Yield of Okra (*Abelmoschus esculentus* L. Moench) Varieties as Influenced by the Application of Cow Dung and Poultry Manure in Jega, Kebbi State, Nigeria

ABSTRACT

Field trials were conducted at the Fadama Teaching and Research farm Jega, Kebbi state University of Science and Technology Aliero, during the 2017 and 2018 dry seasons, to study the Yield of Okra (*Abelmoschus esculentus* L. Moench) Varieties as Influenced by Cow Dung and Poultry Manure Application. The treatments consisted of two (2) manure levels (Cow dung 12t ha^{-1} and Poultry manure 6.6t ha^{-1}); each were designed to supply 120 kg N ha^{-1} using cow dung and poultry manure and three (3) varieties of okra namely LD88, NHAE47-4 and Dogo variety which were laid out in a Randomized Complete Block Design (RCBD) and replicated three times. The results obtained revealed that yield parameters such as Number of pods per plant (13.08 and 14.11), Mean pod weight (17.59g and 19.31g), Mean pod length (6.13cm and 6.83cm), Fresh pod weight per plant (0.19kg and 23kg) and Pod yield (5.65 and 6.38t ha^{-1}) were significantly increased when the nitrogen dose of 120kgN ha^{-1} was applied using PM 6.6t ha^{-1} in conjunction with NHAE47-4 in both 2017 and 2018. Mean pod diameter (cm) was statistically similar with both the application of CD 12t ha^{-1} and PM 6.6t ha^{-1}. Significant interaction effect was observed between variety and manure on Number of pod $plant^{-1}$ (13.97 and 13.43), and Pod yield (6.21 and 7.29t ha^{-1}) in both 2017 and 2018 while Mean pod diameter (3.42cm) in only 2017. From the results obtained, it can be concluded that in Jega, Kebbi state of Nigeria which falls within the Sudan Savannah agro-ecological zone, NHAE47-4 okra variety yields better than Dogo and LD88. Therefore, NHAE47-4 variety in conjunction with PM 6.6t ha^{-1} application could be selected for increased okra production in the study area.

Keywords: Okra; *Abelmoschus esculentus* L. Moench, Cow dung, Poultry manure, LD88, NHAE47-4 and Dogo, Okra pod yield

Introduction

Okra (*Abelmoschus esculentus* L. Moench), like any other indigenous vegetable, is widely cultivated, especially for its green tender fruit, and can be found in most local markets in Africa. The crop belongs to the family Malvaceae [1]. It is a common ingredient of soups and sauces. The fruits can be conserved by drying or pickling. The leaves from the crop are sometimes used as a substitute for spinach [2]. It has a great demand because it forms an essential part of human diet. It is grown mainly for its young tender fruits and can be found in most markets in Africa [3]. Okra is a vegetable of national importance in Nigeria as it is rich in vitamins and minerals. It is produced and consumed all over the country for the mucilaginous or "draw" property of the fruit that aid easy consumption of the staple food products [21]. Its importance ranked above most other vegetables including cabbage, amaranths, and lettuce [4].

According to FAOSTAT [5], Global production for okra approximately stands at 8.90 million tons grown on 2.15 hectares. The major producing countries include India (5.50 million tons), Nigeria (1.97 million tons), Sudan (287,000 tons), Mali (241,033), Pakistan (117,961 tons), Cote d'Ivoire (112,966 tons), Ghana (66,360 tons), Egypt (55,166 tons), Iraq (123,583 tons), and Malaysia (55,856 tons) as at 2016 [5]. Nutritionally, tender green pods of okra are important sources of vitamins and minerals such as vitamins A, B_1, B_3, B_6, C and K, folic acid, potassium, magnesium, calcium and trace elements such as copper, manganese, iron, zinc, nickel, and iodine [6].

Vegetable crop producers in the tropics are bedeviled with the problem of maintaining soil fertility. This is because the native fertility of most agricultural soils in this region is low and cannot support suitable crop production over a long period without the use of fertilizers [7]. This problem is further compounded by the scarcity and high cost of inorganic fertilizers which has forced farmers to make use of fertilizer rates that are lower than the optimum with its resultant reduction in yield. For instance, Tyagi *et al*. [8] discovered that farmers applied less than half of the 120kgN ha^{-1} recommended for Okra in the northern Guinea savannah due to the problem of scarcity and high cost of inorganic fertilizer. Prasad and Naik [9] have described soil fertility degradation as the second most serious constraint to food scarcity in Africa.

Organic manures generally improve the soil physical, chemical and biological properties such as increased infiltration rate, reduced bulk density, aggregate stability, cation exchange capacity (CEC), and biological activities along with conserving the moisture holding capacity of soil and thus resulting in enhanced crop productivity along with maintaining the quality of crop produce although the organic manures contain plant nutrients in small quantities as compared to the fertilizers, the presence of growth promoting principles like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity [10].

Additionally, organic manure serves as slow-release reservoir for plant macronutrients, aids in plants micronutrient absorption, and facilitates water and air infiltration. It has however been argued that organic manures are usually late in nutrient mineralization. In spite of the numerous advantages of organic manure in soil productivity, not many works have been reported on their effects on yield of vegetables in the tropics. Also, the roles of manure to influence many physicochemical and biological properties of the soil as well as increasing high yield of vegetables have not been given the necessary attention. This study was therefore carried out to determine the effects of cow dung and poultry manure on the growth and yield of okra varieties.

Materials and Methods

Experimental site

The research was carried out in two dry seasons of 2017 and 2018 at Fadama Teaching and Research farm Jega (lat. 12°12.99' N; long. 4° 21.90E'; 197m above sea level), belong to Kebbi state University of science and Technology Aliero, Kebbi state, Nigeria.

Plant Materials

Two varieties of okra (LD88, and NHAE47-4) were sourced from the National Horticultural Research Institute (NIHORT) Bagauda sub-station, Kano while a local variety *Dogo* was sourced locally from Jega.

Soil and Organic manure Analysis

Soil samples were randomly collected from the depth of 0-30 cm across the experimental sites. The samples were bulked to form a composite sample and sub-samples about 200g were collected using coning and quartering method. The samples were air dried, grounded, sieved and analyzed for physical and chemical properties (Table 1). Cow dung and Poultry manure samples were collected and analyzed for chemical characteristics (Table 2).

Land preparation

The two sites were ploughed and harrowed to obtain good tilth. The lands was leveled and constructed into seed beds; water channels were constructed to facilitate free and efficient water movement and uniform distribution on the plots. The plot size was 2.5 x 3m (7.5m^2). Space measuring 1.5m was left between blocks and 0.5m between plots. The net plot area consisted of the two middle rows (2.5 x 1.0m = 2.5 m^2). Organic manures (Poultry manure and Cow dung) was then applied evenly into the nursery bed according to treatment in order to improve its fertility status and then watered. The nursery left for 5 days with daily watering to stimulate the release the nutrients from manure applied.

Treatment and Experimental Design

The treatments consist of three (3) okra varieties (LD 88, NHAE47-4 and Dogo variety) and two (2) manure levels, each designed to supply 120 kg N ha^{-1} using cow dung and poultry manure (CD 12t ha^{-1} and PM 6.6t ha^{-1}) and the untreated control. The experiments were laid out in a Randomized Complete Block Design (RCBD) with three (3) replications.

Seed treatment and Sowing

Prior to sowing, the seeds were treated with Apron star at the rate of 10g of the chemical per 4.0 kg of seed, to protect the seeds from soil borne diseases and pests. Seeds were dibbled at an intra and inter row spacing of 50 x 50 cm.

Irrigation

Water pump machine was used to draw water from the source (tube-well) to the experimental field through the constructed water channels. Irrigation was scheduled at 3 - 4 days interval depending on the crop's need.

Weeding

Weeds were controlled manually using hand hoe at 3 and 6 WAS and occasional hand pulling when necessary to ensure weed free plots.

Harvesting

Harvesting was done by picking fresh pods when they are bright green and firm but tender. Pods were snapped off or cut with sharp knife. Harvesting was done at 2 to 3 days interval.

Data Collection

Data were collected on the following yield parameters:

Number of pods plant^{-}1, Mean pod weight (g), Mean pod length (cm), Mean pod diameter (cm), Fresh pod weight plant^{-1} (kg) and Pod yield (t ha^{-1})

Data Analysis

The data collected were subjected to analysis of variance (ANOVA). The treatment means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of significance.

Results and Discussion

Soil Physical and Chemical Properties of Experimental Site

Physical and chemical properties of soils of study locations prior to the experiments are presented in Table 1. The result indicated that particle size distribution at both 2017 and 2018 was dominated by sand, with values of 63.3 and 61.7%, respectively. For silt particles, it was 24.9 and 28.2%, respectively. Least particle size distribution was observed with clay having recorded 11.8% for 2017 and 10.1% for 2018. The soil was found to be sandy loam. This suggests that the soil in both locations has high macro porosity and low ability to retain water. Soil pH at 2017 (7.46) and 2018 (6.11) indicated that the soil at 2017 was slightly alkaline while that at 2018 was slightly acidic. Organic carbon, total N, available P and Ca were observed to be low in both locations. Exchangeable Mg was moderate, while exchangeable K and Na were higher in both 2017 and 2018 locations

Table 1: Physical and chemical properties of soil of the two experimental sites (Aliero and Jega) during 2016/2017 dry session.

	2017	**2018**
	0–30cm depth	

Particles size Analysis		
P^H	6.60	6.11
Organic Carbon %	1.04	0.87
Organic Matter %	1.79	2.01
Total N %	0.084	0.093
P mg/kg	0.93	1.05
Ca Cmol/kg	0.50	0.78
Na Cmol/kg	0.52	0.62
Mg Cmol/kg	0.80	0.74
K Cmol/kg	1.95	2.56
CEC Cmol/kg	8.40	8.94
Sand %	63.3	61.7
Silt %	24.9	28.2
Clay %	11.8	10.1

Chemical composition of cow dung (CD) and poultry manure (PM)

Chemical compositions of manures prior to the experiments are presented in Table 2. The result indicated that, cow dung and poultry manure contained organic manure carbon (g kg^{-1}) with values of 4.01 and 3.11 at 2017 and 4.13 and 3.26 at 2018. Cow dung pH (7.75 and 7.60) and poultry manure (6.20 and 6.25) indicated that, cow dung was slightly alkaline while poultry manure was slightly acidic. However, the result indicated that poultry manure contained high amount of total N (1.80 and 1.83 mg kg^{-1}) than cow dung (1.07 and 1.02 mg kg^{-1}). So also, Cow dung contained high amount of potassium (3800 and 3790 mg kg^{-1}) than poultry manure (2500 and 2500 mg kg^{-1}) but amount of phosphorus is higher in poultry manure (7.83 and 8.04 mg kg^{-1}) than cow dung (4.51 and 3.98 mg kg^{-1}). The result shows an indication of the organic manures's capability of improving the soil nutrient status.

Table 2: Chemical Composition of cow dung (CD) and poultry manure (PM) during 2017/018 dry season

Character	**Cow dung**		**Poultry manure**	
	2017	**2018**	**2017**	**2018**
Organic carbon (gkg^{-1})	4.01	4.13	3.11	3.26
P^H	7.75	7.60	6.20	6.25
Total N (mg kg^{-1})	1.07	1.02	1.80	1.83
Na (mg kg^{-1})	149	155	140	138
K (mg kg^{-1})	3800	3790	2500	2500
Ca (mg kg^{-1})	0.85	0.79	0.44	0.55
P (mg kg^{-1})	4.51	3.98	7.83	8.04

Varietal Response

The differences observed among the three varieties (LD88, NHAE47-4 and Dogo variety) could be attributed to their genetic make-up. Khan *et al*. [11] affirmed that differential growth of crops under similar environmental conditions is normally the result of differences in the genetic make-up of these crops [12]. Results revealed significant effect (P≤0.05) of variety on number of pods per plant. In 2017 trial, the higher number of pods plant^{-1} was recorded by Dogo than LD88 and NHAE47-4 which are similar but in 2018 trial, NHAE47-4 and Dogo gave similar number of pods per plant which in turn was higher than LD88 (Table3). This result corroborates the earlier reports of Rahman *et al*. [3] who also had significant effect of number of pods per plant in different okra cultivars. Significant effect (P≤0.05) of variety was observed as regards to mean pod weight. In 2017 trial, heavier pod was obtained from NHAE47-4 than Dogo which in turn was heavier than LD88 but in 2018 trial, heavier pod was obtained from NHAE47-4 followed by Dogo and LD88 which in turn were significantly the same (Table 3). This result is in accordance with the findings of Ojo *et al*. [13], who observed that Dogo variety produces lighter pods compared to improved variety.

Significant effect (P≤0.05) of variety was observed as regards to mean pod length. In 2017 trial, higher mean pod length was obtained from Dogo and LD88 which were similar than NHAE47-4 which recorded the lowest mean pod length. A similar trend was observed in both 2018 trial (Table 4). This result disagree with the findings of Jamala *et al*. [14] in their work with local and improved varieties of okra where they reported that local variety had the shortest pod length. Significant effect (P≤0.05) of variety was observed as regards to mean pod diameter. In 2017 trial, maximum pod diameter was obtained from NHAE47-4 followed by LD88 which in turn was higher than Dogo. A similar trend was observed in 2018 trial (Table 4). Variety showed significant effect (P≤0.05) with respect to fresh pods weight plant^{-1} (Table 5). In 2017 trial heavier fresh pods plant^{-1} was obtained from NHAE47-4 and Dogo which were similar while LD88 recorded the light fresh pods weight plant^{-1}. In 2018 trial, heavier fresh pods plant^{-1} was obtained from NHAE47-4 than Dogo which in turn was heavier than LD88. This result is in accordance with the findings of Ojo *et al*. [13], who observed that Dogo variety produces lighter pods compared to NHAE47-4(an improved variety). Significant effect (P≤0.05) of variety was observed as regards to fresh pod yield (t ha^{-1}). In 2017 trial, NHAE47-4 had significantly higher fresh pod yield than Dogo while LD88 recorded the lowest yield. A similar trend was observed in 2018 trial (Table 5). This result proved the superiority of the improved cultivars over the local. Jamala *et al*. [14] had reported a similar observation.

Response to Manure

There was significant effect (P≤0.05) of manure on Number of pods per plant (Table 3). In 2017 trial, application of PM 6.6t ha^{-1} gave significant higher number of pods per plant than the application of CD 12t ha^{-1}. The lowest number of pods per plant was recorded by the untreated control. A similar trend was observed in 2018 trial. Poultry manure is known to have high concentrations of N and P and low C:N ratio, this attribute of PM would have enhanced faster decomposition and quicker release of nutrients for okra plant uptake, hence better growth and yield of okra (Table 2). This result is in accordance with the findings Olatunji and Oboh [15]. Results indicated significant effect (P≤0.05) of intra-row spacing on pod weight of okra (Table 3). In 2017 trial, maximum mean pod weight was recorded with the application PM 6.6t ha^{-1} than the application of CD 12t ha^{-1}. The minimum mean pod weight was obtained from the untreated control. A similar trend was observed in 2018 trial. This could be due to faster decomposition and release of nutrients from poultry manure. Similar findings were reported by Eneje and Uzoukwu [16]. There was a significant effect (P≤0.05) of manure as regards to mean pod length (Table 4). In 2017 trial, higher mean pod length was obtained from the application of PM 6.6t ha^{-1} than the application of CD 12t ha^{-1} while the lowest mean pod length was recorded by the untreated control. In 2018 trial, application of PM 6.6t ha^{-1} and CD 12t ha^{-1} significantly had higher mean pod length which in turn was higher than the untreated control. This may likely due to low C:N ratio of the PM (Table 2). This result is in accordance with the findings Olatunji and Oboh [15].

Results indicated significant effect (P≤0.05) of manure on mean pod diameter of okra (Table 4). In 2017 trial, application of PM 6.6t ha^{-1} and CD 12t ha^{-1} gave significant similar value of mean pod diameter while the untreated control recorded the lowest value of mean pod diameter. A similar trend was observed 2018 trial. This could be due to manure acts as nutrient reservoir and upon decomposition; the nutrients are released slowly during the entire growth periods leading to better growth and higher yield. This result is in accordance with the findings Olatunji and Oboh [15]. Significant effect (P≤0.05) of manure was observed as regards to fresh pods weight plant^{-1}(kg) (Table 5). In 2017 trial, application of PM 6.6t ha^{-1} gave significant heavier pods plant^{-1} than the application of CD 12t ha^{-1} which in turn was heavier than the untreated control. A similar trend was observed 2018 trial. This could be due to faster decomposition and release of nutrients from poultry manure. Similar findings were reported by Olatunji *et al*. [17]. Significant effect (P≤0.05) of variety was observed as regards to fresh pod yield (t ha^{-1}) (Table 5). In 2017 trial, application of PM 6.6t ha^{-1} gave a significant higher yield than the application of CD 12t ha^{-1} while the untreated control recorded the lowest yield. A similar trend was observed 2018 trial. The reason for increase in yield with the application of PM 6.6t ha^{-1} could be attributed to the ability of poultry manure to decompose earlier than the cow dung. Similar findings have been reported by Yadav *et al*. [18].

Effect of interaction

Significant interaction effect (P≤0.05) between variety and manure was observed as regards to Number of pod plant^{-1} in 2017 Trial (Table 6). The highest value was obtained from the application of both PM 6.6t ha^{-1} and CD 12t ha^{-1} in conjunction with Dogo variety which were both statistically similar, followed by the application of CD 12t ha^{-1} in conjunction with NHAE47-4 which in turn were higher than the untreated control. This result agrees with the findings of Adekiya *et al*. [19] as the varieties produced higher number of pods when they received more nutrition and light for optimal growth and development. Significant interaction effect ($P \leq 0.05$) between variety and Manure on Mean Pod Diameter (cm) in 2017 Trial (Table 7). The highest value was obtained from the application of PM 6.6t ha^{-1} in conjunction with NHAE47-4 followed by the application of CD 12t ha^{-1} in conjunction with Dogo variety which in turn was higher than the untreated control. Significant interaction effect ($P \leq 0.05$) between variety and Manure on Pod Yield (t ha^{-1}) for 2017 and 2018 Trials (Table 8). In 2017 trial, higher yield was obtained from the application of PM 6.6t ha^{-1} in conjunction with NHAE47-4 followed by the application of CD 12t ha^{-1} in conjunction with LD88. The lowest yield was obtained from the untreated control. A similar trend was observed in 2018 trial. Similar findings have been reported by Singh *et al*. [20] which shown that N and K are the most important macronutrients that okra required for proper growth and pod production. Poultry manure is known to have high concentrations of N and P and low C:N ratio, this attribute of PM would have enhanced faster decomposition and quicker release of nutrients for okra plant uptake, hence better growth and yield of okra

Conclusion

This study has revealed that the application of poultry manure (5.65 and 6.38t ha^{-1}) enhanced the yield of okra when compared with cow dung (4.99 and 5.89t ha^{-1}). However, variety NHAE47-4 (5.62 and 6.80t ha^{-1}) has out-yielded Dogo and LD88 in the years 2017 and 2018, respectively. From the results obtained, it may be concluded that, NHAE47-4 okra variety could be selected in conjunction with PM 6.6t ha^{-1} for increased okra production in Jega, Kebbi state of Nigeria.

Recommendation

From the findings of this study, the following recommendations could be made:

1. Application of poultry manure in form of 6.6t ha^{-1} could be adopted for higher Okra pod yield in the study area.
2. Variety NHAE47-4 could also be considered since it recorded superior performance among the varieties tested in the study area.

Table 3: Number of Pod Plant^{-1} and Mean Pod Weight (g) as Influenced by Variety, Organic and Inorganic fertilization in Aliero, Jega and the Combined Locations during 2017/2018 dry season.

Treatment	**Number of Pod Plant^{-1}**		**Mean Pod Weight (g)**	
	2017	**2018**	**2017**	**2018**
Manure				
Control	6.94c	8.98c	9.66c	12.28c
CD 12t ha^{-1}	12.30b	13.36b	16.72b	18.56b

PM 6.6t ha^{-1}	13.08a	14.11a	17.59a	19.31a
SE±	**0.157**	**0.813**	**0.389**	**0.415**
Variety				
LD88	11.98b	13.06b	14.32c	17.97b
NHAE47-4	11.73b	13.82a	19.48a	20.44a
Dogo	13.12a	13.56a	16.47b	17.55b
SE±	**0.103**	**0.173**	**0.255**	**0.272**
Interaction				
Fert x Var	*	NS	NS	NS

Means followed by the same later (s) in a treatment group are not significantly different at 5% level using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Table 4: Mean pod length (cm) and Mean Pod Diameter (cm) as Influenced by Variety, Organic and Inorganic fertilization in Aliero, Jega and the Combined Locations during 2017/2018 dry season.

Treatment	Mean Pod Length (cm)		Mean Pod Diameter (cm)	
	2017	**2018**	**2017**	**2018**
Manure				
Control	4.48c	4.88b	1.70b	1.93b
CD 12t ha^{-1}	5.54b	6.47a	2.51a	2.67a
PM 6.6t ha^{-1}	6.13a	6.83a	2.54a	2.76a
SE±	**0.214**	**0.233**	**0.041**	**0.033**
Variety				
LD88	5.97a	7.18a	2.26b	2.43b
NHAE47-4	5.40b	5.76b	2.92a	3.21a
Dogo	6.32a	7.21a	2.16c	2.31c
SE±	**0.140**	**0.152**	**0.026**	**0.021**
Interaction				
Fert x Var	NS	NS	NS	*

Means followed by the same later (s) in a treatment group are not significantly different at 5% level using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Table 5: Fresh pods weight plant^{-1} (kg) and Yield (t ha^{-1}) as Influenced by Variety, Organic and Inorganic fertilization in Aliero, Jega and the Combined Locations during 2017/2018 dry season.

Treatment	Fresh pods weight plant^{-1} (kg)		Yield (t ha^{-1})	
	2017	**2018**	**2017**	**2018**
Manure				
Control	0.06c	0.11b	2.30c	3.22c

CD 12t ha^{-1}	0.16b	0.20ab	4.99b	5.89b
PM 6.6t ha^{-1}	0.19a	0.23a	5.65a	6.38a
SE±	**0.043**	**0.047**	**0.070**	**0.110**
<u>Variety</u>				
LD88	0.16b	0.19b	4.77c	5.31c
NHAE47-4	0.20a	0.24a	5.62a	6.80a
Dogo	0.20a	0.23b	5.28b	5.61b
SE±	**0.041**	**0.044**	**0.046**	**0.073**
<u>Interaction</u>				
Fert x Var	NS	NS	*	*

Means followed by the same later (s) in a treatment group are not significantly different at 5% level using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Table 6: Interaction of Variety and Manures on Number of pods plant^{-1} for 2017 Trial

Manure	**Variety**		
	LD88	**NHAE47-4**	**Dogo**
Control	7.09de	6.34e	7.39d
CD 12t ha^{-1}	12.00bc	11.46c	13.43a
PM 6.6t ha^{-1}	12.80ab	12.46b	13.97a
SE±		**0.271**	

Means followed by the same later (s) are not significantly different at 5% level using DMRT

Table 7: Interaction of Variety and Manure on Mean Pod Diameter (cm) for 2017 Trial

Manure	**Variety**		
	LD88	**NHAE47-4**	**Dogo**
Control	1.81d	2.16c	1.80d
CD 12t ha^{-1}	2.43b	3.28ab	2.29bc
PM 6.6t ha^{-1}	2.49b	3.42a	2.38bc
SE±		**0.056**	

Means followed by the same later (s) are not significantly different at 5% level using DMRT

Table 8: Interaction of Variety and Manure on Pod Yield (t ha^{-1}) for 2017 and 2018 Trials.

Manure	Variety		
	LD88	**NHAE47-4**	**Dogo**
	2017		
Control	1.94e	2.07de	2.89d
CD 12t ha^{-1}	4.18d	5.73ab	5.09c
PM 6.6t ha^{-1}	5.45b	6.21a	5.28bc
SE±		**0.121**	
	2018		
Control	2.20e	3.96d	3.51de
CD 12t ha^{-1}	4.71cd	6.52b	6.42b
PM 6.6t ha^{-1}	6.30bc	7.29a	5.54c
SE±		**0.192**	

Means followed by the same later (s) are not significantly different at 5% level using DMRT

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