Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.8, No.6, 2018

The Effect of Growth Environments on the Growth and Yield of Onion (Allium cepa L.) in Jos, Plateau State, Nigeria

Kyenpiya Deshi[1] Micheal Obasi[1] Karya Nanbol[1] Salamatu Sirajo[2] Brains Okechalu[1]
1.Department of Plant Science and Technology, Faculty of Natural Sciences, University of Jos, Nigeria
2.Department of Botany, Federal University Lafia, Nigeria

Abstract
An experiment was carried out between the months of August, 2016 to January, 2017 at the Botanical Garden, Bauchi Road Main Campus, University of Jos, Plateau State, Nigeria, (latitude 09° 51[1] N and Longitude 08° 53[1] E and altitude of 1, 159 meters above sea level) to study 'The effect of growth environments on the growth and yield of Onion (Allium cepa L.) in Jos, Plateau state, Nigeria''. A completely randomized design in split plots consisting of three onion varieties (Red creole 5, Dan Zaria 1 and Wase) and two growth environments (open field and green house) giving a total of six treatment combinations replicated three times were employed. The parameters assessed include: leaf length, leaf girth (neck), number of leaves, fresh and dry weight of whole plant, fresh and dry weight of bulbs and fresh and dry weight of leaves. The data collected was subjected to analysis of variance and the means were separated using least significant difference (LSD). The result showed that the main effect of variety was significant for the parameters assessed with variety Dan Zaria 1 being significantly ($P<0.05$) different from varieties Red Creole 5 and Wase. During crop growth, the main effect of growth environment was not significant at initial stages of growth (4, 6 and 8 weeks after transplanting (WAT)) but from 10, 12 and 14 WAT it was significant. The two growth environments did not affect the fresh and dry weight of whole plant at harvest. Onions from the open field resulted in significantly higher fresh and dry weight of bulbs (27.13 and 3.69 g respectively) than those in the green house (19.99 and 2.71 g respectively). Onions grown in the green house had significantly higher ($P<0.05$) fresh and dry weight of leaves (35.80 and 3.59 g respectively) than those in the open field (25.96 and 2.68 g respectively). There was significant interaction between variety x growth environment on leaf length, leaf girth (neck), number of leaves and fresh weight of leaves. The differences between varieties may be due to genetic variability. Plants in the open field showed a better performance with regards to fresh and dry weight of bulb while plants grown in the green house had higher leaf length and fresh weight of leaves suggesting that green house will give best result for spring onion cultivation, while open field favours bulb production.
Keywords: Onions, open-field, green- house, growth, yield

1. Introduction

Onion (*Allium cepa L.*) belongs to the family *Alliaceae*. Onion originated from Southwest Asia but it is cultivated all over the world today. Onion is one of the oldest bulb vegetables in continuous cultivation dating back to at least 4000BC (Ahmad *et al*., 2008). Onion is one of the most important vegetable crops grown in the world. Onion contains some important vitamins (A,B and B_2) and minerals (Ca, P, Fe, Cu and Zn) in addition to some soluble sugars and nicotinic acid. According to Raj and Yadav (2005), they have high mineral and organic content essential for human health. Ross (2001) reported onions to have a number of clinical uses which includes: anti-cholesteroloric activity, antitumor activity, antiviral activity and blood pressure effect.

Onion is a biennial crop propagated either by seeds, bulb or sets (small bulb) (Charkroborty, 2014). Fontes (1998) reported that onion shows a relatively slow growth rate at the first stage of development, followed by a rapid increase of leaf area and plant height .As the onion matures, food reserves begin to accumulate in the leaf bases and the bulb of the onion swells. The leaf is produced from the moistened apex (Abubakar *et al*., 2010).

The main environmental factors which affect onion bulb and set production are temperature, photoperiod and interaction between them (Mettananda, 2003). Temperature has effect on all functions of onion plant (Coolong and Randle, 2003), suitable temperature causes growth and development in each step, for example plants did not flower when sets were maintained at 30°C; but when sets are maintained for the long period at 10°C, more percentage of them will bolting (Khokhar *et al*., 2007). Optimum temperature for germinating onion seed is 20°C (Parmar *et al.,* 2001), but suitable temperature which 70% of seeds germinate is 13-28°C. Minimum temperature which onion seed can germinate is determined at 1.8°C (Voss *et al*.,1999). Low temperature is the main limiting factor for germinating at early spring season. Relative growth rate of onion leaf depends on temperature changes. Minimum temperature for leaf growth is 6°C (Ansari, 2007), he added that the relative growth rate of onion leaf increases linear 6 to 20°C. Onion development is dependent on environmental conditions such as photoperiod and temperature as well as growth rate and the number of days to maturity. During early growth and development, onions require cool temperatures (6 to 20°C), but during bulb initiation and development, warmer temperatures (25 to 27°C) are required (Ansari, 2007). If environmental temperature reaches above 27°C, relative growth rate of leaf decreases, in this condition, high yield is obtained in high

density which 1000-4000 plants per m^2 are grown (Brewster, 1997).
This work is aimed to study the effect of growth environments on the growth and yield of Onion (*Allium cepa* L.) in Jos, Plateau state, Nigeria with the following specific objectives;
To determine the effect of growth environments on the growth and yield of onion.
To determine how the onion varieties are affected by growth environment
To determine the performance of the onion varieties.

2. Materials and Methods

This research work was conducted in the Botanical garden of the Department of Plant Science and Technology, University of Jos, Nigeria (latitude 09^o 51^1 N, longitude 08^o 53^1 E and altitude 1,159 meters above sea level) to investigate the effect of growth environment (greenhouse and open field) on the growth and yield of onion (*Allium cepa* L.) in Jos, Plateau State, Nigeria. The experiment was carried out between the months of August 2016 to January 2017.

Three onion varieties were used in this research work. Variety Red creole 5 was obtained from the Center for Pastoral and Agriculture Research, Usmanu Danfodiyo University, Sokoto on the 25th August, 2016 while varieties Wase and Dan Zaria1 were obtained from Wase Local Government Area of Plateau State, on the 27th August, 2016.

2.1. Experimental Design

The experiment was carried out in a completely randomize design in split plots consisting of three (3) Varieties (Red creole 5, Dan zaria 1 and Wase) and two (2) growth environments (open field and greenhouse) giving a total of six treatment combinations replicated three (3) times.

2.2. Cultural Practices

A soil mixture of top soil, sharp sand and cow dung in the ratio of 2:1:1 was filled into pots for raising the onion seedlings while a mixture of top soil and cow dung in the ratio of 2:1 was filled into polythene pots for transplanting of onion seedlings in the open field and in the green house. The onion seedlings were transplanted at four weeks after planting. Weeding was carried out every two weeks after transplanting until the harvest time by hand-picking. The plants were irrigated after every two days until harvest. The onion plants were harvested at fourteen (14) weeks after transplanting (WAT) on January 2, 2017.

The parameters assessed included: leaf length (cm), leaf girth (neck) (cm), number of leaves, fresh and dry weight of whole plant, fresh and dry weight of bulb, fresh and dry weight of Leaves. The data collected was subjected to analysis of variance (ANOVA) and the means were separated using the Least Significant Difference (LSD) (Steel and Torrie, 1960).

Meteorological data such as temperature, relative humidity, sunshine hour and sunshine radiation were collected throughout the duration of the study (Table 1).

Table 1: Weather Readings for the Months the Trial was carried out

Months	Temperature (^{o}C)		Relative	Sunshine	Sunshine
	Max.	Min.	Humidity (%)	Radiation (BTU)	Hour (H)
August	23.00	18.80	85.50	32.80	3.00
September	24.30	19.00	77.00	42.60	4.70
October	27.80	17.00	64.90	54.90	7.60
November	27.60	14.60	50.20	51.00	9.10
December	23.70	12.60	43.70	43.30	8.60
January	25.50	19.60	40.50	45.00	9.00

Source: Federal College of Forestry, Meteorological Station, Jos, Plateau.

3. Results

3.1. Leaf Length

The main effect of variety was significant with respect to leaf length at all the sampling dates. Variety Dan Zaria 1 resulted in significantly higher mean leaf length than the other two varieties at all the sampling dates (Table 2). The two growth environments (open field and greenhouse) differed significantly at 10, 12 and 14 (WAT) with onions grown in the green house having significantly ($P<0.05$) longer leaf length than those grown in the open field (Table 2).

The interaction of Variety and Growth environment on mean leaf length is represented in Table 3. With crop grown in the field, Variety Dan Zaria 1 resulted in longest length while Variety Wase 1 and Red Creole 5 had similar leaf length (Table 3). With crop grown in the greenhouse, all the Varieties had significantly different ($P<0.05$) mean leaf length with Variety Dan Zaria 1 having the highest (58.22cm) while Red Creole 5 had the least (41.54cm) (Table 3).

3.2. Leaf Girth (Neck)

The main effect of variety as affected by Environment (field and greenhouse) on mean leaf girth (neck) is shown in Table 2. Variety Dan Zaria 1 resulted in significantly ($P<0.05$) higher leaf girth than the other Varieties which were similar at all the sampling dates (Table 2). The main effect of environment (open field and greenhouse) were significant ($P<0.05$) at 12 and 14 WAT with onions grown in the field resulting in significantly ($P<0.05$) higher neck girth than those grown in the greenhouse (Table 2).

Table 3 shows the interaction of variety and environment (field and greenhouse) on mean leaf girth (neck), there was significant ($P<0.05$) difference for all varieties grown in the greenhouse with variety Dan Zaria 1 having the highest leaf girth (4.06 cm) and variety Red Creole 5 having the least (2.64 cm) (Table 3). With plants grown in the open field, variety Dan Zaria 1 had significantly ($P<0.05$) higher neck (3.71 cm) than the other varieties which were similar (Table 3).

3.3. Number of Leaves

Table 2 shows the main effect of variety and growth environment on mean number of leaves. At 4 WAT, there was no significant difference between all the varieties. At 6 and 8 WAT, varieties Wase and Red Creole 5 had similar number of leaves and were significantly ($P<0.05$) lower than variety Dan Zaria 1 which had the highest number of leaves (Table 2). All varieties differed significantly ($P<0.05$) from each other at 10, 12 and 14 WAT with Dan Zaria 1 having the highest mean number of leaves while variety Red creole 5 had the least (Table 2). The growth environment was only significantly ($P<0.05$) different at 12 and 14 WAT with plants grown in the field having the highest mean number of leaves (Table 2).

Table 3 shows the interaction between variety and growth environment (open field and greenhouse) on mean number of leaves. With onions grown in the open field, variety Dan Zaria 1 had significantly higher mean number of leaves (7.85) while Red Creole 5 had the least (6.52). The same pattern was repeated with onions grown in the green house (Table 3).

3.4. Fresh Weight of Whole Plant (g)

The effect of variety as affected by environment on mean fresh weight of plant is presented in Table 4. Variety Dan Zaria 1 had the highest fresh weight (73.44g), which was significantly ($P<0.05$) different from variety Red Creole 5 and Wase which were similar (Table 4). The main effect of growth environment was not significant on mean fresh weight of plant (Table 4). There was no significant ($P<0.05$) interaction of variety and growth environment on fresh weight of whole plant.

3.5. Dry Weight of Whole Plant (g)

The effect of variety as affected by environment on mean dry weight of plant is also presented in Table 4. Variety Dan Zaria 1 had the highest dry weight (8.85 g), followed by Red Creole 5 (5.79g) while Wase had the least (4.37 g) and the difference was significant ($P<0.05$). The main effect of environment was not significant on mean dry weight of plant. There was no significant ($P<0.05$) interaction of variety and growth environment on dry weight of whole plant.

3.6. Fresh Weight of Bulb (g)

The effect of variety as affected by growth environment on fresh weight of bulb is represented in Table 4. The main effect of variety was significantly ($P<0.05$) different for mean fresh weight of bulb. Variety Dan Zaria 1 had the highest fresh weight of bulb (31.37g) while variety Red Creole 5 and Wase had significantly lower fresh weight of bulb (19.29 and 20.02 g respectively). The main effect of growth environment was significant ($P<0.05$) for fresh weight of bulb. Plants in the greenhouse had the lowest fresh weight of bulb (19.99 g) while the plants in the field had the highest (27.13 g) fresh weight of bulb and the difference was significant ($P<0.05$) (Table 4). There was no significant ($P<0.05$) interaction of variety and growth environment on fresh weight of bulb.

3.7. Dry Weight of Bulb (g)

Tables 4 shows the effect of variety as affected by growth environment on mean dry weight of bulb. The main effect of variety and environment were significantly ($P<0.05$) different on mean dry weight of bulb. Variety Dan Zaria 1 had the highest dry weight of bulb (4.63 g) while variety Wase and Red Creole 5 were similar (Table 4). Plants grown in the field had significantly ($P<0.05$) higher dry weight of bulb (3.69 g) than plants grown in the greenhouse (2.71 g) (Table 4). There was no significant ($P<0.05$) interaction of variety and growth environment on dry weight of bulb.

3.8. Fresh Weight of Leaves

The effect of variety as affected by growth environment on fresh weight of leaves is represented in Table 4. The main effects of variety and growth environment were significant ($P<0.05$) with respect to mean fresh weight of

leaves. Variety Dan Zaria 1 had the highest (42.07 g), followed by variety Red Creole 5 (28.66 g) while variety Wase had the least (21.90 g) fresh weight of leaves (Table 4). Plants in the greenhouse had a significant ($P<0.05$) higher fresh weight of leaves (35.80 g) than those in the field (25.96 g) (Table 4). All interactions were significant.

Table 5 shows the interaction of variety and growth environment on mean fresh weight of leaves. With crop grown in the open field, variety Dan Zaria 1 had significantly higher fresh weight of leaves than Wase and Red Creole 5 which were similar. With crop grown in the greenhouse, variety Dan Zaria 1 resulted in highest fresh weight of leaves (44.68 g), this was followed by Red Creole 5 (36.93 g) while variety Wase was least and they were significantly different from each other (Table 5).

3.9. Dry Weight of Leaves

Table 4 shows the effect of variety as affected by growth environments on mean dry weight of leaves. The main effects of variety shows that variety Dan Zaria 1 had the highest (4.22 g) dry weight of leaves followed by variety Red Creole 5 (3.11 g) and variety Wase was least (2.08 g) (Table 4). The main effect growth environment was significant ($P<0.05$). Plants in the greenhouse had significantly higher dry weight of leaves (3.59 g) than plants grown in the field (2.68 g) (Table 4). There was no significant interaction of variety and growth environment on dry weight of leaves.

4. Discussion

All varieties used for this study performed differently for both the growth and harvest parameters. The significant differences observed between onion varieties may be as a result of their genetic variability and environmental conditions. Jilani and Ghafoor (2003) and Kimani *et al*. (1993) reported that the performance of onion cultivars depend mainly on the interaction of genetic makeup and the environment. Onion cultivars have also been found to perform differently with local variety Parachinor resulting in higher yield (Shah *et al*., 2012). This might be because onion varieties may have different morphological and biochemical characteristics that affect the biomass accumulation among different vegetative parts as reported by Jilani and Ghafoor (2003). Effect of variety on leaf length, leaf girth (neck) and number of leaves was significantly ($P<0.05$) different for all the varieties. This suggests that different varieties perform differently under the same environmental conditions (Jilani *et al*., 2009).

With all the varieties and growth environments studied, leaf length increased steadily with time from 4 weeks after transplanting (WAT) and reached the longest length at 14 WAT. Variety Dan Zaria 1 resulted in longest leaf length of 64.17 cm while plants in the green house had longest leaf length of 63.74 cm. Ibrahim (2010) observed maximum plant height at 10 weeks after transplanting and found that it is also at this age that the maximum number of leaves was recorded. Ibrahim (2010) obtained tallest plants which reached 64cm with up to 17 leaves when the crops were 2-3 weeks to harvest. Babalola and Lawal (2000) observed that plant height ranged from 24, 33, 46 and 49 cm at 4, 6, 8 and 12 weeks after transplanting. Umar *et al*. (2000) found plant height to range from 37, 44 and 49 cm at 40, 50 and 60 days after transplanting (DAT).

The number of leaves produced per plant also increased with time from 4 WAT and the highest was attained at 12 WAT and remained constant at 14 WAT. This indicates that the maximum number of leaves was at 12 WAT. Variety Dan Zaria 1 had the highest number of leaves 10.72 while Onions grown in the open field had the highest number of leaves 9.33. While Ibrahim (2010) had tallest plant 64 cm with up to 17 leaves, in this trial, variety Dan Zaria 1 had tallest plant of 64.17 cm with 10.72 mean number of leaves. Pursglove (1992) reported that approximately one new leaf is produced per week by onion plant. However, he did not give the time maximum leaf number produced in onion. Babalolo and Lawal (2000) observed the number of leaves varied from 3 to 9 at 4 and 12 WAT. Similarly, Umar *et al*. (2000) found the number of leaves were 8.3, 7.44 and 8.98 at 40, 50 and 60 DAT respectively.

Two growth environments (open field and greenhouse) were used for this study, the effects of growth environments was significantly different ($P<0.05$) for most of the parameters studied except for mean fresh weight of whole plant and mean dry weight of whole plant which were similar. Plants grown in the open field showed to be the best for mean fresh weight of bulb, dry weight of bulbs, number of leaves and leaf girth while the plants grown in the greenhouse was best for mean fresh weight of leaves, dry weight of leaves and length of leaves. From this result the best environment for onions bulb cultivation would be the open field while greenhouse grown plants will give the best results for spring onions cultivation. Abdallah (1967) found that where temperature reached 40-45^{o}C in a glass house, bulbing was retarded in 10 out of 12 cultivars, although leaves were still produced at these temperatures. This suggests high temperature as the reason for the significantly higher fresh and dry weight of leaves in onions grown in the green house.

5. Conclusion and Recommendation

In this research Variety Dan Zaria 1 showed better performance for most of the parameters. Varieties Wase and

Red Creole 5 has also shown good results. Plants in the open field showed better performance in regards to weight of bulb and total yield while plants grown in the greenhouse had lower bulb weight but higher leaf length and fresh weight of leaves. More onion varieties therefore need to be evaluated in the two growth environments to determine their growth and yield.

6. References

Abdallah, A.A.(1967). Effects of Temperature and Photoperiod on bulbing of the common onion (*Allium cepa* L.) under arid tropical conditions of the Sudan. *Experimental Agriculture* 3:137-142

Abubakar S.S., Murtala G.B, Sani I. and Jaliya M.M. (2010). Garlic production under irrigation. EXTENTION BULLETIN No. 205. *Agricultural Engineering series* no. 6

Ahmad, S., Chohan, T.Z. and Saddozai, K.N. (2008). An investigation into coat and revenue of onion production in Azad Jammu Kashmir. *Sarhad Journal of Agriculture* 24(4)737-743.

Ansari N.A. (2007). Effect of density, cultivars and sowing date on Onion sets production. *Asian journal of Plants Science* 6:1147-1150.

Babalola, L.A. and Lawal, O.L. (2000). Comparative Yield and storability of two tropical onion (Allium cepa L.) cultivars under different storage structures. Proceedings of 18th Horticultural Society of Nigeria conference, IAR/ABU, Zaria. May 28th-1st June.

Brewster J.L. (1997). Onion and Garlic ln: Wien, H.C (Ed.) *The physiology of vegetable crops*. CAB International, Wallingford, UK. pp.581-619.

Charkroborty, M. (2014). Cytological investigation and molecular characterization of selected mutant line of Onion against purple blotch using SSR marker. *A thesis*, Bangladash Agricultural University. Roll no. 13Ag GPB JJ-13M.

Coolong T.W. and Randle W.M. (2003). Temperature influences flavor intensity and quality in Granex 33 onion.. *American Journal Society of Horticultural Science* 128 (2):176-181.

Fontes, P.C.R. (1998). *Cultura da cebola*. Vicosa: UFV. 40p.

Ibrahim, N. D. (2010).Growth and Yield of Onions (Allium cepa L.) in Sokoto, Nigeria. Agriculture and Biology Journal of North America 1(4): 556-564.

Jilani, M.S. and Ghafoor, A. (2003). Screening of Local Onion Varieties for Bulb Formation. *International Journal of Agriculture and Biology*. 5(2)129-133.

Jilani, M.S., Khan, M.Q. and Rahmann, S. (2009). Planting densities effects on yield and yield components of onion (*Allium cepa* L.) *Journal of Agricultural* Research 47(4)397-404.

Khokhar, K.M., Hadley, P and Pearson, S. (2007). Effect of Cold Temperature Durations on Onion sets in Store on the Incidence of Bolting, Bulbing and Seed Yield. *Scientia Horticulturae*, 112(1):16-22.

Kimani, P.M., Kariuk,J.W., Peters, R. and Rabinowitch, H.D. (1993). Influence of the Environment on the performance of some onion cultivars in Kenya. African Crop Science Journal 1(1):15-23.

Mettananda, K.A. (2003). Effect of extended photoperiod on dry set production of big Onion (*Allium cepa* L.) *Ann. Sri. Lanka Dep. Agric.* 5(1):181-192.

Parmar, J.N., Zode, N.G., Sable, T.H., and Mohod, V.K. (2001). Evaluation of substrata and Temperature for testing germination of onion (*Allium cepa* L.) seed in laboratory. *Annals of Plant Physiology*. 15(2):126-129.

Pursglove, J.W. (1992). Tropical Crops: Monocotyledon. Revised edition. Longman Scientific and Technical, U.K. 607pp

Raj, N. and Yadav, D.S. (2005). *Advances in vegetable production*. New Delhi Research CO Book Centre. 995pp.

Ross, I.A. (2001). *Medicinal Plants of the World: Chemical constituents, Traditional and Modern Medicinal Uses*, Humana press, Totowa, volume 2, pp 1-35.

Shah, S.T., Sajid,M., Alam, R., Rab, A., Mateen, I.J., Ali, A. and Wahid, F. (2012). Comparative study of onion cultivars at Mardan, Khyber Kakhtunkhwa- Pakistan. *Sarhad Journal of Agriculture* 28(3): 399-402.

Steel, R.G.D. and Torrie, J.H. (1960). *Principle and Procedure of Statistics*. McGraw-Hill Book Company Inc. New York, 480pp.

Umar, M.S., Muoneke, C.O. and Magaji, M.D. (2000). Influence of Intra-row spacing and Mulch material on some soil physical properties, weed control, growth and Yield of irrigated onion (*Allium cepa* L.). *Journal of Agriculture and Environment* 2:81-91

Voss, R.E., Mayberry, K.S., Bradford, K., and Miller, I. (1999). Onion seed production in California. *Publication* 8008, pp 1-10.

Table 2: Main Effects of Variety as affected by Growth environment (open field and greenhouse) on mean leaf length Neck Girth and Number of leaves of onion per plant during 2016-2017 dry season in Jos.

	Age of plants (weeks after transplanting)					
	4	6	8	10	12	14
LEAF LENGTH (cm)						
Variety						
Wase	21.72[b]	31.06[b]	43.22[b]	53·43[b]	56.33[b]	56.44[b]
Red creole 5	22.14[b]	28.78[b]	40.25[b]	49.94[c]	54.39[b]	54.89[b]
Dan Zaria 1	31.92[a]	43.53[a]	54.33[a]	61.81[a]	63.83[a]	64.17[a]
LS	*	*	*	*	*	*
$LSD_{0.05}$	3.41	3.41	3.41	3.41	3.41	3.41
Growth Environment						
Open field	24.74	33.75	44.83	51.50[b]	53.11[b]	53.26[b]
Green house	25.78	35.15	47.04	58.65[a]	63.26[a]	63.74[a]
LS	NS	NS	NS	*	*	*
$LSD_{0.05}$	-	-	-	2.78	2.78	2.78
LEAF GIRTH (NECK) (cm)						
Variety						
Wase	2.59b	1.72b	2.59b	3.67b	4.00b	4.00b
Red creole 5	2.53b	1.56b	2.53b	3.50b	3.64c	3.67b
Dan Zaria 1	3.44a	2.16a	3.44a	4.72a	4.78a	4.78a
LS	*	*	*	*	*	*
$LSD_{0.05}$						
Growth Environment						
Open field	2.82	1.82	2.81	4.06	4.33a	4.3a
Green house	2.89	1.80	2.89	3.87	3.93b	3.96b
LS	NS	NS	NS	NS	*	*
$LSD_{0.05}$	-	-	-	-	0.28	0.28
NUMBER OF LEAVES						
Variety						
Wase	3.67	4.33b	5.72b	7.78b	9.28b	9.28b
Red creole 5	3.56	3.72b	5.22b	6.94c	8.56c	8.56c
Dan Zaria 1	4.17	5.39a	7.11a	9.90a	10.72a	10.72a
LS	NS	*	*	*	*	*
$LSD_{0.05}$	-	0.64	0.64	0.64	0.64	0.64
Growth Environment						
Open field	3.59	4.63	6.26	8.22	9.93a	9.93a
Green house	4.00	4.33	5.78	7.85	9.11b	9.11b
LS	NS	NS	NS	NS	*	*
$LSD_{0.05}$	-	-	-	-	0.52	0.52

Note: Pair of means that differ by more than their L S D is significantly different at 5% level of significance.

Table 3: Interaction of Variety and Growth Environment (Open Field and Green House) on Mean Leaf Length, Girth and Number of Leaves per Plant during 2016-2017 Dry Season in Jos

LEAF LENGTH		
	Growth Environment	
Variety	**Open Field**	**Greenhouse**
Wase	40.37b	47.05b
Red creole 5	41.93b	41.54c
Dan Zaria 1	48.31a	58.22a
LS	*	*
$LSD_{0.05}$	1.97	1.97
LEAF GIRTH (NECK)		
	Growth Environment	
Variety	**Open Field**	**Greenhouse**
Wase	3.21b	2.98b
Red creole 5	3.17b	2.64c
Dan Zaria 1	3.71a	4.06a
LS	*	*
$LSD_{0.05}$	0.19	0.19
NUMBER OF LEAVES		
	Growth Environment	
Variety	**Open Field**	**Greenhouse**
Wase	6.91b	6.44b
Red creole 5	6.52c	5.67c
Dan Zaria 1	7.85a	7.98a
LS	*	*
$LSD_{0.05}$	0.37	0.37

Note: Pair of means that differ by more than their L S D is significantly different at 5% level of significance.

Table 4: Effect of Variety as Affected by Growth Environment (Field and Greenhouse) on Mean Fresh Weight of Whole Plant, Dry Weight of Whole Plant, Fresh Weight of Bulb, Dry Weight of Bulb, Fresh Weight of Leaves and Dry Weight of Leaves Per Plant During the 2016-2017 Dry Season in Jos.

WHOLE PLANT		
Variety	**Fresh weight (g)**	**Dry weight (g)**
Wase	41.92b	4.37c
Red creole 5	47.95b	5.79b
Dan Zaria 1	73.44a	8.85a
LS	*	*
$LSD_{0.05}$	10.17	1.17
Environment		
Field	53.09	6.37
Green house	55.79	6.31
LS	NS	NS
$LSD_{0.05}$	-	-
BULB		
	Fresh weight(g)	**Dry weight(g)**
Variety		
Wase	20.02b	2.29b
Red creole 5	19.29b	2.68b
Dan Zaria 1	31.37a	4.63a
LS	*	*
$LSD_{0.05}$	5.89	1.01
Environment		
Field	27.13a	3.69a
Green house	19.99b	2.71b
LS	*	*
$LSD_{0.05}$	4.81	0.83

LEAVES		
	Fresh weight(g)	**Dry weight(g)**
Variety		
Wase	21.90c	2.08c
Red creole 5	28.66b	3.11b
Dan Zaria 1	42.07a	4.22a
LS	*	*
$LSD_{0.05}$	5.29	0.51
Environment		
Field	25.96b	2.68b
Green house	35.80a	3.59a
LS	*	*
$LSD_{0.05}$	4.32	0.42

Note: Pair of means that differ by more than their $LSD_{0.05}$ is significantly different at 5% level of significance.

Table 5: Interaction of variety and environment (field and greenhouse) on mean fresh weight of leaves per plant during 2016-2017 dry seasons in Jos

	Growth Environment	
Variety	**Field**	**Green house**
Wase	18.03b	25.77c
Red creole 5	20.39b	36.93b
Dan Zaria 1	39.45a	44.68a
LS	*	*
$LSD_{0.05}$	7.48	7.48

Note: Pair of means that differ by more than their $LSD_{0.05}$ is significantly different at 5% level of significance.