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Influence of Different Nitrogen Sources on the Growth and Yield of Three Varieties of Okra (*Abelmoschus esculentus*) in Kabba, Kogi State, Nigeria

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Abstract

Experiments were carried out at the Research Site of Horticultural Section, Kabba College of Agriculture to investigate the influence of different nitrogen sources on the growth and yield of three varieties of okra. The experiment was laid out in split block design with varieties as main plots (Lady Finger "LF", LD88 and Okele (local cultivar)) and different nitrogen sources as sub plots (Urea (108.7 kgN/ha), poultry manure (PM) (3.01 t/ha = 108.7 kgN/ha) and cow dung (CWD) (3.83 t/ha = 108.7 kgN/ha). The treatment combinations were as follows LD88 + Urea, LD88 + PM, LD88 + CWD, LF + Urea, LF + PM and LF + CWD, Okele + Urea (108.7 kg/ha), Okele + PM and Okele + CWD. Growth parameters determined were plant height (cm), leafarea (cm^2), number of leaves produced, stem girth (cm), internode length (cm) and days to 50% flowering and podding. Flower characters taken were number of flowers produced per plant, number of flowers aborted per plant, and number of pods produced per plant. Yield characters determined were individual pod weight (g), pod length (cm), pod diameter (cm) and pod yield (t/ha). The data collected were subjected to analysis of variance (ANOVA) and means compared using the least significant difference (LSD) at a probability level of 5%. Urea application and poultry manure had significantly different effects compared with cow dung treated plots for the parameters of growth and yield. Highest mean value was observed with urea application. This was followed by poultry manure application. The cultivar Lady's finger performed better according to the data for number of pods and fresh pod weight. This was followed by the LD88 cultivars. Okra grew taller and had bigger stem girth, greater number of leaves, larger leaf area and higher number of pods and fresh pod weight with urea application. Cultivar Lady's finger performed better than the other cultivars in most meas-

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ured parameters. It is therefore recommended that lady finger should be grown by farmers in the study area with their soil amended with urea fertilizer in the study area.

Keywords

Cultivar, Nitrogen, Poultry Manure, Cow Dung, Pod, Growth, Yield

1. Introduction

Okra (*Abelmoschus esculentus* L.) is an annual herb and vegetable crop grown throughout the tropical and subtropical parts of the world either as the sole crop or intercrop with maize or another crop [1]. Okra plays an important role in the human diet by supplying carbohydrate, protein, fats, minerals and vitamins that are usually deficient in the staple food. It is grown for its young leaves and green pods. Okra seeds contain about 20% protein similar to amino acid composition of soybean protein and 20% oil (similar in fatty acid composition to cotton seed oil) [2]. The seeds however can be roasted and used as substitute for coffee [3]. The essential and non-essential amino acid which Okra contains is comparable to that of soybean [4]. Okra flowers can be very attractive and sometimes used in decorating the living rooms [5]. The nutritional importance of okra pod has reawakened interest in bringing the crop into commercial production.

Despite the nutritional value of okra, its optimum yields have not been attained in the tropical countries partly because of a continued decline in soil fertility. The nutrient requirements of crops depend upon soil texture, types of previous vegetation cover, cropping intensity and soil moisture [6]. Fertilizers are generally applied to improve the crop yield, nutritional quality and aesthetic value of crops [7]. Nutrients especially nitrogen is needed for optimum yield of cultivated crop [8]. Reasons of low yield of crops are imbalanced fertilizer use; improper nitrogen sources and high rate of leaching of the nitrogen [9]. Nitrogen is the important part of plant parts such as chlorophyll, amino acid, proteins and pigments. It is most essential for vigorous growth branching/tillering, leaf development and enlargement root expansion, high photosynthetic activity and formation of protoplasm [10]. Nitrogen fertilizers being used for vegetable production has increased by 21% between 1997 and 2003 [11].

Nutrient imbalance and soil physical degradation hinder sustainable use of inorganic fertilizers in the tropics [12]. In order to sustain soil fertility over a long period of time, the use of organic manure is been advocated. This is because the nutrients contained in organic manures are released more slowly and are stored for a longer time in the soil, thereby ensuring a long residual effect [13]. [14] Also reported that manures provide a source of all necessary macro- and micro-nutrients in available forms, thereby improving the physical and biological properties of the soil. There are different types of nitrogen sources including cow dung, compost, green and farmyard manure etc.

Therefore, keeping in view the importance of nitrogen on growth of okra, a field research was conducted to study the influence of different nitrogen sources on the growth and yield of three varieties of okra with the objectives to find out the best nitrogen source and the best cultivar for the study area.

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out for two consecutive growing seasons (2011 and 2012) at the Research Site of Horticultural Section, Kabba College of Agriculture, Kabba. The site is located at latitude of 07˚35'N and longitude of 06˚08'E and is 1000 m above sea level, in Southern Guinea Savanna Agro Ecological Zone of Nigeria, where the dry seasons are dry and hot while, wet seasons are cool. The rainfall spans between April to November with peak in June. The dry season extends from December to March. The mean annual rainfall is 1570 mm per annum with an annual temperature range of 18˚C - 32˚C. The mean relative humidity (RH) is 60%. The major soil order within the experimental site is Gleysol [15]; [16]. The experiment was sited within a 14 ha agricultural field that has been mechanically tilled and cropped with tropical arable crops (maize, cowpea, sorghum, garden egg, okra, tomato and cassava) continuously for over twenty years.

2.2. Soil Sampling and Analysis

In order to determine some chemical properties of the soil before the treatments were applied, 10 random soil samples were collected from the field and bulked to for a composite sample. The sample was air-dried for 48 hr and sieved with a 2 mm sieve and analyzed in the laboratory for N, P, K, pH and Organic carbon. Total N (%) was determined by the macro-Kjeldahl method [17]. Available P (ppm) was determined using the Bray I method according to Olsen (1982). Soil pH values were obtained by using a HI9813-5 portable pH/EC/TDS/˚C meter (HANNA instruments, Romania, 2002). Soil organic carbon was determined by the Walkley-Black procedure [18].

2.3. Field Methods

The experiment was laid out in split block design with varieties as main plots (Lady Finger "LF", LD88 and Okele (local cultivar)) and different nitrogen sources as sub plotsUrea (108.7 kgN/ha), poultry manure (3.01 t/ha = 108.7 kgN/ha) and cow dung (3.83 t/ha = 108.7 kgN/ha). The treatment combinations are as follows LD88 + Urea, LD88 + PM, LD88 + CWD, LF + Urea, LF + PM and LF + CWD, Okele + Urea (108.7 kg/ha), Okele + PM and Okele + CWD.

The land was ploughed each year and harrowed with the aid of tractor mounted implements. Three varieties of okra were used: LD88, Lady's finger and Okele. LD88 and Lady's finger are known to be early flowering, medium in height with nearly entire leaf margin and branches diagonally upwards at an angle of 450 with the main stem. Seeds of lady finger and LD 88 were obtained from Kogi State Agricultural Development Project (ADP) office, Aiyetoro Gbede, Nigeria. Seed of Okele cultivar was from local market at Ponyan.

Cow dung and poultry manure were applied in to the soil one week before planting while the urea fertilizer was split and applied at two and four weeks after sowing [19].

Three seeds per hole of the cultivar under trial were sown on the flat with a spacing of 0.6 m × 0.2.5 m between and within the rows respectively and later thinned to one plant/stand.

2.4. Parameters Taken

Growth parameters determined were plant height (cm), leafarea (cm^2), number of leaves produced, stem girth (cm), internode length (cm) and days to 50% flowering and podding. Flower characters taken were number of flowers produced per plant, number of flower aborted per plant, and number of pod produced per plant. Yield characters determined were individual pod weight (g), pod length (cm), pod diameter (cm) and pod yield (t/ha).

2.5. Data Analysis

The data collected were subjected to analysis of variance (ANOVA) and means compared using the least significant difference (LSD) at a probability level of 5% according to [20].

3. Results and Discussion

The Physico-chemical properties of the experimental sites are given in **Table 1**. Total nitrogen value in the soil was low (0.19%). Similarly, the soil had a medium level of phosphorus 3.41 mg/kg with a corresponding low level of potassium 1.21 respectively. Relatively moderate amounts of exchangeable bases (Ca and Mg) were present in all the soil units. Organic matter was low 2.14%, while the pH in water was slightly acidic (**Table 1**). **Table 2** showed the chemical composition of poultry manure and cow dung used. The materials are relatively high in the essential nutrients required for the growth and development of crop.

Table 3 also showed that the results of plant height, number of leaves, leaf area were significantly increased compared to control by different nitrogen sources. The effects of the urea and poultry manure on these parameters were statistically similar and better than plots treated with cow dung. Urea however recorded the highest value in these parameters and was closely followed by poultry manure, then follow by plots with cow dung while the control plots recorded the least values. There was no significant difference in days to 50% flowering in okra due to different nitrogen sources.

The result of the growth parameters of the three okra varieties and different nitrogen sources in 2013 and 2014 is presented in **Table 3**. The growth parameters were significantly affected by the okra variety and different nitrogen sources. In both years, LD88 and Lady's finger were significantly taller than the local variety.

Table 1. pre planting soil samples.

Soil properties	*Values*
Sand (%)	62.4
Clay (%)	18.4
Silt (%)	19.2
Soil pH	6.2
Organic matter (%)	2.14
Total nitrogen (%)	0.19
Available P (mg/kg)	3.41
Available K (Cmol/kg)	1.21
Calcium (mg/kg)	2.46
Magnesium (mg/kg)	3.36
Bulk density (g/cm^2)	1.43
Total porosity (%)	44.3

Table 2. Composition of organic residues used in the experiment.

Properties	*Poultry manure*	*Cow dung*
Organic C (%)	38.4	43.4
Total N (%)	3.61	2.84
C/N ratio	10.62	15.19
Phosphorus (%)	1.31	1.14
Potassium (%)	3.12	0.84
Calcium (%)	1.24	1.28
Magnesium (%)	0.34	0.26

Table 3. Influence of different nitrogen sources on the growth character of Varieties of okra.

Organic residues	*Plant height* (cm)		*Number of leaves*		*Stem girth* (cm)		*Leaf area* (cm^2)		*Internode length* (cm)		*Days to* 50% *flowering*	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
No application	36.0	28.5	10.1	10.4	1.8	2.1	56.4	67.8	5.4	4.8	32.4	33.0
Urea fertilizer	60.1	58.6	11.0	11.2	4.0	3.8	116.5	107.2	9.2	7.6	31.2	30.9
Poultry manure	51.3	52.4	13.5	12.6	3.4	3.8	105.4	114.1	8.7	8.7	31.4	31.0
Cow dung	46.4	49.6	12.0	13.1	3.5	3.8	92.1	88.4	7.9	6.3	30.9	31.5
LSD 0.05	4.21	3.66	ns	1.13	0.23	ns	12.6	13.8	0.94	1.33	ns	ns
Varieties												
Lady's finger	41.1	47.2	12.0	13.4	4.1	3.8	83.4	93.6	8.3	8.1	32.3	31.8
LD88	50.2	48.5	12.3	12.8	4.5	3.8	106.2	89.1	9.4	9.1	30.6	30.7
Okole	32.6	39.4	11.4	10.6	2.8	3.6	64.4	73.0	6.6	5.4	42.1	40.4
LSD 0.05	5.61	2.23	ns	1.14	0.52	ns	26.4	4.90	0.86	2.4	4.31	2.88
Organic manure × variety	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

This is in conformity with the growth habits of the cultivars. LD88 and Lady's finger produced significantly larger number of leaves, more leaf area than the local cultivars. [21] observed insignificant growth parameters of LD88 and Lady's finger varieties of okra. Days to 50% flowering were earlier inLD88 and Lady's finger compared to local variety. [22] observed that organic manure improves growth character of crop when fertilizer or manure is applied at the required amount. While, [23] reported an increase in the supply of nutrients following organic manure application.

The numbers of flowers per plant were significantly (P = 0.05) increased by the application of different nitrogen sources (**Table 4**). More number of flowers was recorded in plot amend with cow dung in 2013 and in plot amend with urea in 2014. However, plot treated with cow dung recorded the largest number of flower aborted and consequently least number of pod produced. Plot treated with urea produced highest number of pod per plant in both years. Among the varieties observed, local variety had the highest number of flower in both years but produced least number of pods as a result of high rate of abortion in the flower. The varietal effect of LD88 and Lady's finger were statistically similar.

It was observed that different nitrogen sources had no significant effect on individual pod weight (g), pod length and pod diameter but there was significant effect on pod yield per hectare (**Table 5**). The highest number

Table 4. Influence of different nitrogen sources on the flower characters of varieties.

Organic residues	*Number of flowers per plant*		*Number of flowers aborted per plant*		*Number of pods per plant*	
	2013	2014	2013	2014	2013	2014
Urea fertilizer	15.8	18.4	1.2	4.8	14.6	13.6
Poultry manure	14.4	15.3	4.0	4.2	10.4	11.1
Cow dung	17.6	16.3	8.3	5.9	9.3	10.4
LSD 0.05	1.56	1.86	3.2	0.6	1.3	0.84
Varieties						
Lady's finger	16.2	14.8	4.1	2.3	12.41	12.46
LD88	15.6	15.6	4.1	3.6	11.5	12.0
Okole	18.6	18.3	9.7	8.8	8.9	9.5
LSD 0.05	2.24	0.96	2.61	1.46	1.06	1.26
Organic × variety	ns	ns	ns	ns	ns	ns

Table 5. Influence of different nitrogen sources on the pod characters and yield of threevarieties of okra.

Organic residues	*Individual pod weight* (g)		*Pod length* (cm)		*Pod diameter* (cm)		*Pod yield* (t/ha)	
	2013	2014	2013	2014	2013	2014	2013	2014
Urea fertilizer	13.4	12.3	6.3	6.4	4.83	4.63	5.83	5.68
Poultry manure	13.8	11.4	6.0	6.6	4.21	4.41	5.33	5.11
Cow dung	12.6	11.9	6.5	6.1	4.36	4.09	4.98	4.33
LSD 0.05	ns	ns	ns	ns	ns	ns	0.43	0.44
Varieties								
Lady's finger	12.62	11.66	7.3	7.6	5.14	6.31	6.83	5.48
LD88	15.98	14.48	6.1	5.8	5.84	5.66	4.16	4.98
Okole	8.98	9.43	4.3	3.9	3.96	4.11	2.96	3.04
LSD 0.05	4.6	3.82	1.36	1.63	0.54	0.98	2.37	1.23
Organic × variety	ns	ns	ns	ns	ns	ns	ns	ns

of pod per hectare was produced by the plant receiving urea and the lowest was given by plant with cow dung application. Application of urea and poultry manure was statistically similar. [24] Also found higher number of fruits per plant by the application of urea at 120 kg·N/ha.

The result obtained from the studied showed that poultry manure was the richer manure compared to cow dung. [25] Reported that applications of poultry manure to the soil are necessary for a satisfactory response to okra. Poultry manure has the highest nutrient and was able to release these nutrients for okra plant competitively faster than goat and pig manure. There were significant differences among the varieties considered. Individual pod weight, pod length, pod diameter and pod yield were significantly lower in local variety compared to both Lady's finger and LD88. Though, LD88 had higher values of individual pod weight, it has lower yield compared to lady's finger in both years. The variation observed could be as a result of genetically composition of the varieties.

4. Conclusions

This study was designed to investigate the effect of different nutrient sources on three okra cultivars *(Abelmoschus esculentus*). Data were collected at different growth stages for plant height, stem girth, number of leaves, total leaf area, number of fresh pods and fresh weight of pods. In the treatment, urea application and poultry manure had significantly different effects compared with cow dung treated plots for the parameters of growth and yield. Highest mean value was observed with urea application. This was followed by poultry manure application. The cultivar Lady's finger performed better according to the data for number of pods and fresh pod weight. This was followed by the LD88 cultivars. Based on the results of this study, the following conclusion was drawn: okra grew taller and had bigger stem girth, greater number of leaves, larger leaf area, higher number of pods and fresh pod weight with urea application. Cultivar lady's finger performed better than the other cultivars in most measured parameters. It is therefore recommended that lady finger should be grown by farmers in the study area with their soil amended with urea fertilizer at rate 108.7 kg/ha. Where there is scarcity of fertilizer or available at high cost poultry manure is a good substitute.

Finally, this present study could also provide a base for further work that should encompass a wider range of varieties, while different nitrogen sources could be studied for its effect on crop performance. This work also needs to be extended to other crops and other agro-ecological zones.

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