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Performance of Onion (*Allium Cepa* L.) Enhanced By Organic Fertilizer in a Forest Agroecology, Nigeria

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ABSTRACT
There is a growing interest in the use of organic fertilizers for vegetable production in Nigeria, it is important to determine the appropriate rate of application. Field trial was conducted in 2016 to evaluate the effects of cow dung application on growth and yield of onion (*Allium cepa* L) at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. The treatments consisted of cow dung applied at 0, 5, 10 and 20 t ha^{-1} arranged in randomized complete block design with three replicates. Data were collected on plant height, length of leaf, number of leaves, bulb length, bulb diameter and number of bulb, weight of single bulb $plant^{-1}$, total biological weight and bulb yield. The result indicated that cow dung rates significantly influenced growth of onion with tallest plant, highest number of leaves and leaf length of 53.87 cm, 6.33 and 58.94 cm respectively. The highest number of bulb (51.8), weight of single bulb (51.9 g), total biological weight (57.4 g) and bulb yield (14.5 t/ha) were obtained with 20 t/ha rate of application. Addition of cow dung can improved the fertility of the soils for onion production in the forest agroecology leading to low cost input by peasant farmers.
Keywords: Agroecology, bulb, cow dung, onion, organic manure, yields.

1. Introduction

Onion (*Allium cepa L.)* is the most important member of the *Alliaceae* family and one of the most important vegetables in the world. The crop ranks second in importance after tomatoes among the vegetables in Nigeria. Nigeria production average for five years stands at 76,489 MT accounting for about 10 % of total onion production in Africa (FAO 2018). Onions is extensively used in many culinary preparations; therefore it commands a large internal market. Onion is preferred for its flavour and pungency which is attributed to the presence of volatile oil "allyl propyl disulphide" Onion bulb is a rich source of carbohydrates, protein, vitamin C, phosphorus and calcium also possess good medicinal properties (Ramesh *et al.*, 2017). . It can be eaten raw, in salad, fried, boiled or roasted, and also used in flavouring soups, canned food products and other savoury dishes. It is used in every home virtually on daily basis (Hussaini *et al.,* 2000). The mature bulb contains some starch and appreciable quantities of sugar, protein and vitamins A, B and C. National Onion Association reported that the nutrients composition of onions was given as; moisture (89 %), sugar, (4 %), protein (1%), fiber (2 %) and fat (1 %) (Adeyeye *et al.,* 2017).

Onion can be grown on a wide range of climatic conditions, but thrives best in tropical climate with moderate rainfall (Rabinowitch, 2018). Cultivation of onion in Nigeria is limited mostly to the northern part of Nigeria because of the assumption that it will not survive or strive well in the southern part of Nigeria. Onion has been strictly limited to the dry season when disease prevalence is limited. The cultivation of onion should be possible if irrigation and manure application is done to enhance growth and yield (Rabinowitch and Currah, 2002; Falodun and Egharevba 2018). Proper fertility is important in onion production as it requires well drained, non-crusting soils, with substantial amount of nutrients particularly from organic manure which improves soil physical and chemical properties (Snyman *et al.,* 1998). Although inorganic fertilizer provides nutrient in

concentrated form for crop use, the problem of affordability and availability of inorganic fertilizer by resource-poor farmers make the use of organic manure a viable alternative.

The production and nutritional values of onion are limited due to low soil fertility among many other factors, the reduction in yields of onion like other food crops has prompted farmers to amend the soils with different organic materials in order to supply the nutrients needed to enhance growth and yield of crops (Adepetu, 1997). Several organic materials has been suggested to farmers in West Africa as soil nutrient amendment for increasing crop yield, these include cow dung, poultry dropping, pig dung and refuse composts (Olayinka, 1996; Ojeniyi, 2000). According to Yai and Radav (2004), crops grown with organic manures are not only free from harmful chemicals, they have superior nutritional quality and free from pollutants that arise from the use of inorganic fertilizer. To optimize the use of cow dung in onion production it is important to evaluate the most appropriate rate, therefore this study was conducted to compare different rates of application on the performance of onion in a forest agroecology of Nigeria.

2. Materials and Methods

2.1 Study Site

A field trial was conducted at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. Ado-Ekiti (long. 7º47'N and lat. 5º22'E) and 456 meters elevation above the sea level. It is located in the forest zone and experiences a warm sub-humid tropical climate with a distinct bimodal rainfall pattern with mean annual rainfall of 1,367 mm received in an average of 112 days between March and November, temperature range of 26-39ºc and sunshine of about 5 hours (Ayodele and Oso, 2014; Omotoso *et al.,* 2016). The soil of the study site has been classified as an Alfisols developed on basement complex rock, highly leached and with low to medium organic matter content (Fasina *et al.,* 2005). The site was previously cultivated to some arable crops such as maize, cassava, yam and melon.

2.2 Sampling and Soil analysis

Before planting, soil samples were randomly collected from the top layer (0-15 cm) of soil and bulk to form a composite. The sample was air-dried, crushed and allowed to pass through a 2mm sieve. The sample was analyzed for particle size distribution with the hydrometer method, soil pH in soil:solution ratio 1:2 in 0.01M $CaCl_2$. Organic carbon by the wet dichromate oxidation method and total N by micro-kjeldahl digestion method using the procedures described in Udo *et al.,* (2009). Available P was determined by Bray and Kurtz (1945) extraction method as described by IITA, (1979); Exchangeable bases were extracted with neutral 1M NH_4OAC at a soil solution ratio of 1:10; Sodium, Calcium and Potassium were measured by flame photometry while Magnesium was read on Atomic Absorption Spectrophotometer. The exchange acidity was extracted with 1M KCl and titrated against 0.05M NaOH to a pink end point using phenolphthalein as indicator (McLean, 1982). The total N, P and K contents of PM and POME was determined following the methods described in IITA (1982).

2.3 Experimental Design, Treatment and Planting

The experiment was laid out in a randomized complete block design with three replications. Treatments consisted of: 0, 5, 10, 20 t/ha Cow dung. The manure was well rotted cow dung manure that had stabilized for about 100 days. The seeds of onion 'red creole' were planted in a nursery bed 2 x 2m and the plant was allowed to grow up till about 30 cm before transplanting. The sprouted seeds (3-4 in number) of onion were sown directly in the raised seedbed of about 20cm height. Seedlings were uprooted from the nursery seedbeds and transplanted in the main field with a spacing of 10 × 15 cm consisting of four rows on each bed. Each plot size was 3 x 2m and separated by 0.5m paths while treatment blocks were 1m apart. Cow dung manure was applied 2 week before planting and weeding was done manually by hand. Insect and diseases were controlled with appropriate control measures.

2.4. Data Collection and Analysis

The growth parameter taken were plant height (cm), length of leaf (cm) and number of leaves per plant from the selected five plants in each plot. The height was taken from the neck of the bulb to the tip of the longest leaf and the length of leaf was measured from pseudo stem to the tip of the leaf and the number of leaves per plant was counted visually while yield and yield components measured are; bulb diameter per plant (cm), bulb length per plant (cm), number of bulbs per plot, single weight of bulb, total biological weight and bulb yield (t/ha).

All data collected were subjected to analysis of variance (ANOVA) and mean were separated using Duncan's multiple range test (DMRT) at 5% level of probability.

3. Results and Discussion

The results of the analyses of soil and cow dung manure used are presented in Table 1. The content 710 $g.kg^{-1}$, 247 $g.kg^{-1}$, and 43 $g.kg^{-1}$of sand silt and clay respectively classifies the soil as loamy sand, slightly acidic (pH 6.4) with low organic carbon (10.4 g/kg) content, exchangeable cations while total N and available P content were 1.36 g kg^{-1} and 6.85 mg kg^{-1}. The total N and available P are very low compared with the critical levels of 1.0 $g.kg^{-1}$ N and 10-12 mg kg^{-1} available P established as the critical available P for soils in South-West, Nigeria (Adeoye and Agboola, 1985; Adepetu, 2014). Using the critical levels of 0.16-0.20 cmol kg exchangeable K was also low (Akinrinde and Obigbesan, 2000).

The exchange acidity and effective cation exchange capacity were 0.04 and 3.73 $cmol.kg^{-1}$ respectively. The chemical analysis of cow dung manure used is shown in Table 2. Cow dung has pH of 7.3 which is slightly alkaline and contained and 8.5, 3.30 and 2.11 g/kg total N, P and K values of respectively.

The effects of organic manure on onion plant height are indicated in Table 3. The Onion increased in height with age and those plants that received higher rate were tallest throughout the periods of measurement. Plant height was not significantly different at 4WAT between control and 5 t/ha and 10 and 20 t/ha application. This observation was similar for all the period of observation. The tallest plant from 20 t/ha at 8WAT represented 26.4 % increase in plant height relative to control. Xu *et al.,* (2003) had reported that vegetables grown with higher rates of organic manure gave a better performance in plant height and final total yield. Similar results were also reported by Gudugi *et al.,* (2013) that application of 20 t/ha cow dung gave a better performance in okra in term of growth parameters and yield. The work of Amara *et al.,* (2016) also reported that the application

of organic fertilizer significantly enhanced growth, development and yield of potato in terms of leaf area and tuber yield, this was attributed to nitrogen availability which promoted vegetative growth during plant development and help maintain functional leaf area during the vegetative phase.

Table 1: Physical and Chemical composition of the soil used.

Soil characteristics	Soil value
Chemical properties	
pH (H_2O)	6.41
Organic carbon (g/kg)	10.4
Total N (g/kg)	1.36
Available P (mg/kg)	6.85
Exchangeable bases(cmol/kg)	
Ca	2.36
Mg	1.19
K	0.11
Na	0.03
Exchangeable acidity	0.04
ECEC	3.73
Base saturation (%)	98.9
Physical properties (g/kg)	
Sand	710
Silt	247
Clay	43
Textural class	Loamy Sand

Table 2: Chemical composition of cow dung manure used.

Chemical properties		Values
pH (H_2O)		7.3
Organic carbon (g/kg)		13.4
Total N (g/kg)		2.50
Total P	(mg/kg)	3.30
Ca	,,	1.36
Mg	,,	0.92
K	,,	2.11
Na	,,	0.03

The leaf length increased with age of onion and application of organic manure rates at all sampling periods (Table 4). There was no significant difference among the rates of application except at 7 and 8WAT. At 8WAT, application of 20 t/ha gave the highest leaf length (58.9 cm) which accounted for 26.9, 28.3 and 42.2 % increases over the lower rates of applications and control respectively. However, the leaf length was not significantly different between 5 and 10t/ha while the lowest (41.5 cm) was at the control plots.

The numbers of leaves are shown in Table 5. The number of leaves was highest with application of 20 t/ha at all sampling periods whilst the least was obtained in control. At 4WAT number of leaves observed in 10 t/ha was statistically at par with 5 t/ha. The number of leaves increased up to 7WAT and thereafter decreased at 8WAT. This might probably be due to the maturity exhibited by the plant. This is similar to the findings of Khan *et al.,* (2002) that number of leaves per plant was higher in plots treated with cow dung up to a period and thereafter

declined as reported by Bashir *et al.,* (2015). Also, a similar response has been observed by Amos *et al.,* (2015). Tindall (1992) had observed that application of manure gave luxuriant vegetative growth of crops and stressed the importance of nutrient during vegetative growing period which would reflect in the parameters such as number of leaves, leaf area and plant height produced.

Table 3: Effects of cow dung manure on plant height (cm) of onion

	Weeks After Transplanting				
Cow Dung Rate (ton/ha)	**4**	**5**	**6**	**7**	**8**
0	34.40b	39.50bc	43.10b	47.46b	50.55b
5	40.53b	34.09c	40.47b	42.56b	45.50b
10	59.90a	52.44ba	50.79ba	52.88ba	55.54ba
20	60.26a	59.69a	59.62a	60.02a	63.88a
Mean	48.77	46.43	48.50	50.73	53.87
CV (%)	3.86	4.31	4.40	4.82	6.20

Means with the same letter(s) are not significantly different at 5% level of probability by DMRT.

Table 4: Effects of cow dung manure on leaf length (cm) of onion

	Weeks After Transplanting				
Cow Dung Rate (ton/ha)	**4**	**5**	**6**	**7**	**8**
0	30.40c	33.47bc	36.67b	37.71c	41.46c
5	34.33b	35.98bc	37.20b	40.90b	45.93b
10	35.92b	39.12bc	42.16ba	43.45ba	46.44b
20	52.23a	50.90a	51.19a	51.32a	58.94a
Mean	41.13	42.05	41.81	43.35	48.19
CV (%)	2.18	2.43	2.26	3.64	4.02

Means with the same letter(s) are not significantly different at 5% level of probability by DMRT.

Table 5: Effects of cow dung manure on number of leaves of onion

	Weeks After Transplanting				
Cow Dung Rate (ton/ha)	**4**	**5**	**6**	**7**	**8**
0	4.00c	5.33a	5.40b	6.33a	4.17c
5	4.33c	5.67a	5.90b	6.67b	4.25b
10	6.44a	6.78a	7.11a	7.78a	6.60a
20	6.67ba	7.11a	7.38a	7.56a	6.33a
Mean	5.61	6.22	6.50	6.84	6.23
CV (5%)	3.92	5.26	4.68	2.96	2.89

Means with the same letter(s) are not significantly different at 5% level of probability by DMRT.

The effects of cow dung manure on yield and yield components are shown in Table 6. Application of 20 t/ha gave the highest bulb length (5.81cm) which accounted for 26, 44.2 and 87.4 % increases over 10, 5 t/ha and control respectively. There was no significant ($p>0.05$) difference between plants that received 5 and 10 t/ha in bulb length and bulb diameter. However, the bulb diameter (5.29 cm) was highest in onion plant treated with 20 t/ha application followed by 10 t/ha (4.14 cm) and 5 t/ha (3.30 cm) while control significantly gave the least bulb diameter (2.48cm) respectively. The reason for high bulb length and diameter may be due to more photosynthetic activities of the plant on account of adequate supply of N from higher rate of manure. Akhtar and

Silva (1999) had reported a significant increase in cob diameter and cob length of maize with increasing rates of nitrogen from different sources.

The effect of cow dung on number of bulb, weight of single bulb, total biological weight and bulb yield was significant and 20 t/ha application gave the highest values of 51.8, 51.9 g.plant^{-1}, 57.4 g.plant^{-1} and 14.5 t/ha which is 30.7, 65.7, 83.2, and 73.3 % more than control. The increase in biological yield and bulb yield reflects a better growth and development of the plants and probably due to balanced and more availability of nutrients for the plant during the growing period. This is also reported by Ibeawuchi *et al*., (2007), Khan *et al.,* (2008) and Amos *et al.,* (2015).

Table 6: Effects of cow dung manure on bulb yield and yield components of onion

	Yield Components					
Cow Dung Rate (ton/ha)	**Bulb length (cm)**	**Bulb diameter (cm)**	**Number of bulb**	**Weight of Single bulb (g)**	**Total biological weight (g)**	**Bulb Yield (t/ha)**
0	3.10c	2.48c	39.60d	14.20d	31.33c	8.36d
5	4.03b	3.30b	44.41c	26.12c	33.28c	10.64c
10	4.61b	4.14b	48.60b	48.24b	49.67b	12.38b
20	5.81a	5.29a	51.75a	51.93a	57.39a	14.49a
Mean	4.71	3.80	46.09	35.12	42.92	11.47
CV (%)	2.84	2.62	3.40	2.32	3.46	4.16

Means with the same letter(s) in each column are not significantly different at 5% level of probability by DMRT.

4. Conclusion

This study demonstrated the importance and potentials of cow dung manure in enhancing the growth and development of onion compared with the untreated plots. The tallest plant, highest number of leaves and leaf length were obtained with application of 20 t/ha manure. Yield and yield components of onion were also significantly enhanced. Application of 20 t/ha significantly gave the highest number of bulb, weight of single bulb, total biological weight and bulb yield. Addition of cow dung can improve the fertility of the soils in the forest agro-ecology for onion productions thereby ameliorate the cost of production to farmers.

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