop production in Minna, Niger State. The farm selected for the study was partitioned along major slope direction into upper, middle and lower slope positions. In each physiographic unit, three soil samples were randomly collected at 0-25 cm depth, making a total of nine samples. The samples were analyzed in the soil science laboratory of Federal University of Technology Minna for particle size distribution, SOC, N, P and K. Data obtained was subjected to one-way analysis of variance (ANOVA) to test the effect of topography on the distribution of the selected soil fertility parameters. Results revealed that loamy sand for the upper and middle slopes and sandy loam texture for the lower slope. Topography had no significant effect on the distribution of N,while significant effect (P<0.05) was observed with regards to SOC, P and K. Fertility assessment revealed that low status in SOC (≤ 3.74 g kg-1) and K (≤ 0.08cmol kg-1) and moderate to high P (15.50 – 21.75 mg kg-1) and high N (≥ 1.47 g kg-1). Phosphorus showed a regular distribution trend (upper>middle>lower slope), a reversed order for SOC (upper<middle<lower slope), and irregular trends in N and K. No significant correlation among the parameters assessed. Productivity and sustainability of the soil, irrespective of slope positions, may require K amendment to satisfy the nutrient requirement for most crop production.

**Keywords:** Toposequence, soil fertility, crops, smallholder farm.

INTRODUCTION

Topography influences redistribution of soil properties through its effect on drainage, soil erosion, transportation and deposition of soil materials (Isola*et al*., 2020). These processes explain why major changes in soil type occur over very short distance as one moves from crest position down to the valley bottom (Egbuchua, 2014; Rezaei*et al*., 2015), even when the soils are developed from the same parent materials (Esu*et al.,* 2008; Lawal*et al*., 2014). Several studies on the effect of topography on soil properties across all ecological zones of Nigeria have been adequately reported (Osodeke and Osondu, 2006; Lawal*et al.*, 2014; Jimoh*et al*., 2020). However, such studies were generic with little or no attention to specific crops.

MATERIALS AND METHODS

Description of the Study Site

The study site is within Gidan Kwano campus of the Federal University of Technology, Minna, approximately 16 km along Minna-Bida road in Niger State of Nigeria. The site is geographically located on latitude 09º 32′ 14.356″ N and longitude 06º 27′ 53.418″ E on average elevation of 202 m above mean sea level. The climate of the environment is sub-humid tropical with mean annual rainfall of about 1283 mm and relative humidity ranging from 33 to 87 %. The mean maximum daily temperature reaches peak at 40 ºC during February to March (Adeboye*et al*., 2011). The site is underlain by igneous and metamorphic rocks of the pre-Cambrian Basement Complex with granites, gneisses, migmatites, quartzites and schists which weathered to form Ferric Luvisols, Ferric Acrisols and Ferric Cambisols (Ojanuga, 2006). Vegetation of the area is southern Guinea savanna of Nigeria. Tubers (yam) and cereals (maize, sorghum, upland rice) and legumes (groundnut, cowpea and soybean) are major crops grown in the area.

Soil sample collection

An age long smallholder farm under intensive crop cultivation was selected for the study. Slope direction was used as a guide to divide the farm into three slope positions, namely: the upper, middle and lower slope. Each slope position served as a treatment, under which three soil samples were randomly collected at 0-25 cm depth. Thus, nine (9) soil samples were collected for laboratory analysis.

Sample preparation and analysis

The air-dried samples were carefully crushed to break the lumps and then passed through a 2 mm mesh to separate fine and coarse fragments. The sieved soil samples were analyzed for particle size distribution and some chemical properties according to standard laboratory procedures as outlined in IITA (2015). Briefly, particle size distributions of the soil samples were determined using the Bouyocous hydrometer method with sodium hexametaphosphate as dispersing agent. The textural classes of the soils were determined using IUSS soil Textural Triangle. Organic carbon was determined by Walkley-Black method of wet combustion involving oxidation of organic matter with potassium dichromate (K2Cr2O7) and sulphuric acid (H2SO4). Total nitrogen (N) was determined by micro Kjeldahl method and available phosphorus (P) by Bray P-1 method. Exchangeable potassium (K) was extracted with 1N neutral ammonium acetate (NH4OAc) saturation method and amount of K in solution was measured using a Flame Photometer.

Data analysis

Data from laboratory was subjected to analysis of variance (ANOVA) using SPSS version 20. Where significant differences were observed, means were separated using Least Significant Difference (LSD) at 0.05 level of probability (Gomez and Gomez, 1984). Correlation analysis was carried out to establish the relationship among the selected soil chemical properties.

RESULTS AND DISCUSSION

Effect of Topography on Particle size distribution

Results of the particle size distribution of the soil investigated are presented in Figure 1a,b&c. Sand fraction ranged from 784 to 886 g kg-1, silt from 37 to 86 g kg-1 and clay from 77 to 130 g kg-1. These soil separates did not show any particular trend in their distribution probably due to prolong human activities through tillage which overshadowed the influence of topography in their distribution. Also, sand content was observed as dominant mineral fraction in the studied soil irrespective of slope positions. The preponderance of sand could be in one part linked to the inherent nature of parent rocks, rich in quartz mineral. This result agrees with the findings of Alhassan*et al*. (2012) which identified quartz as the most dominant mineral in the soils in several locations in Minna. Quartz is resistant to weathering (Wilson, 2010), hence, it accumulates on the surface where sorting processes of finer soil materials (silt and clay) by agents of erosion such as wind and run-off (Akinbola*et al*., 2009; Imadojemu*et al.*, 2017; Isola*et al*., 2020) are active. This probably explained why the surface textures of the soils investigated were loamy sand to sandy loam.

Effect of topography on selected soil fertility parameters

Results on the effect of topography on the distribution of soil organic carbon (SOC), total nitrogen (N), available phosphorus (P) and potassium (K) are presented in Table 1. The correlations among the soil qualities parameters assessed are presented in Table 2. Fertility interpretation followed the fertility ratings of Esu (1991) for the Nigeria’s arable soils. The effect of topography on the distribution of SOC was significant table 1. The concentration of SOC in lower slope (3.74 g kg-1) was significantly higher (P<0.05) than the upper slope (2.37 g kg-1) by a factor of 1.58, while the SOC concentration in the middle slope was statistically similar to both upper and middle slope positions. The trend of SOC distribution was regular in the following increasing order upper<middle<lower down the slope. There was no significant correlation between SOC and other parameters assessed. However, the distribution pattern observed in the current study was similar to the findings by Akinbol *et al*., 2009) which also indicated significantly larger amount of SOC, about 1.38 to 1.44 times higher, at the toe slope positions than those at the shoulders along the top sequences investigated.

In terms of fertility ranking, SOC was very low in the soil, irrespective of slope positions. Reasons for low SOC in these soils could be linked to intensive use of the land coupled with poor management practices by farmers such as burning of vegetation/crop residues which minimized the recycling to enrich the soils. Farmers in the area in recent time resort to burning of crop residues, as a way of wading off encroachment of their farms by herders.

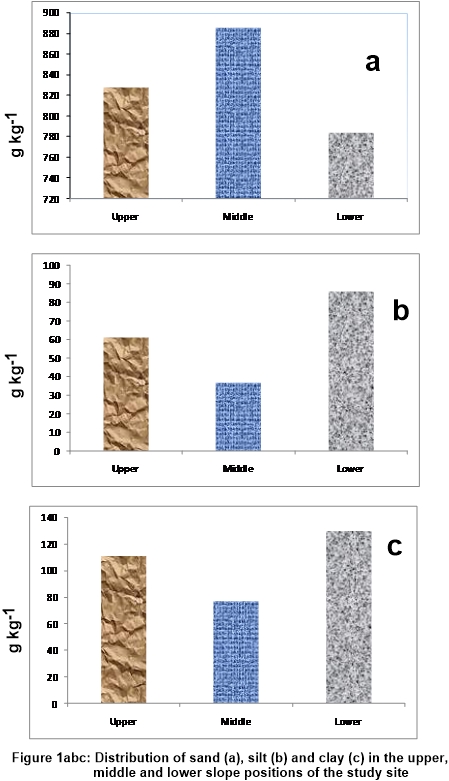
****

Table 1: Selected Soil fertility parameters as affected by topographic positions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Slope position | SOC | N | P | K |
| (g kg-1) | | (mg kg-1) | (cmol kg-1) |
| Upper | 2.37b | 1.54a | 21.75a | 0.05b |
| Middle | 3.14ab | 1.47a | 20.00b | 0.08a |
| Lower | 3.74a | 1.79a | 15.50c | 0.04c |
| LSD (0.05) | 0.84 | 8.4 | 4.2 | 0.0008 |

Means followed by same letter(s) in column are not significantly different (P < 0.05).

Table 2: Correlation matrix among the soil fertility parameters in topographic positions

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | SOC | N | P | K |
| SOC | 1 |  |  |  |
| N | 0.08NS | 1 |  |  |
| P | -0.40 NS | -0.05 NS | 1 |  |
| K | 0.32 NS | -0.29 NS | 0.39 NS | 1 |

\*NS = Correlation not significant at 0.05 level (2-tailed).

There was no significant effect of topography on the distribution of total N in the soil. However, numerically, the lower slope had the highest N content while the middle slope had the lowest in table 1 above. Irrespective of slope positions, the status of N in the soils was high. This was contrary to previous studies which reported very low to low N in similar soils (Lawal*et al*., 2014; Adeboye*et al*., 2020). Further investigation also revealed a non-significant (P>0.05) correlation between N and SOC (r2 = 0.08) probably due to the very low concentration of the latter in the soil. However, studies have shown a direct relationship between SOC and total N content suggesting, an increase in soil organic carbon content will result in an increase in total nitrogen content (Breviket al., 2010). Since the current study revealed a non-significant correlation between SOC and N, it suggests that the high total N status in these soils could be as a result of repeated application of N-rich fertilizers by the farmers within the area. This argument is supported by a report of Wibowo and Kasno (2021) which traced the sources of N added to agricultural soils to be majorly through inorganic fertilizer and partly through other sources such as biological fixation, precipitation, gas adsorption and organic fertilizers (manure, green manure and crop residues).

The effect of topography on the distribution of available P was significant (P<0.05) in the soil. Upper slope had the highest P concentration (21.75 mg kg-1) and lower slope had the lowest (15.50 mg kg-1). Also, a regular distribution trend of increasing order, (upper>middle>lower slope), was observed. However, there was no significant correlation between P and other parameters assessed. The status of P in the soil was moderate to high as against low values (≤ 9 mg kg-1) it was reported by Lawal*et al*. (2021) for similar soils under intensive use close to the current study site. High P status in the soils investigated may be attributed to use of mineral fertilizers by the farmers which resulted to accumulation of the nutrient in the soil. Accumulation of P may have implication in the farming environment. According to Van *et al*. (2017), excessive use of P fertilizers in intensive agricultural systems leads to P accumulation in soil. Notwithstanding, the soils investigated may not show P deficiency for crop production in the nearest future if well managed.

A significant (P<0.05) effect of topography on K distribution was observed despite its low status in the soil. The middle slope had the highest (0.08 cmol kg-1) concentration while the lower slope had the lowest (0.04 cmol kg-1). The status of K in the soils investigated was low irrespective of slope positions and no definite trend in its distribution. Also, there was no significant correlation of K with other chemical properties assessed. Previous investigations on similar soils reported higher values (≥0.11cmol kg-1) of K (Afolabi*et al*., 2014; Lawal*et al*., 2014; Lawal*et al*., 2021). Thus, low status of K recorded in the current study was slightly lower than the average reported for savanna soils (Diby*et al*., 2011), and could be explained in terms of intensity and duration of weathering, leaching and erosion (Sanchez, 1976; O’Sullivan, 2010). Another reason may be associated to intensive use of the land for crop production and poor nutrient management by the farmers, resulting to nutrient mining, more so that the crop is known to be a high-nutrient- feeders. (Carsky*et al*., 2007).

CONCLUSION

The study revealed a non-significant effect of topography on distribution and status of total nitrogen (N) in the soils investigated. Topography had a significant influence on the distribution of soil organic carbon (SOC), available phosphorus (P) and potassium (K) based on the results, management of SOC, P and K should be slope position-specific intensive use of the land has degraded the soil as it manifest low SOC. Recycling of crop residues and application of manure are recommended to improve soil organic matter. Potassium was the only nutrient deficient in the soil and can be amended through application of K-rich fertilizers such as muriate of potash in order to satisfy high K demand by some crops such as yam for tuber formation. High concentration of N and P in the soils should be monitored closely as further application could result in economic wastage and or may cause environmental pollution from run-off.

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## IMPLICATION OF LAND SURFACE TEMPERATURE AS A DRIVER OF LAND COVER CHANGES ON THE URBAN DYNAMICS OF ABUJA NIGERIA.

E.V. Aturuocha1 and I.C. Onuigbo2

Department of Surveying and Geo-informatics, Federal University of Technology, Minna, Nigeria.

[vingdera@gmail.com](mailto:vingdera@gmail.com), +2348065342702

ABSTRACT

The influence of climatic change and global warming are greatly telling on every urban environment and Abuja is not exempted. This is evident in the level of different land cover transitions which have resulted to significant changes to environmental parameters like Land Surface Temperature (LST), Enhanced Vegetation Index (EVI), and Normalized Difference Vegetation Index (NDVI). Hence, it has become necessary for the understanding of the Implication of land cover changes to land surface temperature rise in Abuja. Adopting Remote Sensing technique, imageries of Landsat 7 (ETM +) and Landsat 8 (OLI) of Abuja for four epochs 1990, 2001, 2012, and 2021 were used. The Maximum Likelihood supervised classification method was employed to extract land use land cover classes of Abuja with various accuracy metrics to ascertain the classification accuracy. LST of Abuja was derived using band 6 for Landsat 7 and band 10 for Landsat while bands 1-6 was used to estimate NDVI, EVI and NDBI. Statistically the land cover transitions of the study area were computed. In the last 31 years, it was observed that Water Body and Vegetation had reduced, Vegetation declined from 34.321% to 30.416%. Bare-Land drastically reduced from 54.628 % to 49.442%. Built-Up had increased from 5.424% to 16.982%. Finally, Pearson's correlation (R) between the LST with EVI and NDVI falls between 0.77 to 0.96 and the Regression value (R2) between 0.61 to 0.87, which shows that, Built-Up had affected LST in the last 31years of the study. It is recommended that Federal Capital Development Authority (FCDA), and other relevant agencies in charge of Abuja master plan implementation, should ensure full enforcement of Abuja Master plan, in order to strike a balance between a beautiful city and natural environment.

**Keywords**: Land Surface Temperature, Enhanced Vegetation Index, Normalized Difference Built-up Index, Land use/Land cover, Normalized Difference Vegetation Index.

INTRODUCTION

In search of a befitting new Capital City for Nigeria, after Lagos lost some of the criteria of a Capital City 1976, Abuja was selected with full government operation commencing in 1991. Thirty-one years down the line some of the reasons for relocating the capital to Abuja are being experienced with a lot of misuse and illegal use of land occurring in Abuja. Several urban development control strategies by relevant authorities have been formulated, yet people are not responding, leading to an increase in built-up areas yearly. The influence of climate change and global warming is greatly telling on every urban environment and Abuja is not exempted. This is evidence in the level of different land cover transitions which have resulted to significant changes to environmental parameters like Land Surface Temperature (LST), Enhanced Vegetation Index (EVI), and Normalized difference Vegetation Index (NDVI). Hence, it has become necessary for the understanding of the implication of land surface temperature as a driver of land cover changes on the urban dynamics of Abuja.

The LST is a tool for acquiring the temperature condition of a geographical location on the earth. According to Dash *et al*. (2002). LST is an important variable required for various applications such as Climatological, Hydrological, Agricultural, and other related studies. The Normalized Difference Vegetation Index (NDVI) is another index that predicts the vegetation health condition of any geographical location with the use of Remote Sensing and GIS tools. According to Jiang *et al* (2006), the normalized difference vegetation index (NDVI) is used to retrieve vegetation canopy for biophysical properties. Similarly, the Normalized Difference Built-up index (NDBI) is used in mapping out built-up areas. According to Macarof and Statescu (2017), NDBI is an indicator of development intensity and an indicator of urban impervious surface. The Enhanced Vegetation Index (EVI) is used for crop monitoring and is widely used and recommended to detect Spatio-temporal vegetation patterns like land management, crop rotations, or land use change (Kibret *et al.,* 2021)

**Study Area**

The study area (Abuja) falls in North Central Zone of Nigeria. It is the capital and among the ten most populous city of Nigeria which was built in the 1980s. As shown in figure 1. Abuja is in the guinea savannah of the middle belt between latitude 8° 25″ and 9° 25″ North of the Equator and longitude 6° 45″ and 7° 45″ East of the Greenwich, occupying an area of about 8,000 square kilometres sharing boundaries with Niger state at the west and northwest, Kaduna state to the northeast, Nasarawa State to the east and south, and Kogi State to the southwest. The annual rainfall is about 1,631.7 mm. The annual mean temperature ranges between 25.8°C and 30.2°C Adeyeri et al., (2015).

According to the 2006 census by National Population Commission (NPC) Nigeria, the city of Abuja had a population of 1,430,000. The indigenous inhabitants of Abuja are the Gbagyi, other groups in the area include the Bassa, Gwandara, Gade, Dibo, Nupe and Koro. Finally, Abuja, the Federal Capital, and a planned modern city, is located near the centre of Nigeria’s territory.

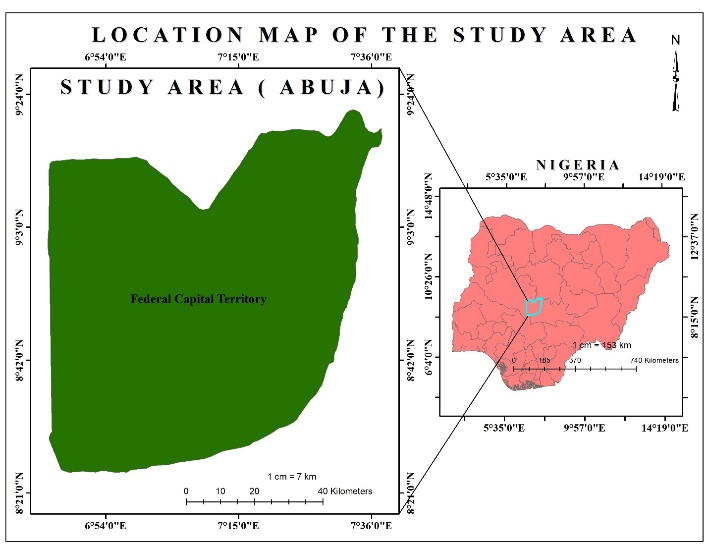


Figure 1: Study Area

MATERIALS AND METHODS

Materials: The table 1.0 below shows the data acquired for this research work.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S/N | Dataset | Scale/  Resolution | Source | Coordinate System | Acquisition Date |
| 1 | Nigeria Shapefile |  | Diva-GIS  ([*https://www.diva-gis.org/gdata*](https://www.diva-gis.org/gdata).) | GCS\_WGS1984  UTM Zone 31N | 15th Of August 2021. |
| 2 | Landsat 7(ETM+) & 8 (OLI) Imagery Path/Row: 189 - 54 | 30m x 30m | NASA/USGS  https://earthexplorer.usgs.gov/ | GCS\_WGS1984  UTM Zone 31N | 16th of August 2021. |

Method

Land use cover: The land use cover map was produced to observe the effect of the specified parameters on each sector within the study area. Landsat 7 (ETM+) and Landsat 8 (OLI) imageries were acquired for the study, band composites were formed from the imageries with bands 6, 5, 4 combinations for Landsat 8 and 5, 4, 3 for Landsat 7. Maximum likelihood supervised classification was then applied to the clipped imagery in the ArcMap environment, mapping four major classes such as Built-up, Bare land, Vegetation, and Water body, using the Classification Scheme deduced by Anderson (1971).

Specified Parameters

The following Parameters were assessed for the execution of this Research.

The NDVI for the years 1990, 2001, 2012 and 2021 was calculated using the equation (1) reported by Jiang, et al. (2006), the band 4(RED) & 5(NIR) of Landsat 8 and band 3(RED) & 4(NIR) of Landsat 7 was used to carry out the NDVI. NDVI=……………………………………………. (1)

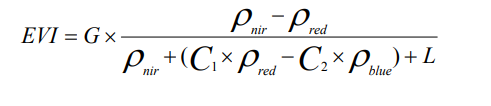
The NDBI of the specified years were estimated using the equation (2) by Jiang, et al. (2007), the band 6(MIR) & 5(NIR) of Landsat 8 and band 5(MIR) & 4(NIR) of Landsat 7 was used to carry out the NDBI in the ArcMap Environment.

NDBI = MIR – NIR / MIR + NIR ………………………. (2)

Similarly, the specified years were also the epoch used in the assessment of LST using the equation (3) by Ikechukwu, et al. (2016), the band 10 of Landsat 8 and band 6 of Landsat 7 was used to carry out the LST.

LST= [BT/ (1+0.0015 X BT/1.4388) X Ln(Ɛ)] ……. (3)

The EVI for the year 1990, 2001, 2012 and 2021 was calculated using the equation (4) by Matsushita et al. (2007), band 2, 4 & 5 of Landsat 8 and band 1, 3 & 4 of Landsat 7 was used to carry out the EVI. Finally, the Relationship between LULC and specified parameters were estimated per statistical influence.

…………………………………. (4)

RESULT AND DISCUSSION

Land use cover: Table 2.0 below shows the land cover change of the study area within an epoch of thirty-one years. Results showed that Bare land had reduced drastically within the period, likewise Vegetation whereas; Built-Up had increased over the epochs in the study area. It also showed that Water Body was stable between 1990 to 2001 epoch but decreased between 2012 to 2021 epoch. Figure 2 shows the study area's land use/land cover map for a span of 31 years.

Table 1.0: Showing the LULC coverage for the last 31 Years in Abuja

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Years | LULC | (KM2) | % | Years | LULC | (KM2) | % |
| 1990 | Bare land | 4017.59058 | 54.628 | 2012 | Bare land | 3889.69664 | 52.889 |
| Vegetation | 2524.12181 | 34.321 | Vegetation | 2290.61793 | 31.146 |
| Water Body | 413.835070 | 5.627 | Water Body | 335.363056 | 4.560 |
| Built-Up | 398.905531 | 5.424 | Built-Up | 838.848908 | 11.405 |
| Years | LULC | (KM2) | % | Years | LULC | (KM2) | % |
| 2001 | Bare land | 3951.40050 | 53.728 | 2021 | Bare land | 3636.18865 | 49.442 |
| Vegetation | 2419.98276 | 32.905 | Vegetation | 2236.93042 | 30.416 |
| Water Body | 403.171113 | 5.482 | Water Body | 232.32717 | 3.159 |
| Built-Up | 579.898618 | 7.885 | Built-Up | 1249.0803 | 16.983 |

|  |
| --- |
| C:\Users\user\Desktop\Victor Minna\Maps\fINAL\LULC1990.jpg*C:\Users\user\Desktop\Victor Minna\Maps\fINAL\LULC2001.jpg* C:\Users\user\Desktop\Victor Minna\Maps\Suggestion\LULC_2012.jpg C:\Users\user\Desktop\Victor Minna\Maps\Suggestion\LULC_2021.jpg  *Figure 2. Land use/land cover map of the study area within the last 31 years*  Relationship between LST with NDBI and EVI:  Figure 4 below shows the relationship between the LST, EVI and NDBI with their respective correlation and regression values. Olatunde and Momoh (2019) reported that a strong regression and correlation value (R) depicts a significant relationship between the specified parameters. This Research revealed that there had been a significant relationship between LST and other Indices (EVI and NDBI) since their Correlative values (R) fall between 0.77 to 0.96 and regression (R2) value within 0.61 to 0.87, which means that temperature in Abuja in the past 31 years had affected Vegetation and Social Infrastructure such as Built-Up. |

CONCLUSION

This Research adopted the GIS and Remote Sensing techniques in assessing the implication LST as a driver of Land cover changes and the specified parameters (NDVI, NDBI and EVI) in Abuja. The results obtained from the research are summarized below.

1. Temperature in Abuja in the past 31 years had affected vegetation and social infrastructure such as Built-Up as the correlation value (R) between LST with EVI and NDBI falls within the range of 0.77 to 0.9 and regression value (R2) within 0.61 to 0.87.
2. Bare-Land drastically reduced in the last 31 years from 54.628 % to 49.442% in area coverage, while Built-Up had increased from 5.424% to 16.982%. Also, Vegetation decreased between 1990 and 2001 from 34.321 % to 32.905 % and further between 2012 to 2021 between 31.146 % to 30.416 %. Water Body in the study area was stable between 1990 and 2001 but, decreased within 2012 and 2021with a percentile value of 4.560% to 3.15%.
3. This Research showed that temperature was higher in 2001 and 2021 as both temperature values were above 360C which must have resulted in medium or extreme drought. Also, 1990 and 2012 had low temperate values whose temperature were above 270C.

ACKNOWLEDGEMENTS

I ascribe all glory and honour to God Almighty for His mercy and protection throughout the process of this research. I appreciate Prof. I.C Onuigbo, and all who contributed to the realisation of this research.

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## RESPONSE OF GROWTH AND YIELD OF MAIZE (*Zea mays* L.) TO LIME, INORGANIC AND ORGANIC FERTILIZER IN MOKWA, NIGER STATE OF NIGERIA

Sani, A.1; Ezekiel-Adewoyin, D.T.2; Saidu, A.1; Osunde, A.O.2

1Department of Crop Production, Federal University of Technology, P.M.B 65, Minna Niger State, Nigeria

2Department of Soil Science, Federal University of Technology, P.M.B 65, Minna, Niger State, Nigeria.

Corresponding author’s email:[abdullahisani649@gmail.com](mailto:abdullahisani649@gmail.com)

Phone number: 08065372499

ABSTRACT

Proper integrated nutrient management is essential for plant growth, yield efficiency and soil health maintenance. A field trial was conducted to investigate the effect of lime, inorganic and organic fertilizer on growth and yield of maize on farmers’ field at Rabba, Mokwa, Local government area of Niger State. The field trial was conducted in the year 2021 (rainy season). The treatments consisted of lime, organic, and inorganic fertilizer combinations. T1: control (no input), T2: 300 kg ha-1 of NPK (OCP special blended NPK micro nutrient fortified fertilizer), T3: 0.5 t ha-1 Agric.- lime + 300 kg ha-1 NPK (OCP special blended NPK ), T4: 0.5 t ha-1 Agric.- lime + 5 t ha-1 cow dung (organic) + 300 kg ha-1NPK (OCP special blended NPK), T5: 5 t-1 ha of cow dung + 300 kg ha-1NPK (OCP special blended NPK), arranged in Randomized Complete Block Design (RCBD) with three farmers’ field as replicates. The gross plot size was 6 m x 6 m (36 m2). The leaf area, husk with cob weight, cob weight and grain yield were measured as at when due. The results showed that maize were significantly improved with application of lime, inorganic fertilizer and organic manure with respect to all parameters taken as compared to the control which had the lowest growth and yield parameters across the farmers field in the study area, therefore the application of 0.5 t ha-1 Agric.- lime + 300 kg ha-1 NPK (OCP inorganic blend) + 5 t ha-1 cow dung recorded the highest yield of maize in the study area.

**Key words:** Agric. - lime, OCP inorganic blend*,* Cow dung, Growth, Yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the important cereal crops in the world that provides essential nutrients for lactating mother for the sustainability of the baby and availability of vitamin A (contributes to the maintenance of normal skin, normal vision and normal function of the immune system). It is the third most important cereal crop after sorghum (S*orghum bicolor*) and millet (*Pennisetum glaucum*) in Nigeria and it is a major staple food that is used as fodder and industrial material with its production at both subsistence and commercial levels in the country (Eleweaya *et al.,* 2005). Maize required a fertile soil to do well. Cultivation of maize in Niger State is being affected by numerous number of factors such as soil acidity, inherent low fertility, imbalance nutrition management, unavailability of the right germplasm, flooding, weed infestation, insecurity, farmers - herdsmen crises, land tenure system, which limit the yield of crops in the state. Likewise modern crop production system is facing a sustainability problem due to indiscriminate use of chemical fertilizer and pesticides (Hidayatullah, 2015) that has resulted in depletion of soil organic carbon, decline in crop productivity and deterioration of nutrient content in the soil. In addition, the continuous and indiscriminate use of chemical fertilizers without organic sources leads to gradual decline of organic matter content and a change on native N status of the soil (Amanullah, 2016). Therefore adequate N sources (organic and mineral) and rates are very important to increase yield and reduce the cost of production and environmental pollution (Fu *et al.,* 2014; Pei *et al.,* 2015). However, chemical fertilizer is associated with decline in some soil properties and crop yields over time and causes serious land problems, such as soil degradation (Hepperly *et al.,* 2009). Integrated use of inorganic fertilizers with organic manures is a sustainable approach for efficiency nutrient usage which enhances efficiency of the chemical fertilizer while reducing nutrient losses (Schoebitz and Vidal, 2016). Farmer’s attention hence needs to be drawn to the synergy which results from the combination of organic and inorganic fertilizer to combat food security challenges without soil health deterioration, hence ensuring bumper harvest. This study was designed to determine the influence of combined application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

This study was designed to:

Determine the influence application of Agric. -lime, inorganic and organic minerals on the growth and yield of maize in the study area.

MATERIALS AND METHODS

Description of the study area:

Field trials were carried out at farmer’s field (on-farm) at Rabba, Mokwa Local Government Area of Niger State, situated in Southern Guinea Savannah zone of Nigeria. Three farmers field were selected. The experiment was conducted during the 2021 cropping season. The trial field was located at latitude 090 13 - 780” N and longitude 050’ 01’ 761”E, with an elevation of 117m, with mean annual rainfall of 1165.0 mm and mean annual temperature of 26.74oC.

Sources of Experimental Materials:

Pioneer Var. Oba super II was obtained from Agricultural Development project (ADP) farm center Minna, Niger State. Cow dung was collected from animal teaching and research farm Federal University of Technology Minna. OCP special blended NPK micro nutrient fortified fertilizer (11N-22-p-22k-1B203-1zn) at 300 kg ha-1, Agric. - lime at 0.5 t ha-1, Urea (46 % N) at 189.13 kg ha-1 were all gotten from ADP Minna.

Soil Sampling and Analysis:

Soil samples were collected with a soil auger from the field randomly from 15 points in the entire field at a depth of 0-20 cm. The collected samples were bulked and thoroughly mixed to form a composite sample. The composite soil sample was taken to the laboratory for routine analysis. The sample was air-dried, gently crushed and passed through a 2 mm sieve. The sieved soil was used for determination of soil physical and chemical properties. The soil sample was analyzed according to standard procedures as described by Agbeni (1995). Particles size distribution was determined by Bouyoucos hydrometer method, soil pH was determined in 1:2.5 soil to water and 0.1 M Cacl2 using a glass electrode pH meter. Organic carbon was determined using Walkley-Black method, total nitrogen was determined by micro-Kjeldal method, exchangeable bases (Ca2+, Mg2+, K+ and Na+) was extracted with IN neutral ammonium acetate (NH4OAC) solution and amounts of potassium and Na in solution was determined using flame photometer, calcium and magnesium by sodium EDTA titration method, exchangeable acidity (H2+ and Al3+) was determined by titrimetric method with standard sodium hydroxide (0.5 N NaOH) and Effective Cation Exchange Capacity by summation method. Cow dung was also analyzed for N, P and K content.

Treatments and Experimental Design:

Treatment consisted of:

T1 = Control (No input)

T2 = 300 kg ha-1 of OCP special blended NPK

T3 = 0.5 t ha-1 of Agric. – lime + 300 kg ha-1 OCP special blended NPK + Urea

T4 = 0.5 t ha-1of Agric. - lime + 300 kg ha-1 OCP special blended NPK + 5 t ha-1 Cow dung

T5 = 5 t ha-1 Cow dung + 300 kg ha-1 OCP special blended NPK The experimental design was a 6 m by 6 m with 1 m apart arranged on a Randomized Complete Block Design (RCBD) with three farmer’s field as replicates.

Land Preparation and Agronomic Practices:

The land was cleared manually using simple hand hoe and cutlass. Six (6) ridges were constructed manually with hoe (6 m length) with an inter-row spacing of 75 cm on each plot size of 36 m2.

Application of Agric. – lime 0.5t ha -1 and cow dung at 5 t ha-1 each was done on the field after land preparation by incorporating into the soil 2 weeks before sowing, three maize seeds were sowed and supplying was done a week after sowing, plants were thinned to one plant per stand 2 weeks after sowing. Manual weeding was done at 3 and 6 WAS to keep the experimental field weed-free. Fertilizer application of OCP inorganic blend, NPK micro nutrient fortified fertilizer (11N-22P-22K-1B2O3-1Zn) at 300 kg ha-1 was immediately done after sowing. Top dressing was done 5 weeks after sowing using urea (189.13 kg ha-1) the total inorganic fertilizer (OCP and Urea) supplied was 120 kg N, 66 kg P2O5, 66 kg K2O ha-1.

Data Collection at Growth Stage:

Data were collected on the following parameters on 8 tagged plants per plot size of 36 m2 at 6, 8, 10 and 12 WAS. The leaf length and width of the plant tagged were measured using measuring tape multiply by 0.75 (i.e., leaf factor) and was expressed in centimeter square (cm2). Day to 50 % tasselling was taken at 7 WAS (when half of the plants had tasseled) by visual observation.

Data Collection at Harvest:

The cobs were harvested manually at crop maturity when 90 % of the cobs in the experimental plots turn from green to straw colour (brownish yellow) at about 90-95 days after sowing. Number of cobs on tagged plants was counted and the average was calculated and recorded at harvest. Dry cobs with husk and dehusk cobs were weighed using manual weighing balance (scale) which was expressed in kg ha-1. Grain yield of the plant tagged was weigh using manual weighing balance and been expressed in kg ha-1.

Data Analysis:

The data collected were subjected to statistical analysis using GENstat 11th edition (2000). Treatment means were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability.

RESULTS AND DISCUSSION:

The results of cow dung analysis are shown on Table 1. The result revealed that, cow dung contain 2.52 Nitrogen (%) , 0. 04 Phosphorus (%) and 0.39 Potassium (%).The results of the routine analysis are shown on Table 2. It revealed that the soil pH was moderately - acidic in nature. The soil organic carbon was very low (4.77 – 5.74 %) likewise the percent nitrogen was moderately. However it was noted that the available phosphorus was low. The exchangeable Ca was low in location 1, 2 and very low at location 3. Exchangeable Mg was moderate at locations 1, 2 and low at 3 (1.80, 1.40 and 0.50) respectively. K was low (0.16, 0.22 and 0.14), while Na was moderate at location 1, 2 and low at location 3 (0.40, 0.47 and 0.18), the soil texture is sandy loam in nature. The available micronutrients analyzed (Zinc, Molybdenum and Boron) were all very low in the study sites. Hence, the need for an integrated nutrient management system, to argument the limiting nutrients in the soil and to improve and sustain maize growth and yield in the study area. The widest leaves produced with the application of OCP inorganic blend + Urea, Agric. – lime + OCP + Urea, Agric. – lime + OCP + Cow dung + Urea and Cow dung + OCP + Urea could be attributed to improvement of soil physical and chemical properties of the soil and the supply of sufficient nutrient required for optimum growth of maize. This finding is in conformity with Dasog *et al*., (2012) who reported that balanced application of NPK fertilizers with farm yard manure (FYM) and lime improve sustainable crop productivity and growth of maize. Amit and Auwal (2017) also reported that significant increase in leaf area were observed due to the effect of integrated nutrient management more than sole application of recommended dose of fertilizer. Grain yield is the end result of many complex morphological and physiological processes during the growth and yield development of crop. The heaviest cobs and highest grain yield produced with the application of Agric. – lime + OCP inorganic blend + Cow dung + Urea could be attributed to its multifaceted potential for the improvement of plant performance and resource efficiency while also enabling the protection of the environment and resource quality, this is also in line with khan *et al.*, (2008) report. The result is in line with those reported previously (Nagassa *et al.,* 2005 and Shah *et al.,* 2009) who revealed that grain yield was significantly affected by fertilizer in combination with farm yard manure likewise Ayoola and Makinde (2009) observe increased nutrient use efficiency with the combination of inorganic and organic manure.

The treatment combinations might have led to the restoration of soil fertility thereby sustaining crop productivity via the availability of organic matter, major and micronutrients enhancing nutrient use efficiency and favouring the physical, chemical and biological status of the soil. This is confirmed by Golla (2020) who reported that the increase in grain yield of maize might be due to improved physical and chemical properties of the soil through the application of organic manure and adequate quantities and balanced proportions of plant nutrients supplied to the crop by the integrated nutrient management as per needed during the growth period resulting in favorable increase in yield attributing characters which ultimately led towards an increase in economic yield of maize. This study also confirmed that grain yield was significantly higher under integrated nutrient management than unfertilized and chemical fertilizer alone. According to Kakraliya *et al*., (2017), wheat yield with synthetic fertilizer (NPK) 42 % more compared with control (unfertilized), and further increased with the use of organic and inorganic fertilizer along with bio-fertilizers.

Table 1: Cow dung analysis.

|  |  |  |
| --- | --- | --- |
| **Nitrogen (%)** | **Phosphorus (%)** | **Potassium (%)** |
| **2.52** | **0.04** | **0.39** |

Table 2: Soil routine analysis per farmer’s field.

|  |  |  |  |
| --- | --- | --- | --- |
| **Soil properties** | **Location 1** | **Location 2** | **Location 3** |
| pH | 5.7 | 5.8 | 6.0 |
| Organic Carbon (%) | 4.77 | 4.77 | 5.74 |
| Total Nitrogen (%) | 0.62 | 0.53 | 0.52 |
| Available P (mg kg-1) | 4.82 | 7.00 | 9.24 |
| **Exchangeable Cation (cmol kg-1)** |  |  |  |
| Ca | 2.00 | 3.50 | 3.40 |
| Mg | 0.80 | 3.70 | 1.00 |
| K | 0.16 | 0.18 | 0.09 |
| Na | 0.35 | 0.30 | 0.29 |
| **Particle size Distribution (g kg-1)** |  |  |  |
| Sand | 858 | 858 | 838 |
| Silt | 30 | 10 | 20 |
| Clay | 112 | 132 | 142 |
| Textural class | LS | LS | SL |

Table 3: Effect of organic and inorganic nutrient management on maize number of leaf area

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Leaf area (cm2)** | | | |
| **Treatments** |  | **6 WAP** | **8 WAP** | **10 WAP** | **12 WAP** |
| Control |  | 267.18b | 339.38b | 424.06b | 72.81b |
| OCP/Urea |  | 436.56a | 546.25a | 592.29a | 154.69a |
| Agric.- lime/OCP/Urea |  | 448.75a | 46.50a | 626.50a | 138.44a |
| Agric.- lime/OCP/Cow dung/Urea |  | 435.94a | 545.31a | 639.71a | 169.38a |
| Cow dung/OCP/Urea |  | 457.81a | 560.00a | 597.56a | 132.50a |
| SE± |  | 25.10 | 28.20 | 16.99 | 34.39 |

Table 4: Effect of organic and inorganic nutrient management on maize yield

|  |  |  |  |
| --- | --- | --- | --- |
| **Treatments** | **weight of dry husk plus cob (plant-1)** | **weight of dry cob (plant-1)** | **grain yield (kg ha-1)** |
| Control | 138.88c | 74.07c | 277d |
| OCP/Urea | 388.88b | 296.29b | 14814c |
| Agric.- lime/OCP/Urea | 444.44b | 342.59b | 19444b |
| Agric.- lime/OCP/Cow dung/Urea | 564.81a | 490.74a | 2592a |
| Cow dung/OCP/Urea | 444.44b | 361.10b | 1759bc |
| SE± | 21.32 | 21.32 | 8.78 |

Conclusions

From the results of this study, it was concluded that the application of OCP special blended NPK + Urea, Agric. - lime + OCP special blended NPK + Urea, Agric. – lime + OCP inorganic blend + Cow dung + Urea and Cow dung + OCP special blended NPK + Urea significantly produced similar taller plants, highest number of leaves and largest leaves than the control, which had the shortest plants, lowest number of leaves and smallest leaves in Raba, Mokwa local government. The application of Agric. – lime + OCP special blended NPK + Cow dung + Urea produced heaviest cobs and highest grain yield compared with the control which had the lightest cobs and lowest grain yield on the farmers field in the study area.

Recommendations

Based on the context of this study, it is recommended that farmers in Raba, Mokwa local government area of Niger State of Nigeria should adopt:

1. The application of OCP special blended NPK /Urea, Agric. - lime/OCP special blended NPK /Urea, Agric.- lime/OCP inorganic blend/Cow dung/Urea and Cow dung/OCP/Urea for increased growth of maize in case the objective is to produce fodder crop.
2. While the application of Agric. - lime/OCP special blended NPK /Cow dung/Urea for higher yield and yield attributes of maize for grain production.

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## PHOSPHATE MOBILIZATION BY ADDITIONS OF THREE ANIMAL MANURE SOURCES IN SOILS OF KARU, NASARAWA STATE

Auta, F. S.\*, Tsado, P. A. and Ezekiel – Adewoyin, D. T.

Department of Soil Science and Land Management

School of Agriculture and Agricultural Technology, Federal University of Technology, P.M.B. 65, Minna, Niger State, Nigeria.

\*Corresponding Author e-mail: [sheks247@gmail.com](mailto:sheks247@gmail.com),

GSM No. +2348032169410.

ABSTRACT

*One mechanism by which plants can mobilize organic and inorganic forms of phosphorus (P) in soils is by exudation of molecular weight organic acids. Screen house trial was carried out in 2021 to study the effects of additions of three levels of animal manures (poultry manure, goat manure and cow dung at 0, 10 and 20 t ha-1 on the mobilization of phosphate in soils from Karu, in Nasarawa State. The experimental design used during the screen house trial was Completely Randomized Design (CRD) with three replications and maize was planted as a test crop. Some agronomic, soil Olsen P, and inorganic P data were taken. All data collected were subjected to Analysis of Variance (ANOVA), significantly different means were separated using the Least Significant Difference at 5% level of probability. The results obtained indicated that Olsen – P and NH4 – P significantly increased by treating with the three organic manures. Al phosphate (Al – P), Fe phosphate (Fe – P), occluded phosphate (Occl – P) and calcium phosphate (Ca – P) were also mobilized and released in various degree irrespective of the organic manure source. The relative fractions of inorganic P was in the order Occl – P > Fe – P > Al – P > Ca – P. The effects of organic manure sources on maize plant height at 4 and 6 weeks after planting was also significant. These three organic manures therefore have the potentials to increase the availability of available P. The practical implication of these processes is that organic residues could be used as a strategic tool to reduce the rates of fertilizer P required for optimum crop growth on P-fixing soils of Nigeria*.

**Keywords;** Molecular weight organic acids, Olsen – P, NH4 – P, Occl – P

INTRODUCTION

Phosphorus (P) is involved in an array of processes in plants such as photosynthesis, respiration, nitrogen fixation, flowering, fruiting, and maturation (Brady and Weil, 2008; Plaxton and Lambers, 2015). The application of combined organic – inorganic inputs has been one management practice suggested to increase P availability in weathered soils (Agbenin and Igbokwe, 2006). Several researchers have reported the use of several organic materials especially cow dung, poultry droppings, refuse compost, farm yard manure and bio humus as soil amendment substrates, suitable for increasing crop production particularly among subsistence farmers in West Africa (Obire and Akinde, 2004; Adegunloye *et al.,* 2007; Mbonu, 2007).

Phosphate in the soil solution P pool is always available but P amount is very small compared to the amount needed by plants and to the total P in soils. This is because the majority of phosphorus applied to the soil in form of fertilizer becomes fixed and unavailable to plants. Soil pH affects phosphate availability in acid soils. P fixation can be minimized by adjusting soil pH to optimum level (Igwe, 2011). P ions can reach larger concentrations in highly fertilized soils, in many soils P concentration in the soil solution is in micro range (between 0.1 and 10 M). They are usually fairly low compared with the adequate P concentration for optimal plant growth. (Hinsinger, 2001).

Already, the widespread occurrence of P deficiency in most arable lands in Nigeria has led to the intensive use of P fertilizer. It has been reported that land utilization also influences P sorption capacity (Odunze, 2009). When phosphorus fertilizers are applied, only a small proportion of it is immediately available to plants. The rest is stored in soils in varying degrees of availability. It is common for farmers to apply phosphorus in excess to make it more available to plants, although this also increases the risk of most phosphorus being lost via run-off, leaching or soil erosion, finally ending up in lakes, rivers and oceans. This represents a financial loss and environmental damage(Reyes and Michelle, 2012).

Phosphorus deficiency in soil is the most common nutritional stress in many regions of the world, affecting 42 % of the cultivated land in the world. The P deficiency is caused either by low P content in the soils parent materials or by transformations of P added to soils to forms not available to plants. The P deficiency results in poor plant root formation, slow development, poor seed set and fruit formation hence, low and poor crop yields (Khan *et al.,* 2007). Thus, the need arises for specific studies aimed at understanding the effect of some selected organic manure on phosphate mobilization and microbial activities in these soils.

MATERIALS AND METHODS

**Study Location**

The study was conducted in Karu Local Government Area of Nasarawa State. The area falls within the southern Guinea Savanna zone of Nigeria and is located on latitude 9.0267ON and longitude 7.6074OE, with an average annual rainfall of 1469 mm with the highest recorded in the months of July, August and September. The highest temperature of the area is recorded during the dry season when there is little or no cloud cover, it has an annual temperature range between 21oC to 32oC (Udeh, 2010). The geologic features in Karu LGA are founded on basement complex structures that characterize much of the country (Dawam, 2000). The major formation constituting the bedrock includes the combination of different metamorphic and igneous rock formations especially migmatites and muscovite biotic schist having occasional outcrop bands. (Kanayochukwu and Dogo, 2019)

Soil sampling and analysis

Soil samples were collected using the simple random sampling method with an auger from 20 points on the research site at a depth of 0 – 15 cm. The samples collected were then bulked, thoroughly mixed together to form a composite sample which was then analyzed according to the procedures described by IITA (1976). Bouyoucos hydrometer method was used to carry out particle size analysis while textural triangle was used to determine the textural class. The soil pH was measured using glass electrode pH meter and organic carbon by Walkley-Black method. Total Nitrogen was determined using Kjedahl method while Available phosphorus (P) was extracted by Bray P1 method. Exchangeable bases, Ca2+, Mg2+, K+ and Na+ were extracted with 1N NH4OAc. Ca2+ and Mg2+ in the extracts were determined using atomic absorption spectrophotometer (AAS) while K+ and Na+ was determined by flame photometer. Exchangeable acidity was determined by titrimetric titration with standard NaOH. Effective Cation Exchange Capacity was determined by summation method.

Treatments and experimental design

The pot experiment was a 3 x 3 factorial arranged in a Completely Randomized Design (CRD). Treatments were three sources of animal manure (poultry, goat and cow dung) applied in three rates 0, 5.0 and 10 tons ha-1 replicated three times giving a total of 21 pots. Maize was planted as a test crop.

Agronomic practices

Before sowing, 5 kg of soil was thoroughly mixed with different animal manures (poultry, cow dung and goat manure) then put into perforated plastic buckets two weeks before planting. The test crop that was used is maize. Three seeds were planted and later thinned to two per pot. 100 kg N ha-1, 50 kg of single super phosphate ha-1, and 50 kg of muriate of potash (K20) ha-1 are the recommended fertilizer rates and were applied in two splits. The first dose (that is 50:50:50 kg ha-1) was applied 2 WAS while the second dose of N (50 kg ha -1) was applied at 5 WAS. (Kamara *et al*., 2020).

Growth Parameters

The plant height of maize was measured from the base of the plant to the tip of the plant using meter rule at 2, 4, 6 and 8 weeks after sowing (WAS). Number of leaf was determined by numerical counting of leaves on each plant at 2, 4, 6 and 8 WAS. Leaf area was measured by multiplying the length of the leaf by the breadth then multiplied by the leaf factor. Plants were harvested at 8 WAS. Shoots were cut down at soil level and weighed before and after drying then the readings were subjected to statistical analysis.

Statistical analysis

All data collected were subjected to Analysis of Variance (ANOVA) using genstat 11th edition (2008). Treatment means were compared using least significant difference (LSD) at 5 % Level of probability.

RESULTS AND DISCUSSION

The soil physical and chemical properties before sowing are shown in Table 1. The textural class of the soil was loamy sand. The soil was slightly acidic in water (pH 6.33) and the organic carbon (2.3 g kg-1), with available phosphorus (10.3 mg kg -1) was low and high N (1.06 g kg-1) The exchangeable bases was observed to be low and was in the decreasing order Ca > Mg > Na>K. The results obtained on table 2 indicated that Iron phosphate (Fe – P) and Ammonium phosphate (NH4 – P) significantly increased by treating with the three organic manures but Al phosphate (Al – P), Calcium phosphate (Ca – P) and occluded phosphate (Occl – P) had no significant effect over the control.

Table 1: Physical and chemical properties of the soil used for the experiment

|  |  |
| --- | --- |
| Parameters Values   |  | | --- | | Sand (g kg-1) 800  Silt (g kg-1) 80  Clay (g kg-1) 120  Textural Class Loamy Sand  pH in water 1:2:5 6.33  Organic Carbon (g kg-1) 2.3  Total Nitrogen (g kg-1) 1.06  Available Phosphorus (mg kg-1) 10.3  Exchangeable Bases (cmol kg-1)  Na+  0.16  K+ 0.06  Mg2+ 1.0  Ca2+ 2.0  Exchangeable Acidity (cmol kg-1) 0.11  ECEC 3.33 | |

**Table 2: Effect of Animal Manure on Maize Plants at 2 WAS, 4 WAS, 8 WAS**.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Treatment | Al-p | Ca-p | Fe-p | NH4cl-p | Occl-p | Total P |
| PM 5 t/ha-1 | 17.65 | 9.97 | 17.42 | 18.62 | 25.06 | 36.0 |
| PM 10 t/ha-1 | 16.60 | 8.56 | 17.72 | 16.10 | 30.39 | 31.7 |
| GM 5 t/ha-1 | 18.58 | 9.58 | 19.49 | 19.57 | 22.43 | 28.7 |
| GM 10 t/ha-1 | 17.39 | 7.40 | 19.41 | 18.65 | 28.22 | 27.3 |
| CD 5 t/ha-1 | 19.39 | 9.56 | 19.68 | 19.36 | 20.99 | 32.0 |
| CD 10 t/ha-1 | 16.69 | 7.55 | 20.56 | 18.18 | 24.07 | 32.3 |
| Control  LSD | 20.07  0.79 | 9.94  0.68 | 22.39  0.99 | 20.50  0.78 | 18.85  0.93 | 34.0  1.94 |
|  |  |  |  |  |  |  |

CONCLUSION AND RECOMMENDATION

These three organic manures; the poultry manure, goat manure and cow dung therefore have the potentials to increase the availability of P. The practical implication of these processes is that organic residues could be used as a strategic tool to reduce the rates of fertilizer P required for optimum crop growth on the soils of Karu. A field trial should be conducted to ascertain this finding.

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