Effect of Poultry Manure Incorporation Rates on the Growth and Yield of Okra (*Abelmoschus esculentus*) in Mubi, Northeast Nigeria

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ABSTRACT
A field experiment was carried out during the 2013 rainy season to assess the effect of poultry manure incorporation rates on the growth and yield of Okra (Abelmoschus esculentus) in Mubi area, Adamawa state, Nigeria. The experimental area covered 9.5 m × 9.5 m and comprised of 4 blocks with 4 plots each measuring 2 m × 2 m and separated by an alley of 0.5 m between blocks and rows. The experimental plots were treated with 3 rates (10, 15, &20 kg equivalent to 25, 37.5, & 50 t/ha) of poultry manure and a control (0 ton/ha) replicated 4 times in a randomized complete block design (RCBD). Data collected was analyzed using the generalized linear model of Statistix 9.1 for the ANOVA. The results showed that Okra growth parameters significantly (P<0.05) differed among the treatments at 2, 4, 6 & 8 weeks after sowing (WAS), except for stem diameter at 2 & 4-WAS and number of leaves at 2-WAS in addition to number of branches, which generally didn't significantly (P<0.05) differ due to the treatments. It was found that higher rates (37.5 & 50 t/ha) of poultry manure incorporation had more influence on Okra performances during the study. Farmers are therefore recommended to either use the 37.5 or 50 t/ha or even higher for Okra production around Mubi, Northeast Nigeria.

Keywords: Okra, Poultry manure, Incorporation rate, Growth, Yield, Mubi, Nigeria.

INTRODUCTION

Okra (*Abelmoschus esculentus*) is a popular home garden vegetable largely consumed in the southern parts of Nigeria. It is thought to be of Asian origin and is reported to have been used by the Egyptians in the 12th century (Ajari*et al*., 2003; Gardner, 2004). Okra is a much cherished vegetable across Nigeria and elsewhere around the World due to its "draw" characteristics which facilitates easy swallowing of bulky food materials such as "*tuwo*", *marshedrice*, and *amala,* when taken with Okra soup (Adeboye, 1996; Gardner, 2004). Okra production has nearly doubled since 1939, with practically all the commercial production for market and processing being in the southern states of Nigeria. Okra is a self-pollinated and a short duration vegetable with considerable variation within species in plant height, fruit size, leaf size, and shape, mucilage content and chemical composition (Farinde&Owalarefe, 2007; Farinde, 2007). The different species available in Nigeria are Jokoso, Tea 38, V35 and NHAC 47. Most varieties are vulnerable to attacks by insects such as flies, beetles, grasshoppers and white flies (Tindall, 1992; Adeboye, 1996). Okra is a vegetable crop popularly called as "*Kubewa; or yauki*" in *Hausa* language and also calledas "*draw*" in southern parts of Nigeria. The fresh fruit can be preserved in dried forms which could still retain its draw properties. The succulent leaves are also consumed as vegetables especially in the northern parts of Nigeria as it also contains mucilage which has the draw properties (Adeboye, 1996).

The factors reported as responsible for low yield of Okra are poor soil fertility and use of unimproved or local cultivars (Akin-Taylor, 1986). William (1975) also observed that when soils are not fertilized, they could become a poor growing media, and is therefore necessary to provide alternative fertilizer sources that could boost Okra production. Poultry manure is an excellent source of nutrient when incorporated into soils. It is a major source of organic matter and has been identified as an excellent source of organic manure (Adekiya and Agbede, 2016). Its use as organic manure helps to improve soil moisture content as well as the physical properties of the soil (Masarirambi *et al*., 2012).It has a high nitrogen content and can serve as a good complement for nitrogen fertilizers. Poultry manure containshigh contents of other essential nutrients such as phosphorous (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo), especially in their available forms thus making it easy for plants to access when applied to soils (Patterson *et al*., 1998).The value of poultry manure varies not only with its nutrient composition and availability, but as well with its management and costs. Other alternatives are organic manure (Aduayi, 1985), which has a problem of bulkiness due to its usually large rates required for crop production (Akinfasoye and Olufolaji, 1998). This study is therefore aimed at determining the optimum application rates of poultry manure on Okra performances in Mubi area.

MATERIALS AND METHODS

The study area

Mubi is located in the Northern part of Adamawa state between latitudes 9º 26'' and 10º 10'' N and longitude 13º 10'' and 13º 10'' E and occupies alandmass of about 506,440 square kilometers. It is bordered by the Mountain ranges of the Mandara of the republic of Cameroon to the East, Michika Local government area to the North, Hong to the South and Askira-Uba to the West (Nwagboso and Uyanga, 1999). The climate of the area comprised of typical wet and dry seasons. The dry season span for about five months (November to March), while the wet season lasts between April and October each year, the annual rainfall amount ranges from 700-1,050 mm (Adebayo, 2004). The land use types are mainly livestock and arable farming. The dominant crop cultivated in the area include maize, sorghum, rice, groundnut, yam, sugarcane and vegetables, which are mainly grown on patched *Fadama* lands under supplemented irrigation.

Field Studies

Local variety Okra seeds were sourced from the Mubi main market and well selected, while poultry manure was sourced from the animal farm (poultry unit) of Federal Polytechnic, Mubi, Adamawa state. The research was carried out between the months of June and September, 2013 at the Department of Agricultural Technology student practical farmland, Federal Polytechnic Mubi, Adamawa state.

Experimental plot design

An experimental area covering 9.5 m x 9.5 m was ploughed in the second week of June 2013, and plots were marked out on a 2 m × 2 m sizes and separated by an alley of 0.5m apart. The plots were laid in a Randomized Complete Block Design (RCBD). Each block comprised of 4 plots incorporated with 3 levels (10, 15 and 20 kg, which are equivalent to 25, 37.5 and 50 t/ha) of poultry manure with 0 t/ha as control treatment, and then replicated 4 times with a total of 16 trial plots.

Data Collection Procedure

Some of the seedlings were labeled with a paper tape after establishment. Relevant data on vegetative growth of the Okra seedlings were collected at given intervals of weeks after sowing (2, 4, 6 and 8-WAS).

Germination and Seedling Establishment:

The percentage germination and seedling establishment were computed from the data on germinated seeds and established Okra seedlings per plot at 2-WAS, and mathematically expressed as:

$$\%\ \text{establishment} = \frac{\text{Number of seedlings established}}{\text{Number of seeds germinated}} \times 100$$

Plant height:

The height of the Okra plants were measured and recorded at 2, 4, 6 and 8-WAS using a meter tape.

Number of leaves per plant per plot:

The number of Okra leaves per plants per plot were also physically counted and recorded at 2, 4, 6 and 8-WAS.

Stem diameter:

Stem diameters of the Okra seedlings were also measured using a Vanier caliper device at 2, 4, 6 and 8-WAS.

Statistical analysis

Data collected was analyzed following the generalized linear model of Statistix 9.1 version 2004 for the ANOVA. Mean values were subjected to a one way anova and separated using LSD at 0.05 level of significance.

RESULTS AND DISCUSSION

Soil properties

A report by Tekwa *et al*. (2010) (Appendix 1) on the soils of the study area showed that the soils are mainly sandy clay loam in texture, and consisted of high sand (49.43%), and low silt (17.92%) and clay (32.65%) contents. The WHC was 15.09%, while the soil particle density was 1.21 Mgm^{-3} in the low to non-plastic soils. The soils are inherently low in fertility with exchangeable K^{+} (0.33 $cmolkg^{-1}$), Ca^{2+} (1.47 $cmolkg^{-1}$), Na^{+} (0.09 $cmolkg^{-1}$) and Mg^{2+} (3.33 $cmolkg^{-1}$) contents that varied between low and high.

Germination and seedling establishment

The results of seed germination and seedling establishment are presented in Table 1. The results showed that there was no significant ($P<0.05$) differences among the treatment effects on both seed germination and seedling establishments in this study. However, the highest percentage germination and seedling establishments were found on plots treated with the largest amount of poultry manure rates (50 t/ha), and were trailed by those treated with 37.5 and 25 t/ha. The least germinated and established seedlings were found in the control experiments. Fagwalawa & Yahaya (2016) reported similar non-significant ($P<0.05$) differences among levels of poultry manure on seed germination and seedling establishments.

Table 1: Effect of poultry manure incorporation rates on germination and seedling establishment

Poultry Manure Rate (t/ha)	Germination Count	Seedling Establishment	%Germination (%)	% Seedling Establishment (%)
0	17.25	16.50	69	95.25
25	18.00	17.50	72	95.75
37.5	19.25	18.25	77	97.50
50.0	19.25	19.00	77	98.75
S.E(±)	NS	NS	NS	NS

Effect of poultry manure incorporation rates on Okra (*Abelmoschus esculentus*) growth

The results of the effect of poultry manure incorporation rates on growth of Okra at 2-WAS are presented in Table 1. The results showed that only the plant heights differed significantly (P<0.05) among the growth parameters at 2-WAS. The 50 t/ha rate recorded the highest effect on the Okra plant height (8.57 cm) compared to the control. Both the 25 ton/ha and 37.5 ton/ha treatment effects on the Okra were however similar statistically. Hence, the treatments did not influence both number of leaves and stem diameters significantly (P<0.05) and 2-WAS in this study.

Table 2: Effect of poultry manure rates on Okra growth at 2-WAS

Poultry Manure Rate (t/ha)	Plant height (cm)	Number of leaves per plant	Stem diamet (mm
0	7.16^{c}	4.50	2.43
25	7.80^{b}	4.33	2.57
37.5	8.10^{b}	4.33	2.63
50.0	8.57^{a}	4.67	2.43
S.E(±)	0.17	NS	NS

Key: Means in the same column having the same letter(s) are not significantly different at 5% level

The results of the effect of poultry manure rates on some of the Okra growth components at 4-WAS are presented in Table 2. The results also showed that both heights and number of leaves per plant varied significantly (P<0.05) among the treatments. The 37.5 t/ha and 50 t/ha rates had similar significant (P<0.05) effects on the plant heights, than both the 25 t/ha and the control treatments, which also recorded similar effects on the plant heights. Fagwalawa & Yahaya (2016) earlier reported such similar positive increase in Okra plant height by 30.40 cm, than the control treatment (23.94 cm), when treated with higher rates of poultry manure. The observed increase in Okra growth components could be due to the treatment effects following the incorporation and gradual release of inherent nutrients in the poultry manure. This also agrees with observations earlier made by Ajari et al. (2003), Tindall (1992); Sanwal *et al*. (2007).

Table 3: Effect of poultry manure rates on Okra growth at 4, 6 and 8-WAS

Poultry Manure rate (t/ha)	Plant height (cm)	Number of leaves per plant	Number of branches per plant	Stem diameter
		4-WAS		
0	13.40^{b}	4.47^{d}	0.33	2.93
25.0	13.87^{b}	4.80^{c}	1.00	4.13
37.5	14.63^{a}	5.10^{b}	1.33	4.20
50.0	15.03^{a}	5.47^{a}	1.67	4.43
S.E(±)	0.20	0.10	NS	NS
		6-WAS		
0	25.50^{c}	7.70^{b}	1.00	4.77^{c}
25.0	26.93^{bc}	8.13^{ab}	1.33	5.30^{b}
37.5	29.00^{b}	8.33^{a}	1.67	5.87^{a}
50.0	31.53^{a}	8.50^{a}	1.67	6.10^{a}
S.E(±)	0.90	0.19	NS	0.12
		8-WAS		
0	63.10^{c}	7.70^{b}	1.00	6.45^{c}
25.0	64.67^{c}	8.13^{b}	1.33	6.87^{c}
37.5	70.67^{b}	8.33^{b}	1.67	7.33^{b}
50.0	76.67^{a}	10.27^{a}	1.67	7.70^{a}
S.E(±)	1.34	0.34	NS	0.12

Key: Means in the same column having the same letter(s) are not significantly different at 5% level

Conversely, the number of leaves per plant recorded a directly proportional increase with increasing application rates. On the other hand, both the number of branches per plant and the Okra plants stem diameter didn't differ significantly ($P<0.05$) among the treatments.

Table 3 also showed the results of the treatment rates on some of the Okra growth parameters at 6-WAS and 8-WAS. The results still revealed that plant heights, number of leaves per plant and the stem diameters significantly ($P<0.05$) differed among the treatments, while the number of branches per plant didn't vary significantly ($P<0.05$). Both the 50 t/ha and 37.5 t/ha treatment rates recorded similar effects on all the Okra growth components, except for the plant heights at the 6-WAS interval. The effect of 25 t/ha on the growth components trailed better than the control treatment (0 t/ha).

At 8-WAS, the Okra growth parameters further varied significantly ($P<0.05$) among the treatments, except in terms of the number of branches per plant. The plant heights ranged between 25.50 cm and 31.53 cm at 6-WAS, and between 63.10 cm and 76.67 cm at 8-WAS. The number of leaves per plant was between 7.70 and 10.27 at 6 and 8-WAS. However, only the 50 t/ha treatment influenced the number of leaves significantly ($P<0.05$) than the 25, 37.5 t/ha and the control, which recorded the same effects on the number of leaves. Premsekhar & Rajashree (2009) and Ajari *et al.* (2003) also observed similar increases in Okra plant growth at advanced stage when treated with poultry manure rates.

Effect of poultry manure incorporation rates on Okra (*Abelmoschus esculentus*) yields

The results of the poultry manure incorporation rates on the number of pods per Okra plant are presented in Table 4.

Table 4: Effect of poultry manure incorporation on Okra (*Abelmoschus esculentus*) yields

Poultry Manure Rate	Number of Pods Per Plant	
(t/ha)	6-WAS	8-WAS
0	6.37^{b}	8.62^{c}
25.0	6.50^{b}	9.60^{bc}
37.5	7.50^{a}	11.73^{b}
50.0	8.03^{a}	16.10^{a}
SE (±)	0.34	0.88

Key: Means in the same column having the same letter(s) are not significantly different at 5% level.

The results showed that both 37.5 and 50 t/ha had similar significant ($P<0.05$) effects on number of pods at 6-WAS. Likewise, the 25 t/ha and the control (0 t/ha) treatments also had similar effects statistically. The plants with the more numbers of pods were found on plots treated with 50 t/ha of poultry manure, followed by plots treated with 37.5, 25 and 0 t/ha (control). At 8-WAS, the Okra yield appreciated relatively in proportion to the poultry manure incorporation rates. The plots treated with 50 t/ha recorded the highest number of pods, followed by plots treated with 37.5 and 25 t/ha. The control (0 t/ha) treatment had the least number of pods at both 6 and 8-WAS in this study. Supply of poultry manure probably improved the nutrient reserves of the soils as evidenced in the general growth in all the Okra plant properties. This position agrees with the reports of previous researches by Sanwal *et al*. (2007); Ajari et al. (2003); Gardner (2004) and Tindall (1992).

CONCLUSION AND RECOMMENDATIONS

From the results of this work, it suffices to conclude that Okra germination, seedling establishments, as well as the vegetative growth increased proportionally to increasing rates of poultry manure applications in this study. In addition, higher rates (37.5 & 50 t/ha) of poultry manure impacted more on Okra performances, than the control treatment (0 t/ha) at all the study segments. It is therefore recommended that Okra farmers should either use the 37.5 or 50 t/ha or even higher rates for Okra production around Mubi, Northeast Nigeria.

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Appendix 1: Physico-chemical properties of soils of the study area.

Soil Property	Mean Value
Particle size distribution (gkg^{-1})	
Sand	494
Silt	179
Clay	327
Texture	Sandy clay loam
Particle Density (gcm^{-3})	1.21
Bulk Density (gcm^{-3})	1.6
Porosity (%)	24.29
Water Holding Capacity (%)	15.09
Soil pH (1:2.5 Soil: Water)	7.36
Organic matter (%)	1.31
Total Nitrogen (%)	0.06
Available Phosphorus ($mgkg^{-1}$)	0.01
Potassium ($cmolkg^{-1}$)	0.33
Calcium ($cmolkg^{-1}$)	1.47
Magnesium ($mgkg^{-1}$)	3.33
Sodium ($cmolkg^{-1}$)	0.09
Cation Exchange Capacity ($cmolkg^{-1}$)	5.22

Adapted from Tekwa *et al.*, (2010).