FOOD INSECURITY IN AFRICA:
AGRICULTURAL DIVERSIFICATION AS A PANACEA

Proceedings of

1st

1st

International Conference of Agriculture and Agricultural Technology
{ICAAT 2019}

VENUE: **Federal University of Technology, Minna**
School of Agriculture and Agricultural Technology

DATE: **23rd - 26th April, 2019**

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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.

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 is hoped that, in due course, a separate Department of Horticulture will be created.

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.

INTERNATIONAL CONFERENCE OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY

The Committee of the 1st International Conference of Agriculture and Agricultural Technology (ICAAT 2018) 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 fighting food insecurity. 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 for the sustainable development aimed at fighting food insecurity in Africa. Therefore, during the three-day conference, all participants will have plenty of opportunities for exchanging ideas, findings and the latest research results and exploring the rich culture of the Nupe and Gbagyi kingdoms in central Nigeria.

PROGRAMME OF ACTIVITIES

DAY 1: TUESDAY, APRIL 23			
Time	**Activity**		
7.00-6pm	Arrival		
DAY TWO: WEDNESDAY, APRIL 24			
8.00 am-	Registration of Participants		
8.00 -9.00	BREAKFAST		
9.00-11.00	**PLENARY SESSION** Paper 1 Seed yield and physiological seed quality of cowpea varieties sown at different planting dates in Minna, Southern Guinea Savanna of Nigeria by Mrs. O.A. Adediran Paper 2 Performance of soybean genotypes under *Rhizobia* inoculation across three Agro ecologies of Nigeria by Dr. K.D. Tolorunse		
11.00-1.00	**TECHNICAL SESSION 1**		
	Hall 1 Prof. A.S. Gana (Chairman) Dr. B. A. Alimi (Rapporteur) Abstract no.: 1,2,3,4,5,6,7,8,9,10	**Hall 2** Prof. E.K. Tsado (Chairman) Dr. E. Daniya (Rapporteur) Abstract no.: 11,12, 15,16,17,18,19,20,21,90	**Hall 3** Prof. K.M.Baba (Chairman) Dr. O. J. Alabi (Rapporteur) Abstract no.: 22,23, 25,26,27,28,29,31, 76, 103
1.00-2.00	**BREAK/LUNCH**		
2.00-3.30	**TECHNICAL SESSION 2**		
	Hall1 Prof. S.O.E. Sadiku (Chairman) Dr. S.S.A.Egena (Rapporteur) Abstract no: 32 ,35,36,37,38,39,40,41,42, 75	**Hall 2** Prof. A. Aremu (Chairman) Dr. C.O.Adebayo (Rapporteur) Abstract no: 43,44,45,47,48,49,50,51,52, 104	**Hall 3** Prof. B.A.Ayanwale (Chairman) Dr. M. Ibrahim (Rapporteur) Abstract no: 53,54,55,56,57,59,60,61,62, 102
DAY THREE: THURSDAY, APRIL 25			
8.00-9.00	BREAKFAST		
8.00-10.00	Arrival of Guests and Dignitaries		
10.00-10.15	National Anthem/Prayer		
10.15-10.30	Introduction of Guests		

10.30-10.45	Opening Address by Chairman of the Occasion		
10.45-11.15	Keynote Address		
11.15-12.00	Goodwill Messages		
12.00-1.30 Break/Lunch			
1.30-3.00		**TECHNICAL SESSION**	
	Hall 1 Prof. R.S. Olaleye(Chairman) Dr. E.Z. Jiya (Rapporteur) Abstract no: 30, 33 46, 65,66,67,68,69,70,71,72,73,74	**Hall 2** Prof. A.T. Ijaiya (Chairman) Dr. A.A.A. Coker (Rapporteur) Abstract no:77,78, 79,80,81,82, 83,84,85,86,87,88,89	**Hall 3** Prof. J.O.Oyero (Chairman) Dr. K.D. Tolorunse (Rapporteur) Abstract no: 24,91,92,93,94,95,96,97,98, 99,100,101
3.00-4.15	Communique and Formal closing		
4.30 – 6.00	Cocktail		

COMMUNIQUE ISSUED AT THE END OF THE 1ST INTERNATIONAL CONFERENCE OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY (ICAAT) HOSTED BY SCHOOL OF AGRICULTURE AND AGRICULTURAL TECHNOLOGY, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE, NIGERIA BETWEEN 23RD-26TH APRIL, 2019.

PREAMBLE

The conference with the theme: “Food Insecurity in Africa: Agricultural Diversification as Panacea” had over one hundred and seventy (170+) participants from all over the world. The conference had a total submission of one hundred and four (104) papers presented in two plenary and 12 technical sessions. The conference was declared open by the Vice Chancellor of the Federal University of Technology, Minna, Professor Abdullahi Bala. The lead paper on the theme of the conference was presented by Professor David Norris, Vice Chancellor of the University of Botswana.

The conference identified food insecurity as a major challenge to improved livelihood for the people of Africa. According to Food and Agriculture Organization (FAO), thirty nine (39) countries in the world were experiencing food emergencies in 2006, twenty five (25) of the countries were in Africa. The recent developments in the region such as climate change, insurgencies, and conflicts are further aggravating the situation. Hence, the conference had robust deliberations which identified key issues affecting food insecurity in the continent and brought forward practical solutions to address the challenges through agricultural diversification. The contributions of agriculture to food security, which could eventually transform to economic growth for the continent are summarized under five inter-sectorial linkages. Thus: Supply of food for both domestic consumption and export; provision of markets; increased domestic savings; foreign exchange earnings; and employment of labor.

The highlights of resolutions are listed as follows:

African governments are advised to invest in infrastructural development at the rural areas where the main agricultural activities take place.

The governments are encouraged to cut down on the huge amounts of money in foreign currency being spent on subsidizing food imports to encourage local food production.

It is the right time to diversify the economy from oil based to agricultural driven, which seems to be the most sustainable way forward.

There is need for agricultural transformation through mechanization and utilization of appropriate technologies

Small scale farmers should be encouraged to form cooperatives to enable them assess government and non-governmental assistance for increased productivity.

Governments are advised to comply with Maputo/Malabo Declaration of 10% national annual budget for agriculture

Academics are challenged to undertake comprehensive researches to provide fundamental solutions to lingering herders-farmers conflict which has led to great reduction in agricultural productivity and claimed several lives, especially in Nigeria.

African leaders are advised to deploy utmost political will, which is essential for achieving food security in the continent.

Conclusively, stakeholders are implored to focus more on agriculture because it is extremely important, highly sustainable, but under-explored.

Professor J. N. Nmadu
(Chairman, LOC)

Dr. O. J. Ajayi
(Secretary, LOC)

Communique Committee

Dr. J. H. Tsado
Chairman,

Dr. B. A. Alimi
Secretary

Dr. D. N. Tsado
Member

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RESPONSE OF COWPEA TO RHIZOBIAL INOCULATION IN SOILS OF SOME COWPEA GROWING AREAS OF NIGER STATE

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ABSTRACT

Yield of cowpea in soils of Nigeria Savanna is often low as a result of deficiency of nutrient particularly Nitrogen. The use of rhizobia inoculants may benefit the cowpea plant through improve Biological Nitrogen Fixation. The objective of this study was to determine the response of cowpea varieties to Bradyrhizobium inoculation in soils of some cowpea growing areas of Niger State. Two greenhouse experiments were carried out at the Teaching and Research Farm of the Federal University of Technology Minna to determine (i) the size of the native rhizobial using Most Probable Number (MPN) method which was a 2 x 4 factorial experiment, and (ii) Need to Inoculate cowpea experiment laid out in a 10 x 2 x 4 x 4 fitted to a completely randomized block design. The treatment consisted of (i) proximities (close to homestead < 50 m, and far from homestead > 250 m) and (ii) cowpea varieties (Kanannado, IT93K-452-1, IT97K-499-35, and IT90K-277-2) for MPN. Treatments for need to inoculate trial consisted of (i) 10 locations (Rijau, Kontagora, Magama, Mashegu, Mariga, Bida, Paikoro, Wushishi, Chanchaga, and Bosso), (ii) 2 proximities to homestead, (iii) 4 cowpea varieties, (Proximity to homestead and cowpea varieties were the same as in the MPN experiment), and (iv) 4 nitrogen sources (N treated plants in form of urea at the rate of 100 kg N ha^{-1}, plants inoculated with Bradyrhizobium sp. strain BR 3262 or BR 3267, and control. The result of this study shows that MPN estimate using IT90K-277-2 as the trap host (9.41 x 10^{6} cells g^{-1}) was significantly lower than estimates by the other varieties (1.29 - 2.23 x10^{7} cells g^{-1}), there was no significant difference between either of the proximities to homestead. Cowpea varieties used in this study responded to either or both inoculant strains, response to inoculation using strain BR 3262 ranged from 10.42% to 27.26% and 15.04% to 55.17% with strain BR 3267. There exists a linear relationship between symbiotic effectiveness of the native rhizobial populatons and response to inoculation. Suggesting the suitability of these inoculant strains for cultivation in the Southern Guinea savanna of Nigeria.

Keyword: cowpea, rhizobia, *Bradyrhizobium* inoculants

INTRODUCTION

The most frequently deficient nutrient in tropical soils is nitrogen, due to continual removal of crop residues, low soil organic matter, leaching, bush burning, and volatilization (Albareda *et al.,* 2008). In order to optimize the supply of this nutrient in agricultural systems, legumes such as cowpea that biologically fix nitrogen are integrated as part of the cropping systems. Nitrogen inputs through biological nitrogen fixation (BNF) may sometimes be sub-optimal because of the absence or low number of effective indigenous rhizobia that are compatible with the host legume (O'Hara *et al*., 2002). Under these circumstances, BNF can be improved through inoculation of soils with effective and compatible elite rhizobial strains (Abaidoo *et al*., 2007).

However, inoculation does not always bring about positive response. Among the frequently mentioned causes of failure are the number and the symbiotic effectiveness of indigenous rhizobia (Thies *et al*., 1991). In other cases, inoculating cowpea with rhizobia has been used to achieve substantial increases in legume nodulation, grain and biomass yield, nitrogen fixation and post-crop soil nitrate levels (Thies *et al*., 1991). These gains are usually highest when the inoculated legumes are grown in nil-rhizobia or low-rhizobia soils, but marginal in soils already containing high number of compatible rhizobia (GRDC, 2013). In Southern Africa, there are result showing existence of inter and intra-field variability in soil fertility. Farmers preferably apply nutrient resources to fields closest to homesteads leading to gradients of decreasing soil fertility with increasing distance from homesteads (Zingore *et al.*, 2007). Cowpea is a staple crop in Nigeria and West Africa at large but the yield of cowpea remains as low as 450 kg ha^{-1} in Nigeria small holder farms depending on varieties, management practices and climatic conditions (Cissé and Hall, 2003). Therefore this study was carried out to determine (i) To determine the varietal response of cowpea to different strains of rhizobia inoculants in soils of some cowpea growing areas of Niger State

To investigate the relationship that exists between the size of the indigenous rhizobia population and cowpea response to inoculation,

To establish the relationship between cowpea response to inoculation and the symbiotic efficiency of the indigenous rhizobial population, and (iv)To determine whether there exist differences in soil physico-chemical and biological properties between soils of field located near farm homesteads and those further away and how soils from either fields affect cowpea response to inoculation.

MATERIALS AND METHODS

The study was conducted in the greenhouse of the Federal University of Technology Minna. The study area is located in the Southern Guinea Savannah of Nigeria which lies between longitudes 90 30' and 90 40' E and latitudes 6° 30' and 6° 35' N at an elevation of about 258.5m above sea level.

The mean annual rainfall is about 1,338 mm which falls between April/May and October, November. The effective length of wet season is about 5 months. The highest mean monthly rainfall is in September with 300 mm. The temperature rarely falls below 22°C. The peaks are 40°C between February to March and 35°C between November and December (Osunde *et al.,* 2003).

Soil sampling and analysis

Soil samples were collected from 20 different points each at 0-20cm depth and were bulked to form composites. The soil samples were taken to the laboratory and a subsample taken and air-dried for physico-chemical analyses. The remaining samples were prepared moist for greenhouse study. Soil aggregates were gently crushed and passed through a 2mm sieve. Physical and chemical properties were carried out by standard methods (IITA, 1989), with soil particle size determined by the hydrometer method and pH using a pH-meter in water (soil solution ratio 1:2:5). Soil organic matter was determined using the Walkley and Black method, total nitrogen by the Kjeldahl method and available phosphorus by the Bray P1 method.

Green house study

Experiment (i) Procedure for the MPN Method

The assay was conducted using modified Leonard jar method in Southern Australia (Howieson *et al.*, 2014) using coarse sand as the potting medium.
The coarse sand was washed several times with tap water to remove all traces of dissolved nutrients and finally rinsed with sterile distilled water before sun drying.

A 3 litre pot was filled with 2.5 kg of sand medium to which 200 ml of calcium solution was added. Cowpea seeds were sown at the rate of 3 seeds per pot and thinned to 1 per pot a week after planting. Plants were watered daily using sandsman's nitrogen free nutrient solution (Sandsman, 1970). One week after planting, the plants were inoculated with 1 ml aliquots of the soil suspensions made from serial dilution of the soil samples. Each soil sample was initially diluted 20-fold by adding 10g of soil in 190 ml of sterile distilled water. Each dilution level was replicated four times resulting in a total of 24 pots per each soil sample.

Harvesting was done in a period of seven weeks after planting to observe the patterns of nodule appearances. The (+) sign was used to indicate presence of at least one nodule, while (–) denoted absence of nodules (Vincent, 1970).

Experiment (ii) Need to Inoculate Assay

Soil samples were added to 2.5 litre pot at 2 kg per pot. To each pot was added 372.6 mg of P, K, Mg, Zn, Mo, and B fertilizer and thoroughly mixed. Cowpea seeds were planted at 3 per pot and thinned to two per pot one week after emergence. The plants were watered daily with sandsman's N free nutrient solution 200 ml per pot for the first four weeks and later one quarter strength of the solution or just sterile distil water plants were harvested 7 weeks after planting. N treated plants were supplied with nitrogen and was split applied to the N treatment at first week (81.60 mg) and second week (244.80 mg) after planting. Inoculants were applied to the seeds before planting in inoculated treatment. The following parameters were carriedout shoot weight (dry), Nodule number, Nodule weight (dry), Nodule activity.

Experimental design and statistical analysis

Experiment (i) was arranged in a 2 x 4 factorial combination fitted to completely randomised design replicated four times. Proximity to homestead (2) and varieties (4) proximity to homestead and varieties were the same as that of experiment (ii). Experiment (ii) was arranged in a 10 x 2 x 4 x 4 factorial combination fitted to completely randomised design replicated four times. Locations (10), Proximity to homestead (2), nitrogen sources (4), and varieties (4). The locations were (Rijau, Kontagora, Magama, Mashegu, Mariga, Bida, Paikoro, Wushishi, Chanchaga, and Bosso). Proximity to homestead was either close or far from the homestead. N sources were (i) plant treated with nitrogen in form of urea at the rate of 100 kg N ha^{-1}, (ii) plant inoculated with *Bradyrhizobium* sp. strain BR 3262 or *Bradyrhizobium* sp. strain BR 3267, and control (Neither N nor inoculant rhizobia applied). The cowpea varieties were IT93K-452-1 (extra-early Maturing), IT97K-499-35 (Early Maturing), IT90K-277-2 (Medium Maturing), Kanannando (Late Maturing).

The data were subjected to statistical analysis using MINITAB 17.0. Analysis of variance (ANOVA) of the general linear model was used to check for significant effects and significant means were separated using Fisher least significant difference (L.S.D) method.

RESULTS

Soil Characteristics of the study area

The physical and chemical properties of soils used for this experiment are presented in (Table 1). Soils obtained from Bida, both close and far from homestead and those sampled from site far from homestead in Wushishi as well as the soil close to homestead in Mashegu were classified as sandy soil. Soils from Chanchaga and Bosso that were sampled from either close or far proximities were sandy loam. Similarly soils from Mashegu and Rijau sampled far from homestead and those from Magama close to homestead were also sandy loam. Loamy sand texture was obtained in the other locations.

The soil pH for both soils obtained close and further away from homestead in the 10 locations was slightly acidic to near neutral ranging from 5.31- 6.79 but a moderate acidity of 4.77 was observed in Kontagora for soils sampled near the homestead.

Soil organic carbon was low but moderate in soils close to homestead. Chanchaga and Kontagora at 0.50 g kg^{-1} and 12.45 g kg^{-1} respectively. Total soil N was very low for all locations in both the close or far proximities to homestead. Available P ranges from low to moderately high but very high in Mariga soils obtained further away from homestead and Wushishi close to homestead. Exchangeable bases were moderately high in all locations. The result of the Effective cation exchange capacity (ECEC) ranges between 11.40 cmol kg^{-1} and 5.79 cmol kg^{-1} with the highest observed in Wushishi for soils collected close to homestead

Estimate for rhizobial population for four variety of cowpea at different location

The rhizobial populations as estimated using four cowpea varieties as trap host are presented in Table 2. The soils of the study sites had high numbers of indigenous rhizobia (>10 rhizobia cells g^{-1} of soil). However, the highest population was observed in Mashegu for soils sampled near homestead, Mariga, and Magama for soils far away from homestead (71.84 x 10^6 cell g^{-1} of soil) using Kanannado variety while the lowest native populations (4.61 x 10^6 cell g^{-1} of soil) were obtained using IT93K-452-1 variety for Bida, Kontagora, Rijau for soils sampled close to homestead these was similar to Bosso for soils far away from homestead using Kanannado variety.

The effect of proximity to homestead and varieties on the most probable number (MPN) of indigenous rhizobial population.

The main effect of proximity to homestead did not significantly ($p>0.05$) affect the native rhizobia population of the soils Table 3. However, varieties significantly affected the rhizobia population and the greatest MPN value was obtained using Kanannado compared to IT93K-452-1, IT97K-499-35, and IT90K-277-2 varieties. The interaction of proximity to homestead and varieties did not significantly affect ($P>0.05$) the population of indigenous rhizobial present in the experimental soil.

Effect of nitrogen sources, proximity to homestead and varieties on shoot dry weight of cowpea

The main effect of nitrogen sources significantly ($P<0.05$) affected shoot dry weight of cowpea at all locations (Table 5). The Urea treated plants produced the highest shoot dry weight of cowpea in all locations while the control plants had the smallest shoot biomass in all locations, except in Chanchaga soils were the BR 3267 plants had the smallest biomass. However, there was a significant response of cowpea to inoculation except for chanchaga soils, plant inoculanted with either or both of the inoculant strains produced the greater shoot dry weight than the control in all soils. The BR 3262 had better shoot dry weight than the control at four of the ten locations, while the BR3267 treatment had the higher shoot dry weight than the control at seven out of ten locations.

The main effect of proximity to homestead on shoot dry weight of cowpea was significant (P <0.05) for all locations except in Magama, Chanahaga, and Paiko (Table 5). Except in Bosso, soils sampled close to homestead supported higher cowpea shoot dry matter than soils further away from homestead.

The varietal effect on shoot dry weight was significant in all ten locations (Table 5). The Kanannado variety produced the highest shoot dry weight while IT90K-277-2 variety had the smallest dry weight in all locations. IT93K-452-1 and IT97K-499-35 produced similar shoot biomass at seven out of the ten locations, while the later had higher biomass than the former at the other three locations. The Interaction effect of nitrogen source, proximity to homestead and varieties significantly (P<0.05) affected the shoot dry weight of cowpea in all locations .

The interactive effect of treatments on shoot dry weight of cowpea in Mashegu

The Kanannado plant inoculated with BR3262 as well as IT93K-452-1 and IT90K-277-2 plants inoculated with BR3267 and grown in the soil sampled close to the homestead produced the highest shoot dry weight. These are however, similar to those produced by the N treated Kanannado and IT90K-277-2 plant grown in soils sampled further from the homestead and that close to the homestead, respectively.

The least shoot dry biomass was produced by the IT93K-452-1, IT97K-499-35 and IT90K-277-2 that were treated with neither N or inoculant in soils sampled from both close and far from homestead. Similar biomass yields were all produced Kanannado and IT93K-452-1 inoculated with BR3267 and by IT93K-452-1 and IT90K-277-2 inoculated with BR3267 in soils sampled far from homestead.

The interaction of treatments on shoot dry weight of cowpea in soils from Rijau

The interactive effects of the treatments on shoot dry weight of cowpea are presented in (Table 6). The Kanannado and IT93K-452-1 plant treated with N in soils close to homestead had the heaviest shoot weight while the IT90K-277-2 that were inoculated with either BR3262 or BR3267 in soils close to homestead produced the least shoot biomass. However, IT97K-499-35 inoculated with BR3267 in the soils sampled close to homestead produced as much biomass than the N - treated with IT97K-499-35 and IT90K-277-2.

The interaction of treatments on shoot dry weight of cowpea in soils from Chanchaga

The N treated Kanannado and IT97K-452-1 in both soils of far and near proximities had the highest biomass weight. This was however, not significantly different from the dry matter weight of the unamended kanannado plants and those inoculated with BR3262 in soils close to homestead.

The BR3262 plants irrespective of variety were among the treatments with the least biomass.

DICUSSIONS

Soil physicochemical analyses

The physical and chemical properties of the soil at the experimental site reflected the common features of savanna soils which are generally low in organic carbon and very low in total N contents (Aliyu *et al*., 2013). On the other hand, the extractable P of the soil falls within optimum available P concentration that would help to enhance nodulation and nitrogen fixation in the grain legume (Enwezor, 1990). The ECEC analysis shows that soils sampled close to homestead contained more nutrient than those sampled away from homestead, this is in consistence with the findings of (Zingore *et al.,* 2007) In Southern Africa, that farmers preferably apply nutrient resources to fields closest to homesteads leading to gradients of decreasing soil fertility with increasing distance from homesteads.

Most Probable Number (MPN)

The MPN results of the experimental soils show that N has fixing ability for cowpea. The likelihood of response to inoculation can also be assessed by counting the population of rhizobia in soil using appropriate host (Woomer *et al*., 1990). If small populations of effective rhizobia are present (20-50 cells/g), then it is likely that a yield response will be found (Thies *et al*., 1991). The rhizobial cell count in this study indicated that soils sampled away from homestead had higher population density of cowpea rhizobia compared to proximities close to homestead. These suggest that there may likely be no response to inoculation in these soils. Contrary to this observation, a response was observed in this sudy.

Effect of nitrogen sources on the shoot dry weight of cowpea

The success of Rhizobium inoculation primarily depends on the rhizobial strain, the legume genotype, the environmental conditions, and the crop management (Woomer *et al.,* 2014). Cowpea shows response to inoculation, but greatest shoot dry weight was obtain with urea treated plant at the rate of 100 kgNha^{-1}, this implies that N was limiting in soils of the study sites. This result agrees with the findings of Subasinghe *et al*. (2001) who reported an increase in dry matter production of cowpea in response to increased N application. Although, the inoculated plant did as well as the N supplied plant in some locations and also better than the control treatment in all location except in Chanchaga despite its promiscuity to indigenous rhizobia in soil. This is in contrast with some reports from the past suggesting that cowpea yields are not improved by rhizobia inoculation (Awonaike *et al.*, 1990; Mathu *et al.*, 2012). This result conforms to the findings of Zilli *et al.* (2009) who reported an increase in biomass production following inoculation of cowpea with inoculant (BR3267) were more than the biomass produced with indigenous rhizobia population.

In this study, proximity of fields to homesteads yields were significantly higher which is in accordance to the research carriedout in South Africa by Waddington and Karigwindi (2001); Zingore *et al.* (2007) whose study shows that the fertile plots is often closest to homesteads, as a result of continous accumulation of organic ammendment including all kinds of manure and household waste applied directly surrounding the villages.

Symbiotic effectiveness is one of the important parameters for selecting strains for inoculant production. It is also a primary factor for the determination of incidence and magnitude of legume response to inoculation (Thies *et al.* 1991). IT97K-499-35 and IT90K-277-2 varieties had the highest frequency of response to inoculation while the least was with Kanannado variety. Cowpea varieties used in this study responded to either or both inoculant strains, response to inoculation using strain BR 3262 ranged from 10.42% to 27.26% and 15.04% to 55.17% with strain BR 3267.

CONCLSION

Soils sampled from different locations in this study have enabled understanding of effects of inoculation on the yield parameters of cowpea. Soils from the cowpea growing areas of Niger state contains large population of indigenous rhizobia that nodulate cowpea with population ranging from 4.61 x 10^6 to 7.19 x 10^6 cells g^{-1}. There were no significant differences in rhizobia number in soils sampled close to homestead and those away from homestead. In spite of the relatively large numbers of the indigenous rhizobia in the soils, cowpea responded to rhizobia inoculation in 19 of the 20 soils. Response to inoculation using strain BR 3262 ranged from 10.42% to 27.26%. In the case of strain BR 3267, it ranged from 15.04% to 55.17%. Variety IT97K-499-35 had the highest frequency of response to rhizobial inoculation at 70%, while the local variety, Kanannado, was the least frequent at 50%.

Table 1 Physico-chemical properties of the soils used for the study

Location	Proximity	pH CaCl	OC	N	Avail.P	Textural Class	K	Mg	Ca	Exch. acidity	ECEC
			g kg^{-1}		mg kg^{-1}			cmol Kg^{-1}			
Bida	Close	6.29	4.20	0.11	10.0	S	0.17	0.96	5.36	0.07	6.98
	Far	6.18	1.95	0.07	6.0	S	0.15	0.85	5.12	0.10	6.68
Kontagora	Close	4.77	12.45	0.20	18.0	LS	0.28	1.60	5.20	0.10	7.64
	Far	5.31	2.55	0.10	6.0	LS	0.18	0.88	4.40	0.10	6.13
Mashegu	Close	5.84	3.75	0.10	6.0	S	0.38	0.64	4.64	0.15	6.34
	Far	5.97	4.95	0.08	5.0	SL	0.26	0.96	5.60	0.09	7.43
Rijau	Close	6.57	4.80	0.06	8.0	LS	0.35	0.64	4.64	0.09	6.17
	Far	5.99	6.15	0.15	9.0	SL	0.21	0.88	4.88	0.08	6.49
Mariga	Close	5.78	6.45	0.22	6.0	LS	0.33	0.96	6.40	0.07	8.25
	Far	5.85	8.25	0.10	31.0	LS	0.27	1.36	5.20	0.27	7.53
Wushishi	Close	6.75	4.20	0.13	61.0	LS	1.00	1.60	7.60	0.69	11.4
	Far	5.48	2.10	0.13	5.0	S	0.15	1.12	5.28	0.25	7.27
Magama	Close	5.47	2.70	0.14	6.0	SL	0.12	0.56	4.56	0.12	5.79

	Far	5.57	3.75	0.20	7.0	LS	0.35	0.80	5.44	0.07	7.18
Bosso	Close	5.74	7.95	0.24	5.0	SL	0.28	2.00	6.00	0.30	9.06
	Far	5.98	4.65	0.17	5.0	SL	0.35	1.84	5.60	0.12	8.35
Chanchaga	Close	6.79	10.50	0.17	15.0	SL	0.57	0.80	7.76	0.11	9.74
	Far	5.63	6.00	0.08	5.0	SL	0.23	1.20	7.44	0.20	9.56
Paiko	Close	5.36	3.60	0.11	6.0	LS	0.19	1.12	4.80	0.10	6.71
	Far	5.80	4.35	0.18	7.0	LS	0.22	0.80	5.04	0.21	6.76

***SL-sandy loamy *LS-loamy sand *S-sandy**

Table 2: Estimate of rhizobial populations for four varieties of cowpea at different location in ($x10^6$ cell g^{-1} of soil)

Location	Proximity	Kanannado	IT93K-452-1	IT97K-499-35	IT90K-277-2	**Means**
Bida	Close	7.19	4.61	12.27	10.94	**8.75**
	Far	10.94	7.19	9.26	7.19	**8.65**
Kontagora	Close	10.94	4.61	11.24	7.19	**8.50**
	Far	22.48	31.85	12.27	11.24	**19.46**
Mashegu	Close	71.89	22.48	11.24	7.19	**28.2**
	Far	12.27	22.48	11.24	7.19	**13.30**
Rijau	Close	12.27	4.61	9.26	12.27	**9.60**
	Far	12.27	12.27	9.26	10.94	**11.19**
Mariga	Close	22.48	42.59	11.24	7.19	**20.88**
	Far	71.89	12.27	12.22	11.24	**26.91**
Wushishi	Close	10.94	10.94	7.19	7.19	**9.07**
	Far	12.27	10.94	9.26	11.24	**10.93**
Magama	Close	22.48	10.94	42.59	7.19	**20.80**
	Far	71.89	12.27	11.24	11.24	**26.66**
Bosso	Close	10.94	12.27	12.22	9.26	**11.17**
	Far	4.61	10.94	12.22	11.24	**9.75**
Chanchaga	Close	12.27	11.24	9.26	9.26	**10.51**
	Far	22.48	11.24	22.48	7.19	**15.85**
Paiko	Close	12.27	12.27	9.26	10.94	**11.19**
	Far	11.28	11.28	12.22	10.94	**11.43**
Means		**22.30**	**13.96**	**12.87**	**9.41**	

Table 3 The effect of most probable number (cells g^{-1} of soil) of indigenous rhizobial in soils sampled from different location in Niger State.

Treatment	MPN
Proximity (P)	
Close	$1.39x10^6$a
Far	$1.54x10^6$a
L.S.D (0.05)	NS
Varieties (V)	
Kanannado	$2.23x10^7$a
IT93K-452-1	$1.40x10^7$a
IT97K-499-35	$1.29x10^7$a
IT90K-277-2	$9.00x10^6$b
Interaction	
P X V	NS

Means with the same letters are not statistically different (P>0.05)

Treatment	Bida	Kontagora	Mashegu	Rijau	Mariga	Wushishi	Magama	Bosso	Chanchaga	Paiko
Nitrogen sources(N)										
Control	1.44c	1.27c	1.16c	1.39c	1.52b	1.44b	1.13c	1.59c	1.94a	1.64b
Urea	2.09a	1.87a	1.86a	2.13a	2.06a	1.98a	1.75a	2.32a	1.94a	2.01a
BR 3262	1.31c	1.54b	1.48b	1.36c	1.50b	1.59b	1.27bc	2.02a	1.71b	1.97a
BR 3267	1.69b	1.22c	1.80a	1.65b	1.91a	1.90a	1.30b	1.85b	1.49c	2.05a
Significance	**	**	**	**	**	**	**	**	*	*
LSD (0.05)	0.18	0.17	0.17	0.23	0.25	0.18	0.16	0.22	0.22	0.22
Proximity (P)										
Close	1.78a	1.55a	1.70a	1.63a	1.85a	1.86a	1.33a	1.86b	1.77a	1.91a
Far	1.48b	1.40b	1.45b	1.63a	1.64b	1.60b	1.40a	2.03a	1.76a	1.93a
Significance	**	*	*	NS	*	*	NS	*	NS	NS
LSD (0.05)	0.13	0.12	0.12	0.16	0.17	0.13	0.11	0.15	0.15	0.15
Varieties (V)										
Kanannado	2.11a	1.95a	1.88a	2.01a	2.02a	2.13a	1.67a	2.44a	2.02a	2.22a
IT93K-452-1	1.47c	1.39b	1.34c	1.65b	1.89ab	1.43c	1.17c	1.96b	1.59b	1.86b
IT97K-499-35	1.84b	1.42b	1.49bc	1.72b	1.71b	1.83b	1.38b	2.03b	1.74b	2.07ab
IT90K-277-2	1.10d	1.14c	1.58b	1.16c	1.37c	1.52c	1.23bc	1.35c	1.72b	1.52c
Significance	**	**	**	**	**	**	**	**	*	**
LSD (0.05)	0.18	0.17	0.17	0.23	0.25	0.18	0.16	0.22	0.22	0.22
Interaction										
N X P	NS	NS	*	*	NS	*	NS	**	*	**
N X V	**	**	**	**	**	**	NS	*	**	**
P X V	NS	NS	*	NS	**	NS	NS	*	*	NS
NXPXV	*	*	*	*	*	**	*	**	**	*

Table 4 Effect of nitrogen sources, proximity to homestead and varieties on shoot dry weight (g/ plant) of cowpea
Means with the same letters in a column under a treatment are not statistically different (P>0.05). Significant at (P<0.05), ** highly Significant at (P< 0.05), NS (not significant)

Table 5 Interaction effect of nitrogen sources, proximity of field to homestead and varieties on shoot dry weight of cowpea in Mashegu Niger state.

		Varieties			
Nitrogen sources	Proximity	Kanannado	IT93K-452-1	IT97K-499-35	IT90K-277-2
Control	Close	1.74e-i	1.15k-p	1.07l-p	1.20k-p
	Far	1.34i-o	0.96m-p	0.93nop	0.90op
Urea	Close	2.23b-e	1.28i-p	1.49f-l	2.31a-d
	Far	2.78a	1.98c-f	1.51f-l	1.31i-p
BR3262	Close	2.43abc	1.07l-p	1.41h-n	1.60f-k
	Far	1.91d-g	0.82p	1.70f-j	0.90op
BR3267	Close	1.42g-m	2.33a-d	1.91d-g	2.53ab
	Far	1.23j-p	1.17k-p	1.95c-f	1.85d-h

Means with the same letters are not statistically different (P>0.05)

Table 6 Interaction effects of nitrogen sources, proximity to homestead and varieties on shoot dry weight of cowpea in soils sampled from Rijau.

		Varieties			
Nitrogen sources	Proximity	Kanannado	IT93K-452-1	IT97K-499-35	IT90K-277-2
Control	Close	1.69e-i	0.96j-n	1.26i-m	0.98j-m
	Far	1.94c-h	1.55e-k	1.41g-l	1.30h-m
Urea	Close	3.20a	2.81ab	1.85c-i	1.61e-j
	Far	2.20b-e	2.49bc	1.40g-l	1.52f-k
BR3262	Close	1.50f-k	0.91k-n	1.55e-k	0.84lmn
	Far	2.13c-f	1.39g-l	2.07c-f	0.49n
BR3267	Close	2.02c-g	1.83d-i	2.43bcd	0.70mn
	Far	1.35h-m	1.29i-m	1.75e-i	1.85c-i

Means with the same letters are not statistically different (P>0.05)

Table 7 **Interaction effect of nitrogen sources, proximity to homestead and varieties on shoot dry weight of cowpea in soils from Chanchaga.**

		Varieties			
Nitrogen sources	Proximity	Kanannado	IT93K-452-1	IT97K-499-35	IT90K-277-2
Control	Close	2.64ab	1.70d-j	2.31abc	1.31h-k
	Far	1.54f-j	1.6le-j	2.07b-f	2.29a-d
Urea	Close	2.27a-d	2.21a-e	1.39g-k	1.12jk
	Far	2.71a	2.30a-d	1.98c-g	1.53f-j
BR3262	Close	2.29a-d	1.27ijk	1.43g-k	1.37h-k
	Far	1.30h-k	0.87k	1.64e-j	1.75c-i
BR3267	Close	1.54f-j	1.61e-j	1.18ijk	2.72a
	Far	1.89c-h	1.14jk	1.89c-h	1.69d-j

Means with the same letters are not statistically different (P>0.05)

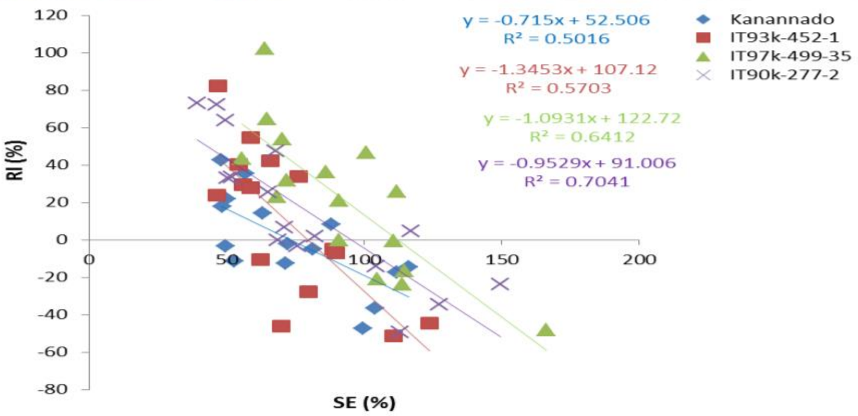

Figure 1: Linear relationships between symbiotic effectiveness (SE) of indigenous rhizobia and response to inoculation (RI) with BR3262 by cowpea varieties Kanannado, IT93k-452-1, IT97k-499-35 and IT90k-277-2 in soils sampled at sites close and far proximity to homestead.

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