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COMPARATIVE EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK FERTILIZER ON THE GROWTH, YIELD AND NUTRIENT CONTENT OF OKRA (*abelmoschus esculentus*)

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ABSTRACT

Field and laboratory experiments were conducted to evaluate the comparative effects of poultry manure, piggery manure and NPK fertilizer on the growth, yield and nutrient content of Okra (*Abelmoschus esculentus*) in Umudike southeastern Nigeria. The treatments were: Control (A), 10 tons/ha Piggery manure (B), 10 tons/ha poultry manure (C), 10 tons/ha poultry manure + 100 kg/ha NPK (15:15:15) fertilizer (D), 10 tons/ha Piggery manure + 100 kg/ha NPK (15:15:15) fertilizer (E) and 400 kg/ha NPK (15:15:15) fertilizer (F). The treatments were replicated three times. The experiment was laid out in a randomized complete block design. The test soil was strongly acidic, having a pH (5.0) and low in % total nitrogen, % OC and the exchangeable bases. The okra variety Ivra v 21 was used for the study. From the results obtained from the study, plant height, stem girth and the number of leaves of Okra were significantly ($P<0.05$) increased over the other treatments by treatment B. However at harvest, treatments C and D gave the highest values of fresh fruit weight and fruit number respectively. The N, P and K contents of the okra was also investigated, but the result obtained could not be attributed to the treatments applied. Treatments C (10tons/ha PM) and D (10tons/ha PM + 100kg/ha NPK fertilizer) were therefore recommended for profitable Okra (*Abelmoschus esculentus*) production.

Key Words: Abelmoschus esculentus, Inorganic fertilizer, Andomized complete block design

INTRODUCTION

Nigerian soils are being degraded at an alarming rate through continuous cultivation, deforestation and inappropriate farming practices (Oshunsanya, 2011). This practice results in low organic matter content that makes the fragile soils collapse under the impact of rain drops leaving the soil more prone to compaction and erosion (Aiyelari and Oshunsanya, 2008). Consequently, the potential capacity of the soil to support healthy and nutrition yield of crop to meet the demand of the ever increasing human population is hindered.

Continuous cultivation of crops on the same piece of land is practiced in Africa due to rapid growth in population coupled urbanization and industrialization (Isokrari, 1995).

Vegetables play a vital role in the improvement of the diet of mankind (Schippers, 2000). Okra (*Abelmoschus esculentus*) is a vegetable of national importance in Nigeria. 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 such as 'eba', amala, akpu, pounded yam, etc. (Denton and Olufolaji, 2000). It is a good source of vitamins, minerals, calories, and amino acid found in its seeds compare favourably with those in poultry, eggs and soybean (Schippers, 2000).

Tropical soils are adversely affected by sub-optimal soil fertility are erosion causing deterioration the nutrients status and changes in soil organism population (Economic Commission for Africa, 2001)

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Fertilizer is a very essential input in crop production. The application of fertilizer is necessary for enhancing the soil nutrient status and increasing crop yield (Olaniyi *et al.,* 2010).

Use of inorganic fertilizers can improve crop yields and total nutrient content and nutrient availability but its use is limited due to scarcity, high cost, nutrient imbalance and soil acidity (Olaniyi *et al.,* 2010). Therefore use of organic manures as a means of increasing and maintaining soil fertility has been advocated (Smil, 2000). Organic manures improve soil fertility by increasing the activity soil microbial biomass (Ayuso *et al.,* 1996) thereby improving the physical and biological properties of the soil (El-Magd *et al.,* 2006).

It has being reported that combing organic and inorganic fertilizers has a greater beneficial residual effect than can be derived from use of either organic or inorganic fertilizers alone (Akande *et al.,* 2010, Akande *et al.,* 2003, Akanbi *et al.,* 2005).

Many researchers have carried out some work on the combined use of organic and inorganic fertilizers on the growth of some crops including okra in the southwestern part of Nigeria (Giwa and Ojeniyi, 2004, Olaniyi *et al.,* 2010, Akande *et al.,* 2010).

However, research on the combined use of organic and inorganic fertilizers on the growth, and yield of okra in the ultisol of southeastern Nigeria has not been carried out in the recent past. This is the reason for this study.

OBJECTIVES

1. To compare the effects of organic manure, inorganic fertilizer (NPK 15.15:15) and their combination on the growth and yield of okra (*Abelmoschus esculentus*) in an ultisol of Southeastern Nigeria.
2. To find out the effects of the above treatments on the nutrient content of okra ***(****Abelmoschus esculentus****)***

MATERIALS AND METHODS

DESCRIPTION OF THE EXPERIMENTAL SITE

Site Location

The experiments were conducted at Michael Okpara University of Agriculture, Umudike.

Umudike lies within latitude 05° 29'N and longitude 07° 33'E within an elevation of 122mm above the sea level.

SOIL SAMPLING/SAMPLES PREPARATION

Pre-planting sampling was carried out on the experimental field to determine the inherent soil characteristics before treatment incorporation. Soil samples were collected at the depth of 0-15cm at various point of the field and bulked together for laboratory analysis.

Sample preparation

Samples were air-dried, gently crushed with a wooden roller and passed through sieves of 0.5mm and 2mm sizes for Total Nitrogen and Organic Carbon and other determinations respectively.

LABORATORY STUDIES

General physical and chemical analysis of the soil

Standard methods of physical and chemical analyses for soils were used to analyze these parameters.

Particle size analysis

The particle size analysis was carried out using the Bouyoucos hydrometer method (Jackson, 1964).

Soil reaction (pH)

Soil pH was determined using the glass electrode pH meter in a soil to water ratio of 1:2.5

Exchangeable acidity (Al^{3+} and H^{+})

Soil exchangeable acidity (Al^{3+} and H^{+}) was determined by titration method (Mclean, 1982).

Organic carbon

Soil organic carbon was determined by Walkley and Black (1934) method.

Total Nitrogen

Soil total nitrogen was determined using the micro-kjeldahl digestion and distillation method (Jackson, 1964).

Available phosphorus

The available phosphorus was determined using Bray and Kurtz (1945) No. 2 method.

The exchangeable bases

The soils were leached with 1N NH_4OAc (Ammonium acetate) at pH 7. Calcium and Magnesium were determined using the EDTA titration method while potassium and sodium were determined by flame photometry.

Effective Cation Exchange Capacity

Effective Cation Exchange Capacity was calculated as the sum of exchangeable bases (Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}) and exchangeable acidity.

Base Saturation

The base saturation was determined using the equation.

$$\text{Base saturation} = \frac{\text{Total exchangeable bases x 100}}{\text{ECEC}}$$

Treatments

The treatments consist of Poultry manure (P M), Piggery manure (PD) and N P K (15: 15:15) fertilizer combined thus:

A- Control
B- .10 tons/ha PD
C- 10 tons/ha PM
D- 10 tons/ha PM + 100 kg/ha NPK fertilizer
E- 10 tons/ha PD + 100 kg/ha NPK fertilizer
F- 400 kg/ha NPK fertilizer

The treatments were replicated three times in a randomized complete block design

FIELD EXPERIMENT

The field was slashed, ploughed and made into beds 2m by 2m. The experiment was laid out in a randomized complete block design (R C B D) with three replications. The organic manures were applied on the necessary plots two weeks before planting. Okra seeds (variety, Ivra v 21) was planted 3 seeds per hole at a distance of 50 cm x 50 cm and thinned to one seedling per stand at 3 weeks after planting.

Records of agronomic measurement

- Random samples of five plants per plot were selected and tagged for data collection.
- Data on growth parameters (plant height, stem girth and number of leaves) were taken at two weeks interval on the tagged plants form 3 weeks after planting (WAP)
- At harvest, numbers and fresh weights of fruits were recorded.

NUTRIENT CONTENT OF OKRA

The dried fruits okra was grinded and milled to pass through 1mm sieve. The grinded samples were subjected to kjeldahl digestion at 360^{0}C for 4 hours with concentrated H_2SO_4. Total Nitrogen was determined form the digest by steam distillation with excess NaOH. Phosphorus and potassium contents were determined by ashing 0.2g plant sample in a muffle furnace at 600^{0}C for 2 hours. The ash was cooled and dissolved in 1N HCl and from the solution, phosphorus was determined by the vanadomolybdate yellow calorimetry method using spectrophotometer. Potassium was determined using flame photometer

STATISTICAL ANALYSIS

Data generated from field experiment and laboratory analyses were subjected to analysis of variance (ANOVA) using the SAS software and the treatment means was separated using Fischer's Least Significance Difference (FLSD) at 5% probability level.

RESULTS AND DISCUSSION

Physico-chemical properties of the soil under study

The physico-chemical properties of the soil used for this study are presented in Table 1. The soil pH was low, signifying very strong acidity (Hazelton and Murphy, 2011). Organic carbon and total nitrogen were low, and available phosphorus was moderate (Akinrinde and Obigbesan, 2000). This result shows the need of the soil under study for organic amendment.

Table 1: Physico-chemical properties of the soil before experimentation

Parameters	Values
Soil pH (1:2.5 H_2O)	5.00
Soil pH (1:2.5 KCl)	4.20
% Total nitrogen	0.01
% Organic carbon	0.67
Available phosphorus (mg/kg)	11.52
Exchangeable Potassium (cmol/kg)	0.21
Exchangeable Sodium (cmol/kg)	0.52
Exchangeable Calcium (cmol/kg)	0.12
Exchangeable magnesium (cmol/kg)	1.60
TEB (cmol/kg)	2.45
Exchangeable acidity (cmol/kg)	1.68
ECEC (cmol/kg)	4.13
Base saturation (%)	59.32
Sand (%)	92.40
Silt (%)	2.40
Clay (%)	5.20
Soil texture	Sand

TEB = Total Exchangeable Bases

CHEMICAL PROPERTIES OF ORGANIC AMENDMENTS USED FOR THE STUDY

The chemical properties of the organic materials used in this study are shown in Table 2. Both manures contain nutrient elements that will be useful to the growth of the okro plant. The piggery manure had higher percentage of mineral nutrients all through. This is an indication that the piggery manure would enhance the growth of the crop under study.

Table 2: Chemical properties of the Poultry and Piggery manure used for the study

Parameters	Values	
	Piggery	Poultry
pH (water)	8.50	5.70
pH (1N KCl)	8.20	5.50
% Calcium	5.84	3.80
% Magnesium	1.92	0.24
% Total carbon	26.60	14.11
% Organic matter	45.86	24.33
% Nitrogen	2.63	2.45
% Total phosphorus	0.39	0.32
% Total potassium	0.02	0.01

EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK (15:15:15) FERTILIZER ON PLANT HEIGHT IN OKRA (Abelmoschus esculentus)

Table 3 shows the effects of Poultry manure, piggery manure and NPK fertilizer on plant height in Okra (*Abelmoschus esculentus*). 10 tons/ha piggery manure applied singly gave the highest values for plant height throughout the period of measurement, followed by 10 tons/ha piggery manure + 100 kg/ha NPK fertilizer, then 10 tons/ha poultry manure + 100 kg/ha NPK fertilizer, 10 tons/ha poultry manure, then the 400 kg/ha NPK fertilizer and then the control gave the least values. The results were significantly different ($P<0.05$) among the treatment means; the organic manures gave better plant height of the okra plant. It shows that organic manure is an excellent soil amendment, providing both organic matter and nitrogen. It also improves the soil physical structures, initiating a good soil environment for plant growth (Eneje and Uzoukwu, 2012)

Table 3: Effects of Poultry manure, piggery manure and NPK fertilizer on plant height in Okra (Abelmoschus esculentus)

Treatments	3 WAP	5 WAP	7 WAP	9 WAP
	(cm)			
A	5.80	8.63	9.49	8.67
B	15.00	22.89	24.41	29.83
C	8.19	13.69	19.89	18.55
D	10.65	19.42	25.61	26.47
E	11.47	17.73	19.47	18.94
F	7.19	12.07	15.95	19.98
$LSD_{(0.05)}$	1.86	2.60	5.37	7.02

WAP = Weeks after planting, A-Control, B- 10 tons/ha Piggery manure, C-10 tons/ha Poultry manure
D-10 tons/ha Poultry manure + 100 kg/ha NPK fertilizer,
E-10 tons/ha Piggery manure + 100 kg/ha NPK fertilizer,
F-400 kg/ha NPK fertilizer

EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK (15:15:15) FERTILIZER ON THE STEM GIRTH OF OKRA (Abelmoschus esculentus)

Table 4 presents the Effects of Poultry manure, piggery manure and NPK (15:15:15) fertilizer on the stem girth of Okra (*Abelmoschus esculentus*). The stem girth of the okra plant was significantly ($P<0.05$) increased when10 tons/ha piggery manure only was applied. The next to it was 10 tons/ha piggery manure + 100 kg/ha NPK (15:15:15) fertilizer, whose effect produced a lower value than the former but the difference was not significant ($P>0$-05). This result is consistent with the findings of Olatunji and Uboh (2012), who found out that piggery manure was more effective than other organic manures used in his study, for the growth of okra and tomato.

Table 4: Effects of Poultry manure, piggery manure and NPK fertilizer on the stem girth of Okra (Abelmoschus esculentus)

Treatments	3 WAP	5 WAP	7 WAP	9WAP
	cm			
A	0.98	1.18	1.25	2.14
B	1.88	2.65	3.07	3.15
C	1.10	1.74	2.09	2.10
D	1.27	2.05	2.51	3.09
E	1.72	2.33	2.58	2.56
F	1.03	1.58	1.83	1.94
$LSD_{(0.05)}$	0.18	0.29	0.46	NS

WAP = Weeks after planting, A-Control, B- 10 tons/ha Piggery manure, C-10 tons/ha Poultry manure
D-10 tons/ha Poultry manure + 100 kg/ha NPK fertilizer,
E-10 tons/ha Piggery manure + 100 kg/ha NPK fertilizer,
F-400 kg/ha NPK fertilizer

EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK (15:15:15) FERTILIZER ON THE NUMBER OF LEAVES IN OKRA (*Abelmoschus esculentus*)

Table 5 shows the number of leaves of Okra (*Abelmoschus esculentus*) as influenced by poultry manure, piggery manure and NPK (15:15:15). From the table, the plots treated with 10 tons/ha piggery manure produced the highest number of leaves when compared with other treatments starting from the 3rd WAP till the 7th WAP; the difference was significant (P<0.005) among the treatment means. At the 9th WAP the treatment 10 tons/ha poultry manure + 100 kg/ha NPK (15:15:15) fertilizer gave a higher value than the other treatments. It could be that the nutrients in the poultry manure were not quickly released when compared with the piggery manure and the other treatments. Olatunji *et al*. (2012) also reported an increase in cowpea yield when poultry manure was used in combination with NPK fertilizer.

Table 5: Effects of Poultry manure, piggery manure and NPK (15:15:15) fertilizer on the number of leaves in Okra (Abelmoschus esculentus)

Treatments	3 WAP	5 WAP	7 WAP	9 WAP
A	3.93	4.53	3.83	1.27
B	5.80	6.93	7.87	5.27
C	5.47	5.73	6.40	4.53
D	4.87	6.33	7.73	5.67
E	5.47	6.33	4.87	2.93
F	4.33	5.53	6.53	4.67
LSD $_{(0.05)}$	NS	0.74	1.69	1.96

WAP = Weeks after planting, A-Control, B- 10 tons/ha Piggery manure, C-10 tons/ha Poultry manure
D-10 tons/ha Poultry manure + 100 kg/ha NPK fertilizer,
E-10 tons/ha Piggery manure + 100 kg/ha NPK fertilizer,
F-400 kg/ha NPK fertilizer

EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK (15:15:15) FERTILIZER ON THE FRESH FRUIT YIELD OF OKRA (*Abelmoschus esculentus*)

Table 6 presents the yield of okra (*Abelmoschus esculentus*) as a result of the treatments with poultry manure, piggery manure and NPK (15:15:15) fertilizer. At harvest, the fresh fruit weight (g) of okra (*Abelmoschus esculentus*) was in this order: 10 tons/ha poultry manure >10 tons/ha poultry manure + 100 kg /ha NPK (15:15:15) fertilizer > control> 10 tons/ha piggery manure> 10 tons/ha piggery manure + 100 kg /ha NPK (15:15:15) fertilizer > 400 kg /ha NPK (15:15:15) fertilizer. The fresh fruit number also followed almost the same pattern although the results obtained were not significantly different among the treatments (P> 0.05). The results were not consistent with what was obtained in the growth period of the okra. This could be because the poultry manure did not quickly begin the process of mineralization when compared with the other treatments, so at harvest it produced the highest result. The Piggery manure used in this study contains more % nitrogen than the poultry manure (Table 2). As a result, the vegetative growth of the okra was more favoured by the piggery manure than the fruit yield. Nitrogen is known to facilitate vegetative growth of crops (Agbede, 2009). The control having better yield than some of the treatments could be as a result of the rains washing some of the nutrients from the treated plots which was not pronounced until the time of harvest.

Table 6: Effects of Poultry manure, piggery manure and NPK (15:15:15) fertilizer on the fresh fruit yield of Okra (Abelmoschus esculentus)

Treatments	Fresh weight (g)	Fresh fruit number
A	29.70	2.00
B	28.57	2.00
C	46.20	4.00
D	38.07	4.33
E	21.30	2.67
F	13.63	1.33
LSD $_{(0.05)}$	NS	NS

A-Control, B- 10 tons/ha Piggery manure, C-10 tons/ha Poultry manure
D-10 tons/ha Poultry manure + 100 kg/ha NPK fertilizer,
E-10 tons/ha Piggery manure + 100 kg/ha NPK fertilizer,
F-400 kg/ha NPK fertilizer

EFFECTS OF POULTRY MANURE, PIGGERY MANURE AND NPK (15:15:15) FERTILIZER ON THE NUTRIENT CONTENT OF OKRA (*Abelmoschus esculentus*)

The nitrogen, phosphorus and potassium contents of the okra plant (*Abelmoschus esculentus*) are as presented in Table 7. The result obtained could not be attributed to the effect of treatments applied. The nitrogen content of the okra was highest in the control, followed by the 10 tons/ha piggery manure + 100 kg/ha of NPK fertilizer, then the combinations of Poultry and piggery manures with NPK (15:15:15) fertilizer respectively, then the 400kg/ha NPK (15:15:15) and the least value was obtained with 10 tons/ha piggery manure. However, % phosphorus content was significantly (P<0.05) increased by the application of 10 tons/ha poultry manure among the treatments, followed by the application of 10 tons/ha piggery manure + 100 kg/ha NPK fertilizer. The potassium values were not significantly different among the treatments.

Table 7: Effects of Poultry manure, piggery manure and NPK (15:15:15) fertilizer on the nutrient content of Okra (Abelmoschus esculentus)

Treatments	% N	% P	% K
A	0.57	3.67	0.08
B	0.41	3.18	0.08
C	0.43	5.29	0.08
D	0.43	2.83	0.08
E	0.52	4.35	0.08
F	0.46	3.34	0.08
$LSD_{(0.05)}$	0.03	0.02	NS

WAP = Weeks after planting, A-Control, B- 10 tons/ha Piggery manure, C-10 tons/ha Poultry manure
D-10 tons/ha Poultry manure + 100 kg/ha NPK fertilizer,
E-10 tons/ha Piggery manure + 100 kg/ha NPK fertilizer,
F-400 kg/ha NPK fertilizer

CONCLUSION

This study has shown that addition of organic materials such as poultry and piggery manure solely or in combination with NPK fertilizer would improve the growth of okra (*Abelmoschus esculentus*) in the soil of the study area. Despite the environmental and other yield constraints encountered by the crop during the growth and fruit production periods, from the overall assessment, going by the fruit yield performance of okra, the 10 tons/ha poultry manure gave the best result, followed closely by its combination with 100 kg/ha NPK (15:15:15) fertilizer. They are therefore recommended in choosing the level of organic and inorganic fertilizers and their combination for use in okra production in the study area.

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