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Original Article

Influence of Poultry Manure Rates and Spacing on Growth, Yield, Nutrient Concentration, Uptake and Proximate Composition of Onion (*Allium cepa* L.)

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Abstract

Plant spacing determines to a greater extent crop performance in terms of growth and yield. The production of crop with organic fertilizer also plays a vital role in organic agriculture. Field studies were conducted to evaluate the effects of spacing and poultry manure on the growth, yield and quality of onion. Three spacing regimes were carried out consisting of 15 cm × 15 cm, 20 cm × 20 cm and 25 cm × 25 cm and four levels of poultry manure at 0, 5, 10 and 15 t /ha. The effects of spacing and poultry manure were evaluated for two years based on plant growth, yield, nutrient concentration, uptake and proximate composition of onion plant. Leaf thickness, bulb and shoot fresh weights were significantly increased by the wider spacing of 20 cm × 20 cm and 25 cm × 25 cm, compared with the narrower spacing of 15 cm × 15 cm in both seasons. However, the highest total dry yield (1.82 and 1.58) t/ha, shoot yield (2.31 and 1.32) t/ha and total fresh yield (13.69 and 12.55) t/ha were obtained with the spacing of 20 cm × 20 cm in both years. Similarly, application of poultry manure increased leaf thickness, bulb and shoot fresh weights and yields compared with the control. Generally, using 10 t/ha poultry manure has a superior effect on proximate composition and most of growth parameters and yield components achieved the highest nutrient concentrations and uptake on most of the macro and micronutrients in leaves and bulbs as compared with the control in both years.

Keywords: bulb; control; leaf thickness; shoot; quality

Introduction

Worldwide, onion (*Allium cepa* L.) is a vegetable crop of commercial importance and has been the most used flavouring vegetable for centuries. According to Hussaini *et al.* (2000), the crop ranks second in importance after tomatoes among the vegetables in Nigeria. Aliyu *et al.* (2008) documented that it is grown mainly for its bulbs, which are used almost daily in every home in Nigeria. It is ranked among the top 5% of most important vegetables in Nigeria based on level of consumption and other uses (NIHORT, 1986). Plant spacing and manure application are important agronomic factors which can cause substantial increase or decrease in yield of most crops hence, appropriate plant spacing is vital for the interception of enough sunlight necessary for optimum photosynthesis (Aliyu *et al.*, 2008). Proper spacing ensures optimum plant growth through adequate utilization of moisture, light and nutrients. Baloch *et al.* (2001) observed that increasing plant spacing increased the nutrient area per plant and this led to increase in morphological characters. Mortley *et al.* (1992) noted that stem diameter increased linearly as spacing between plants increased and that fresh weight yields are highest at closer within-row spacing. Pandey *et al.* (1996) observed the highest plant height in narrow spacing in tomato hybrids, while wider spacing had the highest number of primary branches per plant. They attributed the higher plant height recorded in narrow spacing to greater competition for space and light and thereby forcing the plants to grow taller. In many developing countries, farmers have limited financial resources and can rarely afford to purchase sufficient mineral fertilizers at the same time. The problem of affordability and procurement of chemical fertilizers by resource-poor farmers make the use of poultry manures a viable alternative (Chen and Hammond, 1988). William *et al.* (1991) recommended organic manure application to cabbage production in the tropics based on the fact that organic manure improves soil water availability through retention, aeration and better response of crops to

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soil amendment materials. Organic manure alone or in combination with mineral fertilizer exerts more beneficial effect on fruit yield when compared to fertilizer applied alone (Ehigiator, 1998). Similarly, according to Adekiya and Agbede (2009) all levels of poultry manure alone and NPK fertilizer + poultry manure increased leaf N, P, K, Ca and Mg amounts significantly, the concentration of nutrients increased with the amount of poultry manure up to 40 t ha NPK fertilizer + poultry manure gave higher leaf N, P and K contents than poultry manure alone. According to Aisha *et al*. (2007), crops cultivated with organic manures are not only free from harmful chemicals, they are also safer, healthier and tastier. Apart from supplying plant nutrients, Akinfasoye and Akanbi (2005) also justified that they improve soil physical and microbial properties and eliminate pollution of underground water. Onions are more susceptible than other crops in extracting nutrients, especially the immobile types such as Ca, Mn, Fe and Zn, because of their shallow and unbranched root system; hence they require and often respond well to addition of fertilizers (Brewester, 1994). Onion is a heavy feeder, requiring ample supplies of nutrients. The use of organic manure and compost has been shown to improve the soil organic matter content and crop yield (Soumare *et al*., 2003). The mineral composition of crops depends on the amount and type of nutrients taken from the growth medium, and it is necessary that adequate amount of nutrients should be available for the production and nutrient content of crops (Barker *et al*., 2006). The organic manure is very important in improving soil productivity and its function is performed through the improvement of the physical condition of the soil structure (Lombin *et al*., 1991). Adenawoola and Adejoro (2005) also found out that organic matter and soil nutrients increased with application rate of poultry manure and therefore affirmed that poultry manure contains organic matter, N, P, K, Ca and Mg which are released into the soil upon decomposition of the manure, and that depletion of soil organic matter under intensive cropping can be amended by proper addition of poultry manure into the soil.

In this light, the present study was carried out to determine the effect of spacing and poultry manure on the growth, yield, nutrient concentration and uptake of onion plant.

Materials and Methods

Soil properties

The study was carried out in the 2011/2012 and 2012/2013 dry seasons at the Teaching and Research Farm of the University of Benin, Ugbowo Campus, Benin-City, in Edo State, Nigeria. The climate was tropical and the vegetation was lowland rainforest in the south (with mean annual rainfall of 2300 mm) to guinea savanna in Edo North with 1,400 mm mean rainfall. Prior to analysis, the soil samples were air dried and crushed to pass through a 2 mm sieve. Soil pH was determined using a pH meter. Organic carbon was determined by Walkley and Black (1962) wet oxidation method as modified by Jackson (1969). Total nitrogen was obtained by macro Kjeldahl methods as modified by Jackson (1969). Available P was extracted by Bray I method (Bray and Kurtz, 1945) and the P was estimated by the blue colour method of Murphy and Riley (1962).

Exchangeable K and Na were determined using flame photometer, and Ca and Mg using the Atomic Absorption Spectrophotometer (Table 1).

The study design

The experiment was conducted as a randomized complete block design (RCBD) with three replications. The treatments were composed of a factorial combinations of four rates (0, 5, 10 and 15 t/ha poultry manure) and three spacing 15 × 20, 20 × 20 and 25 × 25 cm. Each replicate had 12 plots giving a total of 36 plots in this experiment.

The onion seeds of 'Kano red', a local cultivar, were sown in the nursery and transplanted to the field when seedlings were seven weeks after sowing and at about 14 cm tall. Plots were mulched to conserve soil moisture and suppress weeds. Data collection started four weeks after transplanting. Four plants were randomly selected from each plot and tagged for the purpose of collecting data for leaf length, individual bulb and shoot weight, leaf thickness, harvest index, bulb yield and total fresh yield per hectare.

Determination of nutrient concentration and uptake of onion bulbs

At 101 DAT (at harvest) bulbs were harvested, cleaned of soil particles and weighed with a sensitive balance. The bulbs were chopped into small bits and oven dried in a forced-Air Sanyo Gallen kamp moisture extraction oven at 70 °C to a constant weight (ISTA, 1993). The dried samples were there after weighed using a sensitive electronic balance and the weight recorded. These were milled to pass through 0.2 mm sieve using Thomas Wiley Hammer Mill in preparation for laboratory analysis. Calcium (Ca), Sodium (Na) and Magnesium (Mg) along with N, P and K were determined following standard laboratory procedures. The analytical procedures for the nutrients were as described by AOAC (1990). Nitrogen, P, K, Ca, Na and Mg uptake were derived from multiplying the oven dry weight of the tissue with the corresponding value of the nutrient in the tissue.

Table 1. Physical and chemical properties of poultry manure and soil of the experimental site pre plant and post-harvest

Soil properties	Poultry manure	Experimental soil	
		Pre	Post
pH (H_2O)	6.40	4.80	5.26
Organic carbon (g $100g^{-1}$)	23.00	0.40	0.73
Total N ($g100g^{-1}$)	2.13	0.05	0.03
Total P (mg kg^{-1})	4.30	18.9	14.7
K (cmol kg^{-1})	1.12	0.19	0.12
Ca (cmol kg^{-1})	3.76	1.15	0.81
Mg (cmol kg^{-1})	N/A	0.74	0.56
Mn (cmol kg^{-1})	1.14	N/A	N/A
Zn (cmol kg^{-1})	0.13	N/A	N/A
Fe (cmol kg^{-1})	3.27	N/A	N/A
Sand (g kg^{-1})	N/A	752.1	756.0
Clay (g kg^{-1})	N/A	198.0	163.4
Silt (g kg^{-1})	N/A	46.0	48.2
Textural class	N/A	Sandy loam	

N/A - Not available

Statistical analysis

The data obtained were subjected to statistical analysis of variance (ANOVA) using SAS following the model for factorial experiment in a randomized complete block design and means separated by Duncan Multiple Range Test (DMRT).

Results

In both years, the effect of spacing and poultry manure on crop growth rate and leaf thickness of onion was significant. Wider spacing of 20 cm × 20 cm and 25 cm × 25 cm significantly increased crop growth rate and leaf thickness above the narrower spacing of 15 cm × 20 cm. However, the effect of spacing on harvest intervals in both years was not significant. The shoot fresh weight per plant increased with increase in spacing with the highest shoot fresh weight produced at 25 cm × 25 cm spacing in both years. Similarly, the effect of poultry manure was significant for all the parameters measured except for harvest interval in 2010 cropping season which was not significant. In all cases plants treated with either 10 or 15 t ha^{-1} poultry manure produced similar results and these were significantly increased above the other treatments (Table 2). The application of poultry manure increased crop growth rate and leaf thickness up to 10 t/ha and a further increase in application rate did not result in a significant increase in these parameters. However, shoot fresh weight per plant increased with increase in application rate up to 15 t ha^{-1}. The effect of spacing on bulb fresh weight per plant was not significant in 2010/2011 cropping season however, in 2011/2012 it was significant, narrower spacing of 15 cm × 20 cm significantly produced lower bulb weight than wider spacing of 25 cm × 25 cm. In contrast to the bulb weight per plant, the highest shoot fresh yield and total dry yield was obtained at the narrower spacing of either 15 cm × 20 cm or 20 cm × 20 cm. The effect of manure application was significant on shoot fresh, dry and total dry yield and these increased with increase in manure application up to 10 t ha^{-1} with the control producing the lowest yield for these parameters (Table 3). The nutrient concentration of K in onion leaves increased with increase in spacing however not significant in onion bulbs. The effect of poultry manure was significant in the concentration of N and K in both leaves and bulbs and significantly increased with increase in manure rates. However, there was no significant response in P content to increase in manure rates. The control significantly had the lowest concentrations of these nutrients (Tables 4 and 5).

The uptake of N, K, Ca and Mg decreased with increase in spacing in onion leaves and bulbs and then increased as the manure rates increased from 0 t ha^{-1} to 10 t ha^{-1}. Nutrient concentration and uptake of P was not significant for both spacing and poultry manure application rates on onion leaves and bulbs. The effect of spacing on the proximate composition of onion leaves and bulbs were not significant however, the effect of manure application was significant for moisture content, ash and percentage dry matter content of onion leaves. The moisture content increased with increase in manure rates up to 10 t ha^{-1} while the ash content increased up to 5 t ha^{-1}. There was an inverse relationship observed with the percentage dry matter content of onion leaves and bulbs when compared with the percentage moisture content (Tables 8 and 9). The percentage of dry matter content decreased with increase in manure application rate lower application rates of 0 tha^{-1} and 5 t ha^{-1} produced significantly higher percentage of dry matter content above the higher application rate of 15 t ha^{-1}, while the percentage moisture content increased with increase in manure application from 0-15 t ha^{-1}(Tables 8 and 9).

Table 2. Effect of spacing and poultry manure on crop growth rate (CGR) $gm^{-2}wk^{-1}$, leaf thickness (cm), harvest index and shoot fresh wt/plant (g) of onion 2010/2011 and 2011/2012 dry cropping seasons

Treatment	2010/2011 Cropping season				2011/2012 Cropping season			
	(CGR) ($gm^2 wk^{-1}$)	Leaf thickness (cm)	Harvest Index	Shoot fresh wt/plant (g)	(CGR) ($gm^{-2}wk^{-1}$)	Leaf thickness (cm)	Harvest Index	Shoot fresh wt/plant (g)
Spacing (cm)								
15×20	0.39^{b}	0.09^{b}	0.65^{b}	6.89^{b}	0.37^{b}	0.07^{b}	0.87^{a}	3.95^{b}
20×20	0.42^{ab}	0.13^{a}	0.66^{ab}	7.04^{b}	0.39^{a}	0.11^{a}	0.88^{a}	5.31^{a}
25×25	0.43^{a}	0.14^{a}	0.69^{a}	9.25^{a}	0.40^{a}	0.12^{a}	0.88^{a}	5.65^{a}
SEM	0.01	0.01	0.03	1.22	0.01	0.01	0.04	1.10
Poultry manure ($t\ ha^{-1}$)								
0	0.32^{b}	0.03^{c}	0.59^{b}	5.25^{b}	0.19^{c}	0.02^{b}	0.84^{a}	2.48^{d}
5	0.34^{b}	0.13^{ab}	0.67^{ab}	6.37^{ab}	0.30^{b}	0.12^{a}	0.86^{a}	4.75^{c}
10	0.42^{a}	0.14^{a}	0.72^{a}	8.72^{ab}	0.40^{a}	0.13^{a}	0.88^{a}	5.30^{b}
15	0.43^{a}	0.16^{a}	0.72^{a}	10.36^{a}	0.42^{a}	0.13^{a}	0.91^{a}	7.37^{a}
SEM	0.02	0.03	0.10	1.67	0.03	0.02	0.12	0.13

Means followed by the same letter in a column are not significantly different at 5% level of probability using DMRT.

Table 3. Effect of poultry manure and spacing on yield and yield components of onion 2010/2011 and 2011/2012 dry cropping seasons

Treatment	2010/2011 Cropping season				2011/2012 Cropping season			
	Bulb fresh wt/bulb (g)	Shoot fresh yield ($t\ ha^{-1}$)	Total fresh yield ($t\ ha^{-1}$)	Total dry yield ($t\ ha^{-1}$)	Bulb fresh wt/bulb (g)	Shoot fresh yield ($t\ ha^{-1}$)	Total fresh yield ($t\ ha^{-1}$)	Total dry yield ($t\ ha^{-1}$)
Spacing (cm)								
15×20	28.21	2.27^{a}	13.58^{a}	1.82^{a}	27.26^{b}	1.29^{b}	12.28^{a}	1.58^{a}
20×20	34.92	2.31^{a}	13.69^{a}	1.86^{a}	37.50^{ab}	1.32^{a}	12.69^{a}	1.62^{a}
25×25	39.87	1.13^{b}	9.76^{b}	0.94	40.45^{a}	0.90^{c}	9.17^{b}	0.91^{b}
SEM	10.02	0.23	1.04	0.12	10.24	0.04	1.02	0.20
Poultry manure (tha^{-1})								
0	16.82^{c}	1.31^{b}	6.47^{c}	0.68^{c}	15.12^{c}	0.58^{d}	5.71^{c}	0.53^{c}
5	30.32^{b}	1.58^{b}	10.03^{b}	1.34^{b}	28.04^{b}	0.97^{c}	9.17^{b}	1.05^{b}
10	42.78^{a}	2.16^{ab}	14.01^{a}	1.89^{a}	42.39^{a}	1.27^{b}	13.04^{a}	1.76^{a}
15	45.42^{a}	2.56^{a}	15.34^{a}	2.27^{a}	44.63^{a}	1.74^{a}	14.39^{a}	1.98^{a}
SEM	10.02	0.25	1.07	0.15	10.24	0.05	1.08	0.22

Means followed by the same letter in a column are not significantly different at 5% level of probability using DMRT.

Table 4. Effect of poultry manure and spacing on nutrient concentration of onion leaves

Spacing (cm)	Nutrient concentration				
	N $g\ kg^{-1}$	P $g\ kg^{-1}$	K $g\ kg^{-1}$	Ca $g\ kg^{-1}$	Mg $g\ kg^{-1}$
15×20	0.51	0.02	0.48^{b}	0.10	0.05
20×20	0.52	0.02	0.51^{a}	0.12	0.05
25×25	0.53	0.03	0.51^{a}	0.12	0.06
Significance	N.S	N.S	*	N.S	N.S
SEM	0.02	0.01	0.02	0.02	0.01
Poultry manure ($t\ ha^{-1}$)					
0	0.46^{c}	0.01	0.30^{b}	0.08	0.05
5	0.50^{b}	0.01	0.50^{a}	0.10	0.06
10	0.54^{a}	0.02	0.52^{a}	0.12	0.07
15	0.56^{a}	0.02	0.52^{a}	0.12	0.07
Significance	*	N.S	*	N.S	N.S
SEM	0.02	0.01	0.02	0.02	0.03
P*S	N.S	N.S	N.S	N.S	N.S

Means followed by the same letter in a column are not significantly different at 5% level of probability.
* Significant at 5% level of probability.

Table 5. Effect of poultry manure and spacing on nutrient concentration of onion bulbs

Spacing (cm)	Nutrient concentration				
	N $g\ kg^{-1}$	P $g\ kg^{-1}$	K $g\ kg^{-1}$	Ca $g\ kg^{-1}$	Mg $g\ kg^{-1}$
15×20	0.50	0.04	0.48	0.11	0.04
20×20	0.52	0.05	0.48	0.12	0.05
25×25	0.52	0.05	0.50	0.12	0.05
Significance	N.S	N.S	N.S	N.S	N.S
SEM	0.02	0.01	0.02	0.02	0.02
Poultry manure ($t\ ha^{-1}$)					
0	0.43^{c}	0.02	0.40^{b}	0.09^{b}	0.04
5	0.47^{b}	0.05	0.42^{b}	0.10^{ab}	0.05
10	0.50^{a}	0.05	0.48^{a}	0.12^{a}	0.05
15	0.52^{a}	0.05	0.50^{a}	0.12^{a}	0.06
Significance	*	N.S	*	*	N.S
SEM	0.02	0.01	0.02	0.02	0.02
P*S	N.S	N.S	N.S	N.S	N.S

Means followed by the same letter in a column are not significantly different at 5% level of probability.
* Significant at 5% level of probability.

Table 6. Effect of poultry manure and spacing on nutrient uptake of onion leaves

Spacing (cm)	Nutrient uptake (kg ha^{-1})				
	N	P	K	Ca	Mg
15×20	36.68^{a}	1.36	34.49^{a}	6.49^{a}	3.55^{ab}
20×20	43.42^{a}	1.38	37.14^{a}	6.57^{a}	3.64^{a}
25×25	22.17^{b}	1.15	20.18^{b}	5.82^{b}	3.50^{b}
Significance	*	N.S	*	*	*
SEM	8.40	0.42	4.10	0.12	0.10
Poultry manure (tha^{-1})					
0	20.36^{c}	1.42	18.42^{b}	4.12^{c}	1.55^{c}
5	28.21^{b}	1.45	22.14^{b}	5.14^{b}	2.67^{b}
10	40.32^{a}	1.48	35.47^{a}	6.68^{a}	3.42^{a}
15	40.16^{a}	1.57	37.16^{a}	6.72^{a}	3.45^{a}
Significance	*	N.S	*	*	*
SEM	7.40	0.42	4.10	0.12	0.10
P*S	N.S	N.S	N.S	N.S	N.S

Means followed by the same letter in a column are not significantly different at 5% level of probability. * Significant at 5% level of probability.

Table 7. Effect of poultry manure and spacing on nutrient uptake of onion bulb

20×20	85.48^{a}	7.25	81.24^{a}	18.19	6.78
25×25	68.16^{b}	6.17	60.31^{b}	15.22	5.40
Significance	*	N.S	*	N.S	N.S
SEM	12.10	1.20	10.15	3.48	2.10
Poultry manure (kgha^{-1})					
0	48.77^{c}	5.10	42.14^{c}	10.12^{b}	5.15
5	74.63^{b}	5.13	65.69^{b}	16.21^{a}	5.18
10	92.42^{a}	6.39	84.15^{a}	17.10^{a}	6.94
15	98.69^{a}	6.27	87.43^{a}	18.17^{a}	7.17
Significance	*	N.S	*	*	N.S
SEM	12.10	1.28	10.15	3.48	2.10
Interaction					
F*S	N.S	N.S	N.S	N.S	N.S

Means followed by the same letter in a column are not significantly different at 5% level of probability.
* Significant at 5% level of probability.

Table 8. Effect of poultry manure rates and spacing on the proximate composition of onion leaves

	Moisture content (%)	Ash (%)	Protein (%)	Crude fibre (%)	Dry matter (%)
Spacing (cm) 15×20	87.62^{a}	1.16^{a}	3.44^{a}	1.16^{a}	12.38^{a}
20×20	87.61^{a}	1.21^{a}	3.47^{a}	1.18^{a}	12.39^{a}
25×25	87.57^{a}	1.23^{a}	3.48^{a}	1.19^{a}	12.43^{a}
SEM	0.24	0.04	0.03	0.03	0.23
Poultry manure (t ha^{-1})					
0	87.28^{b}	1.06^{a}	3.42^{a}	1.01^{c}	12.72^{a}
5	87.21^{b}	1.16^{a}	3.44^{a}	1.12^{b}	12.79^{a}
10	87.65^{ab}	1.18^{a}	3.47^{a}	1.18^{a}	12.35^{ab}
15	88.32^{a}	1.23^{a}	3.48^{a}	1.19^{a}	11.88^{b}
SEM	0.30	0.05	0.07	0.05	0.27

Means followed by the same letter in a column are not significantly different at 5% level of probability using DMRT.

Table 9. Effect of poultry manure rates and spacing on the proximate composition of onion bulbs

	Moisture content (%)	Ash (%)	Protein (%)	Crude fibre (%)	Crude fat (%)	Dry matter (%)
Spacing (cm) 15×20	87.67^{a}	1.56^{a}	3.28^{a}	1.18^{a}	0.80^{a}	12.33^{a}
20×20	87.56^{a}	1.63^{a}	3.33^{a}	1.15^{a}	0.82^{a}	12.44^{a}
25×25	87.71^{a}	1.65^{a}	3.38^{a}	1.21^{a}	0.82^{a}	12.29^{a}
SEM	0.23	0.12	0.19	0.04	0.05	0.27
Poultry manure (t ha^{-1})						
0	85.35^{b}	1.49^{a}	3.12^{b}	0.94^{b}	0.80^{a}	14.65^{a}
5	85.32^{b}	1.54^{a}	3.15^{b}	1.15^{a}	0.82^{a}	14.68^{a}
10	86.71^{a}	1.61^{a}	3.36^{a}	1.18^{a}	0.85^{a}	13.29^{b}
15	86.95^{a}	1.63^{a}	3.39^{a}	1.21^{a}	0.85^{a}	13.05^{b}
SEM	0.29	0.18	0.20	0.12	0.06	0.32

Means followed by the same letter in a column are not significantly different at 5% level of probability using DMRT.

Discussion

The significant increase in crop growth rate, leaf thickness and harvest index as observed with the wider spacing of 25 cm × 25 cm when compared with the narrower spacing of 15 cm × 20 cm could be due to the fact that the plants in that environment had less competition for nutrient and other growth resources as opposed to the closer spacing of 15 cm × 20 cm which resulted in competition for growth resources. The present results are supported by the findings of Maurya *et al.* (2013) who recorded maximum values at the widely spaced plant and minimum values in the narrowly spaced plants. This also corroborates the findings of Arisha *et al.* (2003) that wider spacing enhances vegetative growth of plants through the development of more thick leaves thereby enhancing these parameters. The superiority expressed by the wider spacing over the closely spaced was in accordance with the findings of Colla *et al.* (2002) on onion. In addition Jeyathilake *et al.* (2006) confirmed that closer spacing results in the growth of less vigorous plant when compared with wider spacing. The results of onion spacing experiment reported by Khan *et al.* (2002) showed that not only were the leaves of onion more from wider spacing but they had thicker and larger leaves. This was probably accounted for by a relatively reduced competition among plants per unit area for available soil nutrients in the lower density plots than the higher density ones.

The highest values recorded for all the vegetative and reproductive characters were obtained from 10 and 15 t ha^{-1} rate of the poultry manure throughout the period of study and this could be due to high rate of nutrient released from the manure. One of the methods through which plants would display its potential genetic capacity is by supplying the plants with adequate amount and types of fertilizer at the right time (Olaniyi, 2006). This positive response to increase in the level of manure application could probably be linked to the fact that onion plants have superficial root system that is rarely branched and lack root hair which has resulted in its high demand for nutrients. The main factor responsible for the increase in measured parameters as a result of increase in manure application could be due to increase availability of total assimilates for distribution to the bulb and shoot and in addition dry matter increased. The lowest values recorded from the control suggests that tropical soils are low in inherent plant nutrients which are required for plant growth and high yield, and thus necessitate the need to supplement the amount of nutrient in the soil to meet crop requirements Khushk *et al*. (1992). These results confirmed the report of Awodun (2007) that there is a significant influence on the growth and yield of Telfaria by application of fertilizers. This result is also in consonance with the findings of Aliyu and Kuchinda (2002) who stated that nitrogen which is a constituent of organic manure enhances physiological activities in crops; thereby improving the synthesis of photo-assimilates and a general increase in vegetative growth of plants. In contrast to growth parameters, significantly highest shoot and total dry and fresh yield was recorded with 20 cm × 20 cm and 15 cm × 20 cm and the least yield recorded for the widest spacing of 25 cm × 25 cm, this result could be attributed to greater crop biomass found with the narrower spacing as supported by Tijani-Eniola *et al.* (2003). The nutrient uptake was highest with 20 cm × 20 cm plant spacing followed by 15 cm × 20 cm and then 25 cm × 25 cm spacing for all the treatments. This probably indicated that plants at this spacing might have experienced better soil conditions to enable them absorb these nutrients effectively, this result could also be attributed to the previous report of Tijani-Eniola *et al.* (2003). Wider spacing reduced yield due to total reduction in plants per hectare and consequently spacing may not be fully utilized. These results are evidently in accordance with that of Tijani-Eniola *et al.* (2003). The significant increase in N, K and Ca contents of leaves and bulbs with increase in manure application could be explained by the work of Adekiya and Agbede (2009) who reported that all levels of poultry manure alone and NPK fertilizer + poultry manure increased leaf N, P, K, Ca and Mg amounts significantly and the concentration of nutrients increased with the amount of poultry manure up to 40 t ha. This indicate that increasing fertilizer rates affected levels of nutrients in leaf and bulb tissues and this is also in agreement with the work of Boyhan *et al.* (2007) who reported that a single fertilizer rate did not increase yield and nutrient content of onion, but increase in doses of N, P and K affected levels of some nutrients in leaf and bulb tissue of onion. The lack of significant response in P content to increase in manure rates could be attributed to the presence of adequate amounts of available P in the soil (18.90 mg kg^{-1}).

Despite that spacing did not have a significant effect on the proximate composition of leaves and bulb of onion, the increase in the moisture content, crude fibre and crude protein as a result of increase in manure levels indicated that manure improved the quality of crops.

Conclusions

Based on the findings of the present study, growth of onion was enhanced at 20 cm × 20 cm and 25 cm × 25 cm compared to 15 cm × 20 cm spacing. However, higher total fresh and dry yield of onion bulbs and shoots were obtained at 15 cm × 20 cm which was not significantly different from 20 cm × 20 cm. Uptakes of N, K and Ca increased with decrease in plant spacing and were higher at 15 cm × 20 cm and 20 cm x 20 cm spacing and at 10 t ha^{-1} and 15 t ha^{-1} poultry manure application.

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