YIELD RESPONSE OF ONION (*ALLIUM CEPA*) TO DEFICIT IRRIGATION IN THE SAHEL SAVANNAH REGION OF NIGERIA

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Abstract

The objectives of this research is to understand water requirement needs, predetermine yield expected from irrigation scheduling under limited supply or water scarcity and the relationship between yield and water deficit by onion plant daily. The irrigation interval observed were; control on the first block of regular seven days irrigation interval, second and the third were irrigated at3days and seven days in excess of the regular seven days irrigation schedule. The three stages of growth were identified as vegetative, flowering and fruiting/ ripening stages. Water was applied at depth of 25cm on each plot. The growing season lasted for four months. Highest yield of 31.5kg/plot (12t/ha) was obtained from 7 days normal irrigation, followed by 10 days,25.0kg/plot, and lowest yield of 18.3kg/plot (1.8t/ha) was obtained from 14 days irrigation. The result of this research shows that irrigating at interval of seven days has the highest significant yield and under critical condition farmer can irrigated at interval of ten days because up to 65-70% yield was obtained compared with treatment A and irrigation should not be schedule at interval of fourteen days because up to 57.6% of yield were lost. It was concluded that deficit irrigation will enhance good water management, reduce soil erosion, reduce cost and energy needed than to irrigate frequently.

Key words: Deficit Irrigation, Irrigation Schedule, Water

Introduction.

The concept of irrigation involves the artificial application of water to the soil for the purpose of supplying moisture essential for plant growth (Michael and Ojha, 2005). However, in a broader sense, irrigation is the application of water to the soil, to improve soil moisture, dilute salts, soften tillage pans and clods and to provide crop insurance against short duration droughts. (Sharma and Sharma, 2006). Deficit irrigation is being known globally as an efficient way of water management whereby there is a balance between minimum water applied to a crop and the maximum crop yield per unit of water applied (Arora, 2004). Thus, in arid and semi-arid regions where water is scares and food must be produced, water must be carefully managed by using optimum approach to the application and use of limited water supply, considering the fact that many farmers involve in crop production do not pay attention to efficient water management. Water requirement of crop varies and that at some certain growth stages crops are more sensitive to water deficit than others. The need therefore for the knowledge of when to apply water and how much of it to apply for optimum production comes into play. (Shock *et al.,*2010). Thus, the knowledge of the marginal productivity of water allocated to each crop at different growth stage is required in order to arrive at an optimal set of decision. According to Jensen (1968) and Stewart *et al.,* (1977), two key parameters commonly required in determining crop water requirement and predictions of yield water response to deficit irrigation are; crop coefficient (kc) and yield response factor (ky). The yield reduction to relative evapotranspiration deficit. It is the factor that integrates the weather, crop, and soil conditions that make crop yield less than its potential yield in the case of deficit evapotranspiration. The yield response factor ky is commonly required as input data in some empirical water production function.

Onion (*Allium cepa*) is a monocot and vegetable crop believed to have originated in the Near East and is grown almost all over the world. It is mainly grown for its bulb, which is used in almost in every home, on daily basis (Gohil and Kaul,2016;FAOSTAT,2001). Its main use include in flavouring and seasoning of a wide variety of dishes. It`s popularity is due to its aromatic, volatile oil, the allyl-prophl sulphide which imports a cherished flavour to food. Onion takes 100 to 140 days before it complete its life cycle. And high humidity leads to greater incidences of pest and disease and bulb rotting. (Steve, 2012, and Igbadun,et,al.2012).

Materials and Methods.

Study Area

The experiment was carried out at Kaduna Polytechnic demonstration farm, Nariya which is on latitude 10^{o} 16’N and longitude 7^{o} 21’E at an attitude of 600 – 800m above mean sea level, during dry season (cold harmattan to dry hot) November 2017 to April 2018. See table 1 for meteorological parameter during the study period. The region falls within the guinea savannah with severe deficit in rainfall from November to April sometime and a surplus of rainfall from May to September, with an average range of 1500mm the average incoming solar radiation range from 15.6MJ/m2/day in August to 21.0MJ/m2/day in March. The range in solar radiation implies that light temperature greatly limit potential crop production at any time of November to February.

Experimental Plot

The experimental plot was laid out using chain surveying method. The instruments used were measuring tape, ranging poles and pegs. The layout was 3m x 2.5m for each plot and 18 plots of experimental unit was used the total area of $45m^2$ (0.045ha).

In order to ensure as much homogeneous soil conditions as possible within the treatment. Each treatment was divided into six (6) basins. The basins were spaced 0.5m (furrow) apart between each treatment, to allowed for easy supply of water and reduce possible seepage water from one experimental unit to another

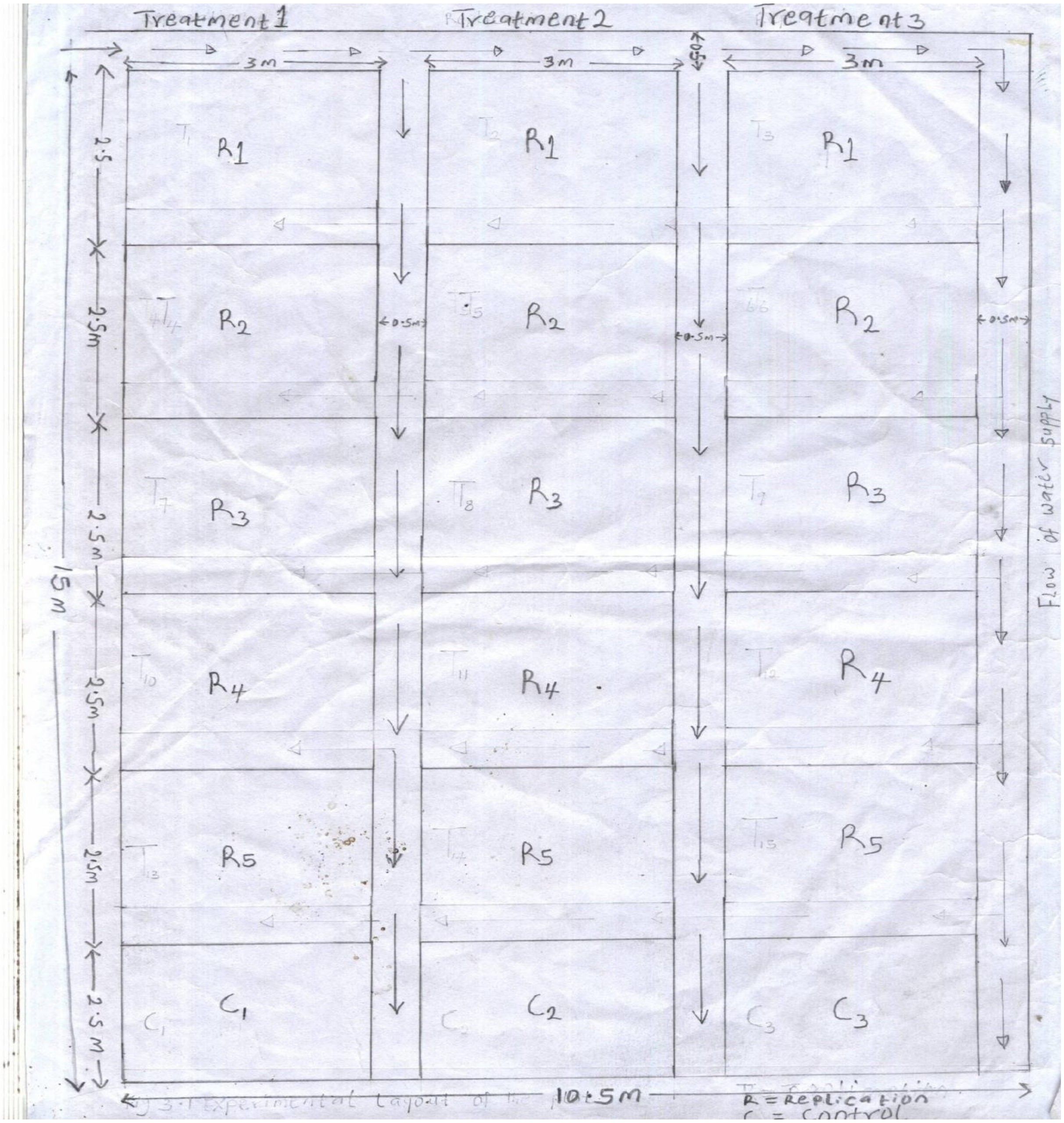

Plate 1: Experimental Treatments and Replication

Experimental Design.

The Randomized Complete Block Design (RCBD) was used in the study of the effect of water stress (Deficit irrigation) on onions yield during the growing stages of vegetative, flowering and bulb formation. The experimental designs were used since, there is no restriction in the randomization.

ANOVA was employed for the analysis of the results such as degree of freedom (df), sum of square (ss), mean square (ms) and F calculated were analysed. The f calculated was compared with table value of F to analyzed it level of significance. The level of experimental errors was determined using Latin square design (LSD) to compared with the result obtained from the treatments of the yield.

Surface irrigation method (check basin type) was used in which basin were irrigated through a break in the embankment and water allowed in until the basin is pounded to a level of about 50mm.The first weeding, application of fertilizer and spraying of chemical was done at Week 4 after transplanting. Second weeding done at Week 8 after transplanting and irrigation was stopped two weeks before harvesting, immediately after the falling of some leaves. Soil texture (percentage of sand, silt and clay), soil structure, bulk density, and soil moisture before and after irrigation were determined to have idea if there are any changes in the soil characteristics. Harvesting and measuring the weight of the harvested onion was done using weighing balance from various replications of treatments.

Results.

The results obtained from the experiment are summarized in the tables and figures below.

Table 1 Average meteorological data recorded during the growing period (late November-early April)

h	nd(km/hr)	Rainfall(mm)	nshine(hr)	temperature(o^c)	
Jan.					
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Table 2 ANOVA TABLE

Source of variation	Degree of freedom (DF)	Sum of square (SS)	Mean Squares (MS)
Replication	r – 1 6 – 1 = 5	SSR 96.95	MSR = 16.16
Treatment	t – 1 3 – 1 = 2	SST = 9.92	MST = 4.96
Total	rt – 1 3 x 6 1 = 17	SST = 232.90	
Error	(r-1) (t – 1) 5 x 2 = 10	SSE = 126.03	MSE = 12.60

Table 3. below show evapotranspiration as measured from the experimental plot (mm) using the meteorological data obtained on the field.

Stages/stress level	Treatment 1 (mm)	Treatment 2 (mm)	Treatment 3 (mm)	Seasonal ET (mm)
R_1	85.40	78.60	79.00	243.00
R_2	75.20	72.60	79.40	227.20
R_3	79.00	80.00	73.30	232.30
R_4	79.40	75.20	71.20	225.80
R_5	73.20	75.30	74.10	220. 60
R_6	72.30	79.00	76.60	227.90

Table3. Physical properties of soil in the experimental plot.

Depth (cm)	Moisture content (%)	Bulk Density (g/cm^3)	Textural Class
0-15	20.7	1.29	Silt loam
15-30	21.9	1.29	Clay loam
30-45	22.5	1.46	Clay loam
45-60	25.2	1.31	Clay

Table 4. Yield obtained from the experimental plot.

Plot	Treatment			Average(kg)	Total(kg)
	1	2	3		
R_1	5.3	4.3	3.1	4.2	12.7
R_2	4.9	4.1	2.9	4.0	11.9
R_3	5.6	4.5	3.3	4.5	13.4
R_4	5.4	3.8	2.9	4.0	12.1
R_5	4.8	3.9	2.8	3.8	11.5
R_6 (control)	5.5	4.4	3.3	4.4	13.2
Total	31.5	25.0	18.3	4.2	74.8

Total yield obtained for the control(seven days irrigation interval was 31.5kg/plot.25.0kg/plot was the obtained for 3days water stress and 18.3kg/plot was obtained when the crop was stressed for seven extra days in excess of the seven days irrigation interval.

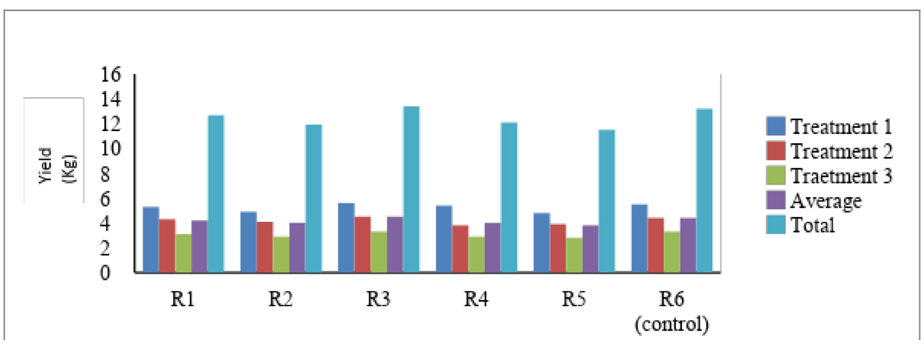

Fig 1: Yield (kg) obtained per plot(m^2)

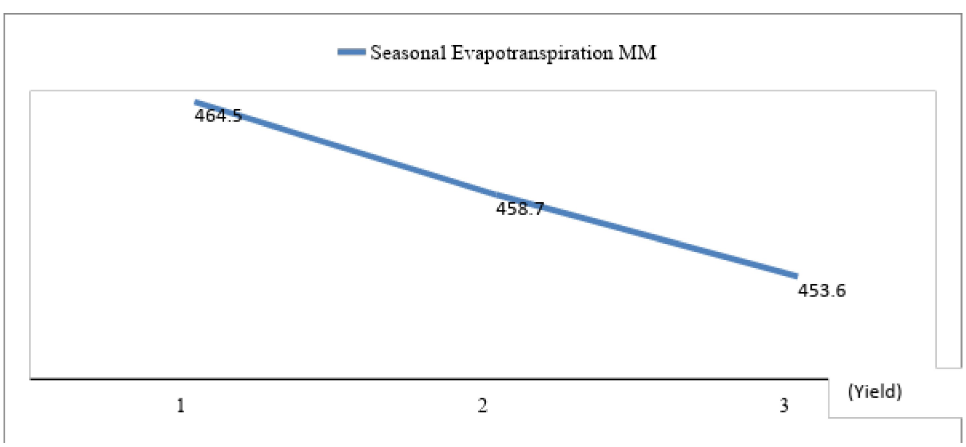

Fig 2. Relationship between water stress and seasonal evaporation.

Discussions

Deficit irrigation promotes good water management, reduce soil erosion, reduce cost and energy needed than to irrigate frequently. In this study, irrigation ceases when bulbs have attained the desired marketable size and falling of the leaves. Computing the level of significance fromThere was on the yield from the result obtained, at the three stages of water stress (see fig 1). The maximum yield of 31.5kg/plot(17.03ton/ha) was obtained from treatment 1 (control) where no stress was observed during the growth stage. Treatment($T_{2)}$ which was stressed for an additional 3 days (10days) show little difference in yield of 25.0kg/plot (13.51ton/ha) and Treatment ($T_{3)}$ which was stressed for an additional 7 days (14days) shows about 57.6% reduction in yield,18.3kg/plot (9.81ton/ha). In table 1,F calculated value (11.28) for treatment is less than the table value at 5% (2.57) and 1% (4.03) level of significance different in crop yield which shows that the higher the seasonal evaporation the more the crop required water.(Table 3).

The ranking of the means treatment using LSD of 1.65 value indicated that T_1 31.5kg, T_2 25.0kg, T_3 18.3kg. Treatment T_1 was found to be significant than treatment T_2 and is highly significant than Treatment T_3. It can be deduce therefore that a farmer under critical condition can irrigate with the interval of 10days (figure 2).

Finally, the yield water use relationship shows that yield of onion crop increases with increase in the rate of seasonal evapotranspiration. The evapotranspiration during the cropping season (ie November 2017- April 2018 was 456.5mm and a highest yield value of 31.5kg/plot was recorded.

Conclusions

It was concluded that deficit irrigation will enhance good water management, reduce soil erosion, reduce cost and energy needed than to irrigate frequently. In this study, irrigation treatments significantly affected yield, bulb height, bulb diameter and bulb weight. There was significant difference on the yield from the result obtained, at the three growth stages of onion when it was stressed with an additional days from the normal interval of 7days regular irrigation schedule. The maximum yield of 31.5kg/plot(17.03ton/ha) was obtained from treatment 1 (control) where no stress was observed during the growth stage. Treatment($T_{2)}$ which was stressed for an additional 3 days (10days) show little difference in yield of 25.0kg/plot (13.51ton/ha) and Treatment ($T_{3)}$ which was stressed for an additional 7 days (14days) shows about 45% reduction in yield,18.3kg/plot (9.81ton/ha).

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