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Growth And Yield Traits Of Okra (Abelmoschus Esculentus L.) Moench, As Influenced By NPK 15:15:15 And Poultry Manure In Mubi, Adamawa State.

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Abstract: ***Field experiment was conducted during 2014 cropping season on the Growth and yield traits of okra as influenced by NKP 15:15:15 fertilizer and poultry Manure at Food and Agricultural Organization/ Tree Crop Production Farm, Adamawa state University, Mubi. Three rates of NPK 15:15:15(0, 120 and 150kg NPK/ha) fertilizer and three rates of poultry manure (0, 10, and 15t/ha), were factorially combined and laid out in a randomized complete block design replicated three times. Agronomic data collected were: plant height, number of leaves/plant, days to first and 50% flowering, pod length, pod diameter, pods/plant, hundred seed weight and pod yield. Results showed that plant height, pod length, pod diameter and number of leaves/plant was the highest with sole application of NPK at the rate of 120kgNPK/ha. The 15t/ha sole application of poultry manure recorded the highest plant height and number of leaves at 6 WAP and higher number of pods/plant, 100 seed weight and pod yield (kg/ha). The combined application rates of 120kg/ha NPK and 10t/ha of poultry manure gave the best okra performance in this study.***

Keywords: Okra, NPK 15:15:15, Poultry manure, Treatment combinations, Growth and Yield

I. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) belongs to the family *malvaceae;* widely grown, distributed and consumed either fresh or in dried form (Fatokun and Chedda, 1983). The crop is an annual vegetable, grown from seed and is widely cultivated in the tropics for its fruits used as vegetables (Kochhar, 1986). In Africa, there is great diversification of okra with the most important production regions in Ghana, Burkina-Faso and Nigeria (Raemaekers, 2001). Okra is grown in all types of soils, thriving best in moist friable well manured soil (Kochhar, 1986). The production and economics importance of okra in Nigeria has rapidly increased in recent years and the seasonal supply of this vegetable to a large extent determines how much of it is being consumed by the majority of the people. The total world production of okra is estimated at 6 million metric tones per year and production in West and Central Africa is estimated at 500,000 – 600,000 metric tons annually based on available consumption data (PROTA, 2004). The West and Central Africa region accounts for more than 75% of okra produced in Africa, but the average productivity in this region is low (2.5 t/ha) compared to East (6.2 t/ha) and North Africa (8.8 t/ha). Nigeria is the largest producer (1,039,000t/ha) followed by Cote d' Ivoire, Ghana and others (FAOSTAT, 2008). In Nigeria, the production of okra is done all year round either as rain-fed or irrigated crop,

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but the wet seasons are more favorable for increased fruit yield (Katung, 2007). Okra is a good source of vitamin A, B and C including minerals especially iodine and amino acids found in the seeds; which competes favorable with those in poultry, eggs and soybean (Thompson 1949; Schippers, 2000). The stem is useful as fiber, while the leaves are considered good cattle feed and are sometimes consumed by man. Espig (1991), reported that okra contain about 20% edible oil and protein, while its mucilage is utilized for medicinal purposes.

The improvement of soil fertility through the application of fertilizers has become an essential factor that enables the world to feed billions of people (Brady and Weil, 1999). Organic manure is a compound fertilizer that contains one or more kinds of organic matter and the ingredient may be animal or vegetable matter or a composition of the two. Poultry manure has a fairly high nutrient composition when compared with other animal sources such as goats, pigs, and cattle manures (Akanni *et al.*, 2005). Poultry manure is widely recognized as soil conditioner for raising soil PH and exchangeable bases levels. Inorganic fertilizer (referred to as synthetic fertilizer), is manufactured artificially and contains minerals or synthetic chemicals typically made from petroleum or natural gas including phosphorus, potassium and other trace elements often mined from the earth. The proper use of inorganic fertilizers can improve crop yield, soil PH, total nutrient content and nutrient availability to plants (Akande *et al.*, 2010).

The result of the studies of Akande *et al.*, (2010) on response of okra to organic and inorganic fertilizer revealed that the application of 60kgNPK + 2.5 metric tons tones/ha of organic fertilizer produced the tallest plants, (57cm). Application of 60kgNPK + 2.5 metric tons /ha poultry manure (PM) and application of only gliricidia leaves produced plants of 53 and 51cm, respectively. Application of 60kg NPK + 2.5 metric tons/ha organic based fertilizer (OBF) produced the highest yield of 3.58 metric tons/ha which was similar to 3.29 and 3.20 metric tons/ha from application of 60kg NPK + 2.5 metric tons/ha PM and gliricidia leaves respectively. Olaniyi *et al.*, (2010) also showed that the application of organomineral and inorganic fertilizer and their combinations significantly influenced the growth, yield, quality and nutritional content of okra. The combine application rate of 75kg NPK + 3tons/ha organo-mineral fertilizer gave the best okra performance when compared with other treatments. From the results of their studies, combined application of the two fertilizer type can reduce the farmers' budget for crop fertilization.

Most soils in the tropics especially in Mubi are low in nutrients which are necessary for plant growth and high yield. Therefore, it is necessary to supplement the amount of nutrients present in the soil with inorganic or organic fertilizers or both to meet up crop requirement and increase yield of okra. Continuous application of mineral fertilizer only in tropics without supplementing with organic manure is associated with reduced crop yield, increased soil acidity and nutrient imbalance. Therefore a combination of organic materials and mineral fertilizers is important for management of these soils for high yield and quality harvest of okra (Akande *et al.*, 2010).

The objectives of this study are as follows:

- ✓ To determine the effects of NPK (15:15:15) and poultry manure on growth and pod yield in okra.
- ✓ To evaluate the interaction effects of NPK 15:15:15 and poultry manure on growth and pod yield in okra.
- ✓ To determine the best treatment combination of poultry manure and NPK 15:15:15 that will produce high pod yield in okra.

II. MATERIALS AND METHODS

The study was conducted in July, 2014 wet season at the Food and Agricultural Organization/Tree Crop Production Research Farm, Adamawa state University Mubi, Nigeria, (Latitude 10^{o}05'N and longitude 13^{o}16'E and on the altitude of 696 meter above the sea level) having annual rainfall of 900mm to 1600mm.

Before land preparation, soil samples were collected randomly in the field at a depth of 0 – 30cm using an auger purposely for a test of the physical and chemical properties of the soil. The soil sample was air-dried, crushed using a mortar and pestle and then sieved using a 2 mm mesh. From the sieved soil, the following physio-chemical properties were carried out:

- ✓ Particle size analysis was carried out using hydrometer method (Bouyoucos, 1962).
- ✓ Soil reaction (soil PH) was determined by using the PH meter method (Soil/water ratio of 1:2.5) according to Page *et al*., (1982).
- ✓ Organic carbon was determined by dichromate digestion (Walkey and Black, 1934) from where organic matter was calculated.
- ✓ Available P was extracted (Bray and Kurtz, 1945).
- ✓ Available K was determined by flame photometer using routine analytical methods (IITA, 1979)
- ✓ The total N was determined by macro-kjeldahl procedure as described by Jackson (1958)
- ✓ Water holding capacity (WHC) was determined by gravimetric method (Trout *et al*, 1987).
- ✓ Available Ca was determined by extraction with 1 m ammonium acetate at PH 7.0 using a corning flame photometer with appropriate filter (IITA, 1979).

LAND PREPARATION, SEED SOWING, CULTURAL PRACTICES AND EXPERIMENTAL DESIGN

The experimental field was ploughed and harrowed using tractor and hand hoe in order to bury plant residues and to break soil clods to obtain fine soil tilt for the emergence of okra seeds. The prepared land was demarcated in plots using ropes, pegs and tape. Poultry manure was applied at the rates of 0 (control), 10 and 15 t/ha two weeks before planting to allow for proper mineralization.

Total land area for this trial measured 22 m x 12 m (264 m^2), gross plot was 2 m x 3 m (6 m^2) and the net plot 1.2 m x 2 m (2.4 m^2). The experimental field was divided into twenty-seven plots and each plot was separated by a pathway of 50 cm between each plot and 1m apart between each replicate for easy movement during cultural practice operation. Two to three seeds of okra were planted at a spacing of 40 cm within rows and 60 cm between rows (Akotkar *et al*., 2010), giving a population of twenty-five plants/plot, after thinning at 3 weeks after planting (WAP). To control pest, cymbush (cypermetrin (10%EC) was applied at the rate of 50 ml/10 liters of water at vegetative growth stage (3 WAP) and repeated at flowering stage. Weeding was carried out manually and frequently with hoe. The treatments consist of three levels of NPK 15:15:15 - no treatment or control (0 kg), 120 and 150kg NPK/ha) and three levels of poultry manure – 0 t/ha (control), 10 and 15t/ha; which were factorially combined to give 9 treatments (Table 1). The treatments were laid out in a Randomized complete block design replicated three times.

From the net plot, five sampled plants were used to collect the following parameters: Plant height, number of leaves/plant, days to first flowering, days to 50% flowering, pod length, pod diameter, number of pods/plant, hundred seed weight and fresh pod yield. Data collected were analyzed using Statistical Application for Sciences (SAS 1998) and mean were separated using Duncan's Multiple Range Test at 5% level of probability.

NPK 15:15:15 (Kg/ha)	Poultry Manure (t/ha)		
	P_1 (0t)	P_2 (10t)	P_3 (15t)
N_1 (0 Kg/ha)	N_1P_1	N_1P_2	N_1P_3
N_1 (0 Kg/ha)	N_2P_1	N_2P_2	N_2P_3
N_1 (0 Kg/ha)	N_3P_1	N_3P_2	N_3P_3

Key: Treatment Combinations
0kg NPK + 0t = N_1P_1 120kg NPK +0t = N_2P_1
150kg NPK + 0t = N_3P_1
0kg NPK +10t = N_1P_2 120kg NPK +10t = N_2P_2
150kg NPK + 10t = N_3P_2
0kg NPK +15t = N_1P_3 120kg NPK +15t = N_2P_3
150kg NPK + 15t = N_3P_3

Table 1: Treatment combination between NPK 15:15:15 and poultry manure

III. RESULTS AND DISCUSSION

The physical and chemical characteristics of the experimental soil (Table 2) showed that it was slightly acidic. The organic carbon (0.63%) and available N (0.12%) including the available P (0.43%) value were low. The particle size analysis showed that the soil type of the experimental area was sandy-loam with a high proportion of sand (58.5%) and silt (32.5%) and less clay (3.5%). The soil had a high water holding capacity with a maximum of 39.7%. According to Tekwa *et al*., (2011), Mubi soils have low organic matter and nitrogen content of the range from 0.21 – 1.90% (organic matter) and 0.11 – 0.24% (total nitrogen).

Chemical Analysis	
PH in water	6.50
Organic carbon (%)	0.63
Carbon to nitrogen ratio (C: N ratio)	1.40
Available nitrogen (%)	0.12
Available phosphorus (ppm)	0.43
Available calcium (me/100g)	4.20
Available sodium (me/100g)	0.35
Available potassium (me/100g)	0.49
Particle size analysis	
Clay (%)	3.5
Sand (%)	58.5
Silt (%)	32.5
Soil texture	Sandy loam
Maximum water holding capacity (%)	39.7

Source: Department of Crop Science, Adamawa State University, Mubi.

Table 2: Some physical and chemical properties of the soil used for the study

Table 3 shows the effects of NPK fertilizer and poultry manure on plant height and number of leaves per plant during 2014 cropping season. Plots treated with 120kg/ha of NPK 15:15:15 produced the tallest plants at 6 and 9 WAP. This was followed by plants applied with 150kg/ha and the least plant height was recorded by plots without NPK fertilizer (control plots). In a similar trend, the 120kg NPK/ha plots produced the highest number of leaves per plant at 6 and 9 WAP (i.e. 11.23 and 23.57 leaves/plant). Plant height and number of leaves increases gradually with the age (with increase in number of weeks after planting) for the NPK and the poultry manures. For the poultry manure at 6 WAP, the 15 t/ha plots had the tallest plant height (25.22 cm) and these was followed by plants with 10 t/ha manure (23.38 cm). At 9 WAP, plots with no manure (control plots) recorded the tallest plants (40.84 cm), which was followed by the plants with 15 t/ha manure (38.94 cm) and the least plant height was recorded by 10 t/ha poultry manure plots. However, the 10 t/ha manure plots had the highest number of leaves at 9WAP (25.10). At 6 WAP, the plant height obtained in okra treated with 15t/ha organic manure was taller than those with inorganic fertilizer. This agrees with the findings of Uwah *et al*., (2010) and Nmor (2011). The taller plants with higher number of leaves in plots with poultry manure or NPK fertilizers could be attributed to the improvement of soil fertilizer, which in turn increased the plant height and also the number of leaves/plant as earlier reported by Vincent *et al.*,(2005) and Olaiya *et al*., (2015). The enhanced plant growth following the application of poultry manure has also been observed by Yadav *et al.*,(2006); Lawal *et al.*,(2011); Olaiya *et al*.,(2015) in okra and Saidu *et al.*,(2011) in tomato. Aliyu *et a.*,(2007) also reported that application of farmyard manure increased the plant height of roselle, which is also the member of the malveceae family.

Treatment	Plant height (cm)		Number of leaves/plant	
	6WAP	9WAP	6WAP	9WAP
NPK 15:15:15 (kg/ha)				
0	22.47a	37.69a	8.69a	23.58a
120	23.83a	39.66a	11.23a	23.57a
150	23.06a	38.84a	10.93a	21.69a
SE±	1.12	1.68	0.75	1.51
Poultry Manure (t/ha)				
0	22.69a	40.84a	9.09a	24.58a
10	23.38ab	38.35a	10.88a	25.10a
15	25.22a	38.94a	11.48a	20.86a
SE±	1.13	1.65	0.79	1.59
Combined				
120 + 10	23.21a	40.80a	11.33a	25.93a
120 + 15	25.00a	37.27a	11.87a	20.60a
150 + 10	21.92a	35.80a	10.93a	22.27a
159 + 15	23.01a	39.73a	11.73a	20.27a
SE±	1.71	2.17	1.26	1.33
Interaction				
NPK × PM	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different at $P < 0.05$ using DMRT, NS = Not Significant, Poultry manure = PM

Table 3: Effect of NPK fertilizer and poultry manure on plant height and number of leaves/plant of okra plants during 2014 cropping season

The findings from this study clearly showed that the gradual increase in the plant height and number of leaves as a result of NPK application from 6 to 9WAP agreed with the work of Majambu *et al.,* (1986) and Sajjan *et al.,*(2002).

At 9WAP, okra vegetative traits (plant height and number of leaves/plant) responded significantly to application of 120 kg/ha of NPK fertilizer combined with 10 t/ha poultry manure. Similar results were obtained by Ikeh *et al.,* (2012) in cucumber trial.

Pod length, pod diameter, number of pod/plant 100 seed weight and fresh pod yield as influenced by NPK fertilizer and is presented in Table 4. Increase in NPK fertilizer rate from 0 to 120 kg/ha leads to an increase in pod length, pod, diameter, number of pod and fresh pod yield except for 100 seed weight where an increase in NPK fertilizer from 0 to 120 kg/ha and even to 150 kg/ha leads to a corresponding increase of 5.47g, 5.52 and 5.54 g respectively. This result is in line with Philip *et al*., (2008), whose findings showed that there was increase in okra pod yield with increase in NPK fertilizer up to 150kg NPK/ha. Plants without poultry manure recorded the longest okra pod length (10.06 cm) and this was followed by 10 t/ha plots, which had 9.96 cm pod length and the least was 15 t/ha manure plots. The widest pod diameter was recorded by 10 t/ha poultry manure plots and the least pod diameter was obtained in the control plots.

Treatment	PL	PD	NOP	100 swt	FPY
NPK 15:15:15(kg/ha)					
0	9.70a	2.85a	29.18a	5.47a	925.48a
120	9.81a	3.07a	31.26a	5.52a	982.30a
150	9.80a	3.04a	29.28a	5.54a	950.11a
SE±	0.20	0.60	1.95	0.17	63.93
Poultry manure (t/ha)					
0	10.06a	2.83a	26.32a	5.60a	897.72a
10	9.96a	3.05a	28.69a	5.62a	934.26a
15	9.57a	3.03a	28.76a	5.65a	935.45a
SE±	1.18	0.07	1.92	0.15	68.27
Combined (ha)					
120 + 10	9.90a	3.06a	30.32a	5.75a	964.08 a
120 + 15	9.43a	3.10a	29.23a	4.71a	931.80a
150 + 10	9.67a	3.04a	26.70	5.45a	762.88a
150 + 15	9.53a	2.97a	32.38	5.49a	933.41a
SE±	0.26	0.04	2.10	0.21	75.66
Interaction					
NPK × PM	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not significantly different at P < 0.05 using DMRT, NS = Not Significant, Poultry manure = PM, PL = Pod length, PD = Pod diameter, NOP = Number of pods/plant, 100 swt = Hundred seed weight, FPY = Fresh pod yield (kg/ha).

Table 4: Effect of NPK fertilizer and poultry manure on yield and yield attribute of okra during 2014 cropping season

Furthermore, the 15 t/ha manure plots had the highest number of pod/plant (28.76), followed by 10 t/ha manure plots (28.69) and the control plots recorded the lowest number of pods/plant (26.32). Each increase in poultry manure rate from 0 to 10 t/ha and further increase to 15 t/ha result in a corresponding increase in 100 seed weight and fresh pod yield. This result corroborates with the findings of Ainika *et al*., (2012) in *Amaranthus*; Onwu *et al*., (2014) and Olaiya *et al*., (2015) in okra.

The combined application rates of 120kg NPK /ha and 10 t/ha of poultry manure gave the best okra performance with respect to hundred seed weight and pod yield when compared with other treatments. There was no significant difference in the interaction effects between the NPK fertilizer and the poultry manure during the study.

The response of okra to NPK fertilizer and PM could be attributed to the contribution of the fertilizers in the supply of both macro and micro – nutrients necessary for crop growth and development as earlier reported by Tunku, (2012). The combination of organic materials with reduced NPK fertilizer rate can be used to sustain okra production in the tropics. A similar trend of response had earlier been reported in crops where organic and inorganic fertilizer was applied (Ibeawuchi, 2009; Aliyu *et al.*, (2007); Vincent *et al.*, (2005) and Tunku, (2012) in okra.

IV. CONCLUSION

The usage of inorganic fertilizer and poultry manure on okra growth and yield is important, because the two fertilizers supply the macro- and macro nutrients, which improves soil fertility and increase crop yield. Therefore, from the result of this study, complementary application of 120kg NPK/ha + 10 t/ha of poultry manure would result in better growth and yield performance of okra.

V. RECOMMENDATIONS

From the findings of this research, it may be recommended that sole application of 120kg NPK/ha or sole application of 15 t/ha of poultry manure may improve the growth and yield of okra. But a complementary application of 120kg NPK/ha + 10 t/ha of combined fertilizer would result in better growth yield performance than applying each of these fertilizers separately.

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