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Comparative Effects Of Organic And Inorganic Fertilizer Sources On Growth, Yield And Nutrient Content Of *Okra* In An Ultisol In Southeastern Nigeria

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Abstract
This study examined the comparative effects of organic and inorganic fertilizer sources on the growth, yield and nutrient content of okra (Abelmoschusesculentus) in an ultisol at Umudike. The treatments were: 10 tons/ha chicken manure, 10 tons/ha pig manure, 400kg/ha NPK 15:15:15 fertilizer, 1.0 kg/ha Agrolyser, 10 tons/ha chicken manure plus 400kg/ha NPK 15:15:15 fertilizer, 10 tons/ha of pig manure plus 400kg/ha of NPK 15:15:15 fertilizer and Control. The treatments were replicated three times in a randomized complete block design. The results showed that the test soil was moderately acidic, with a pH (6.0) and medium in percentage total nitrogen, low in percentage organic carbon (0.71) and low in available phosphorus and exchangeable bases. The okra variety SM 35 was used for the study. The results showed that10 tons/ha chicken manuresignificantly increased plant height, number of leaves of okraover the other treatments. However, at harvest, 1.0 kg/ha Agrolyserand 10 tons/ha chicken plus 400kg/ha NPK 15:15:15 fertilizer and 10 tons/ha of pig manure plus 400kg/ha of NPK 15:15:15 fertilizer, respectively gave the highest values of number of fruits and fresh fruit weight respectively. The N, P and K contents of okra was also investigated, but the result obtained could not be attributed to the effects of the treatments applied. 10 tons/ha chicken manure plus 400kg/ha NPK 15:15:15 fertilizer, 10 tons/ha of pig manure plus 400kg/ha of NPK 15:15:15 fertilizer and 1.0 kg/ha Agrolyser were therefore recommended for profitable okra production in the ultisolsof Umudike.

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I. Introduction

Nigerian soils are being degraded at an alarming rate through continuous cultivation, deforestation and inappropriate farming practices (Oshunsanya, 2011). These practices result in low organic 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 growth and yield of crops to meet the ever-increasing human population is hindered.

Vegetables play a vital role in the improvement of the diet of mankind (Schippers, 2000). Okra (*Abelmoschusesculentus* L. Moench) 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 food that aids easy consumption of the staple food products such as "eba", amala, akpu, pounded yam, e.t.c. (Denton and Olufolaji, 2000). Okra is a good source of vitamins, minerals, calories and amino acids found in its seeds and compare favourably with those in chicken, eggs and soybean meals (Schippers, 2000).

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). The use of inorganic fertilizer can improve crop yield, soil pH and total nutrient content and availability, but its use is limited due to scarcity, high cost, nutrient imbalance and soil acidity (Olaniyi et al., 2010). The 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 of soil microbial biomass (Ayuso et al., 1996) and sustain cropping system through better nutrient cycling (El- Shakweer et al., 1998), thereby improving the physical and biological properties of the soil (Abou El-Magd et al., 2006).

In Nigeria, non-availability of chemical fertilizers in terms of cost and time has forced farmers to look inward for cheaper ways of increasing soil productivity and crop yield through addition of locally produced organic fertilizers. It has been reported that combining organic and inorganic fertilizer has a great beneficial residual effect than can be derived from use of either organic or inorganic fertilizer (Akande et al., 2010, Akande et al., 2003, Akanbi et al., 2005).

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

However, research on the effect of different fertilizer sources on the growth and yield of okra in the ultisols of Southeastern Nigeria has not been carried out in the recent past. This is the reason for this study.

OBJECTIVES:

The objectives of this study are to:

1. Determine the complimentary effects of organic and inorganic fertilizer sources on the growth of okra (.*Abelmoschusesculentus*).
2. Assess the effects of organic and inorganic fertilizers sources on the yield of okra and,
3. Assess the complimentary effects of organic and inorganic fertilizer sources on the nutrient content of okra.

II. Materials And Methods

DESCRIPTION OF THE EXPERIMENTAL SITE

The experiment was conducted at Michael Okpara University of Agriculture, Umudike. Umudike lies within latitude 05° 29’N and longitude 07° 33’E within an elevation of 122m above the sea level. The soil is acidic, and characterized as an ultisol (Eke- Okoro et al., 1999).

LAND PREPARATION AND SOIL SAMPLING

Pre-planting sampling was carried out on the experimental field to determine the initial soil properties before treatment incorporation. Representative soil samples were collected at the depth of 0-20cm at various points in the field and bulked together for determination of the physical and chemical properties of the soil.

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 ANALYSIS

General physical and chemical analysis of soil

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

Particle size distribution

Soil particle size distribution was determined by the hydrometer method, Bouyoucus, (1951). Calgon was used as the dispersing agent; a soil sample weighing 51 g was subjected to dispersion overnight with the dispersing agent in a dispersing cup. The hydrometer readings weretaken the next day after stirring the content of the dispersing cup, transfer of the content to the sediment cylinder and a subsequent vigorous agitation of the cylinder from end to end while covering the open end of the cylinder with the palm was carried out. Hydrometer readings were taken after 40 seconds and 2 hours after agitation.

Soil reaction (pH)

Soil pH was determined in a 1:2.5, soil: water suspension (Thomas, 1996). Soil pH was measured in soil-water suspensions using a glass pH sensing electrode and a reference electrode.

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

Soil exchangeable acidity (Al^{3+} and H^+) was determined by titration method (Mclean, 1982). For the evaluation of the Al^{3+} in the extracts of 1 mol $L^{'1}$ KC1 solution, 1:10 (v/v) soil/solution ratio (McLean, 1965), the following procedures were used: a) Titrimetric method (standard method), according to the routine methodology adapted from McLean (1965). Primarily, the exchangeable acidity (Al^{3+} + H^+) was determined by titration of 25 ml KC1 extract with 0.025 mol L^{-1} NaOH, using 1 g L^{-1} phenolphthalein as anindicator (titration from colorless to pink). Then, the concentration of Al^{3+} is obtained by back-titration of the same KCl extract previously used, after the acidification with a drop of HCl and addition of 40 g L^{-1}NaF, with 0.025 mol L^{-1}HCl (titration from pink to colorless).

Organic carbon

Soil organic carbon was determined by the dichromate wet oxidation method (Nelson and Somners, 1996). Wet oxidation followed by titration with ferrous ammonium sulfate or photometric determination of Cr^{3+}.

Total nitrogen

Soil total nitrogen was determined using the micro-Kjedahl digestion procedure (Bremner, 1996). The soil samples were gently crushed to pass through a0.5 mm sieve, and the reaction was enhanced by adding salts to raise the temperature of the digestion mixture and by adding selenium as a catalyst to promote oxidation.

Available phosphorus

The available phosphorus was determined using Bray II method, using a solution of 1M NH4F and 0.5M HC1 in distilled water as the extractant (Kuo, 1996).

The exchangeable bases
The soils were leached with 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 ($Al^{3+} + H^+$).

Base saturation
The percentage base saturation was determined using equation

$$\text{Base saturation} = \frac{\text{Total exchangeable bases}}{\text{ECEC}} \times \frac{100}{1}$$

EXPERIMENTAL TREATMENTS
The experimental treatments consisted of chicken manure (CM) pig manure (PM) and NPK 15:15:15 fertilizer combined thus:
A –10tons/ha CM
B - 10tons/ha PM
C - 400kg/ha NPK 15:15:15 fertilizer
D - 1 kg/ha agrolyser (organo mineral fertilizer)
E - 10 tons/ha CM + 400kg/ha NPK 15:15:15 fertilizer
F - 10 tons/ha PM + 400kg/ha NPK 15:15:15 fertilizer
G - Control (no fertilizer added).
The treatments were replicated three times in a randomized complete block design.

FIELD EXPERIMENT
The field was slashed, ploughed and made into plots (beds) 2m by 2m. The experiment was laid out in a randomized complete block design (RCBD) in three replications. The organic manures were applied on the necessary plots eight days before planting. Okra seeds (variety SM 35) were planted 2 seeds per hole at a distance of 50cm x 50cm and thinned to one seedling per stand at 2 weeks after planting.

Data collection of agronomic measurement
- Random sample of four plants per plot were selected and tagged for data collection
- Data in growth parameters (plant height and number of leaves) were taken at two weeks interval on the tagged plant from 2 weeks after planting (WAP)
- At harvest, number and fresh weights of fruits were recorded

NUTRIENT CONTENT ANALYSIS OF OKRA
The dry fruit of okra was grinded and milled to pass through 1mm sieve. The grinded samples were subjected to Kjeldal digestion at 360°C for hours with concentrated H_2SO_4. Total nitrogen was determined from 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°C for 2 hours. The ash was cooled and dissolved in 1N HCl and from the solution, phosphorus was determined by the Vanadomolybdate yellow colorimetry method using spectrophotometer. Potassium was determined using flame photometer (NRCRI, 2003).

STATISTICAL ANALYSIS
Data generated from field experiment and laboratory analysis were subjected to analysis of variance (ANOVA) using the SAS software and the treatment means were separated using Fischer's least significance difference (FSLD) at 5% probability level.

III. Results And Discussion

PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL UNDER STUDY
Some physical and chemical properties of the soil are presented in Table 1. From the table, sand was 760.00g kg^{-1}, silt was 140.00gkg^{-1}, while clay was 100.00gkg^{-1}. The textural class of the soil was sandy loam. The pH values of 6.0 and 5.30 for H_2O and KCl showed that the soil was acidic (FDALR, 1990). The percentage organic carbon with a value of 7.10 gkg^{-1} was low, available phosphorus of 6.28 mgkg^{-1} was also low (FDALR, 1990). Total nitrogen with a value of 0.17 % was medium. The high rate of mineralization and subsequent high rate of leaching which accompany heavy rains within the southeast, could have been the reason why the nitrogen was not high but medium (Osodeke, 1996). The soil was generally low in exchangeable bases. The exchangeable bases had values of Na (0.28 cmolkg^{-1}), Ca (2.00 cmolkg^{-1}), Mg (0.49 cmolkg^{-1}) and K (0.12 cmolkg^{-1}) and these were very low, this corroborates the findings of Nwite et al. (2009); Ezekiel et al. (2009) who reported that the ultisols of the southeastern Nigeria were low in exchangeable bases.

The low potassium content was probably due to the low levels of illitic clay minerals in the soil. The effective cation exchange capacity of 3.29 $cmolkg^{-1}$ was very low when compared with the threshold level of 4 cmolkg'1. The base saturation value of 87% was, however, average (FDALR, 1990). The extractable micronutrients ranged from 0.80 to 64.8 $mgkg^{-1}$.

Table 1: Some physical and chemical properties of the soil used before the experiment

Soil properties	Unit	Values
1. Mechanical properties		
Sand	gkg^{-1}	760.00
Silt	gkg^{-1}	140.00
Clay	gkg'1	100.00
Texture		Sandy loam
2. Chemical properties		
pH (H20)		6.00
pH (KC1)		5.30
Organic carbon	gkg^{-1}	7.10
Organic matter	Gkg^{-1}	12.24
Exchangeable bases	$Cmolkg^{-1}$	2.90
Exchangeable acidity	$Cmolkg^{-1}$	0.40
Effective cation exchange capacity	$Cmolkg^{-1}$	3.29
Base saturation	%	87.84
3. Nutrient concentration		
Total nitrogen (N)	%	0.17
Available phosphorus (P)	$mgkg^{-1}$	6.28
Calcium (Ca)	$cmokg^{-1}$	2.00
Magnesium (Mg)	$cmokg^{-1}$	0.49
Sodium (Na)	$cmokg^{-1}$	0.28
Potassium (K)	$cmokg^{-1}$	0.13
4. Extractable Micronutrients		
Manganese (M2+)	$mgkg^{-1}$	5.40
Iron (Fe3+)	$mgkg^{-1}$	64.80
Copper (Cu2+)	$mgkg^{-1}$	0.80
Zinc (Zn2+)	$mgkg^{-1}$	20.00

CHEMICAL PROPERTIES OF THE AMENDMENTS USED FOR THE STUDY

Some chemical composition of the manure used in this study is presented in Table 2. From the analysis, chicken manure, pig manure and agrolyser contain certain nutrient elements that can be of agronomic usefulness to crops. The poultry and pig manures used were generally high in the major nutrients (Tables 2 and 3). The poultry manure had properties consistent with those of pig manure from other farms and also compared very well with values obtained from other. The high Ca content was probably responsible for the relatively high pH.

Table 2: Chemical properties of chicken manure /pig manure

	Nutrients' value (%)	
Parameters	**Chicken Manure**	**Pig manure**
Phosphorus (P)	0.65	0.66
Nitrogen(N)	1.40	1.61
Potassium(K^+)	0.27	0.10
Calcium (Ca^{2+})	1.80	1.20
Magnesium (Mg^{2+})	0.73	0.49
Sodium (Na)	0.26	0.18
Organic Carbon (C)	12.44	10.67

Table 3: Chemical properties of the agrolyser used for the study

Parameters	Nutrient Value
Phosphorus (%)	18.00
Potassium (%)	12.00
Nitrogen (%)	20.00
Magnesium (%)	1.22
Calcium (%)	0.85
Boron (%)	0.13
Iron (%)	0.05
Copper (%)	0.08
Manganese (%)	0.07
Zinc (%)	0.05
pH	4.50
Density	1.46

EFFECTS OF CHICKEN MANURE, PIG MANURE, NPK (15:15:15) FERTILIZER AND AGROLYSER ON THE PLANT HEIGHT OF OKRA AT 2, 4, 6, 8, 10 AND 12 WEEKS AFTER PLANTING.

Figure 1 shows the effects of chicken manure, Pig manure, NPK fertilizer and Agrolyser on the height of okra. The highest plant height of 38.22 cm was obtained by 10 tons CM/ha at the 10th week, followed closely by the 10 tons PM/ha rates, while the lowest plant height of 18 cm was obtained from the control. These observations, though values were low, indicated that the plant height was significantly influenced by the different applications of organic manure and mineral fertilizer. It appeared that the 10 tons/ha rate of CM was emerging as a better choice than 10 tons PM/ha+400kg/ha rate of PM probably due to a phenomenon of decreasing returns. Previous researches by Law-Ogbomo (2013);Omotoso and Shittu (2008) reported similar results.

The 10 tons/ha of chicken manure applied singly gave significantly (P<0.05) higher values for plant height throughout the period of measurement, followed by 10 tons/ha of Pig manure relative to others. However, the control treatment significantly had the lowest values of plant height relative to the other treatments. The results were significantly different (P<0.05) among the treatment means. The organic manure gave better plant height of the okra plant.This finding agrees with previous studies reported by Babatola (2006); Adewole and Ilesanmi (2011); Taiwo et al (2002); Awe et al (2006) who worked extensively on Abelmoschusesculentus.

The finding showed that organic manure is an excellent soil amendment, providing both organic matter and nitrogen (Gardner, 2004). It also improved the soil physical structures, initiating a good soil environment for plant growth (Eneje and Uzoukwu, 2012; Law-Ogbomo, 2013;Omotoso and Shittu, 2008)

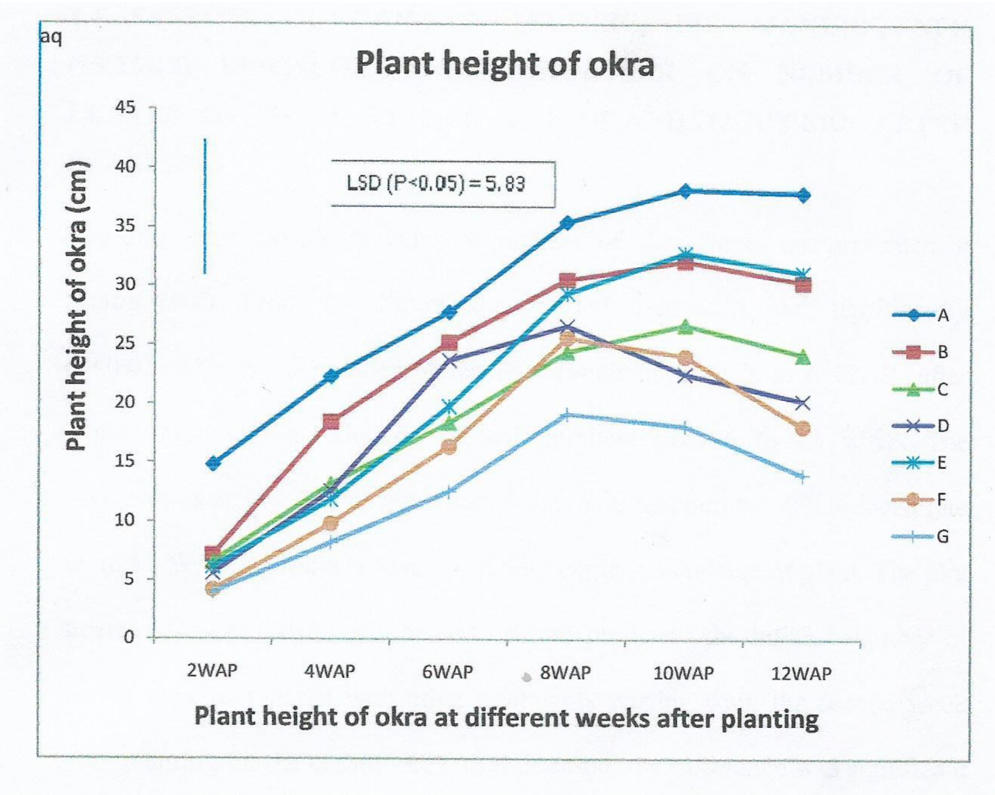

Figure 1: Effects of chicken manure, pig manure, NPK (15:15:15) fertilizer and agrolyser, on plant height of okra at 2, 4, 6,8,10 and 12 weeks after planting

WAP = Weeks after planting

(A) = 10 tons/ha of CM, (B) - 10 tons/ha of PM, (C) = 40Qkg/ha of NPK (15:15:15) fertilizer, (D) = 1 kg/ha of Agrolyser, (E) = 10 tons/ha CM/400kg/ha NPK (15:15:15) fertilizer, (F) = 10 tons/ha PM/400kg/ha NPK (15:15:15) fertilizer and (G) = 0 ton/ha (control).

EFFECTS OF CHICKEN MANURE, PIG MANURE, NPK (15:15:15) FERTILIZER AND AGROLYSER ON NUMBER OF LEAVES OF OKRA AT 2, 4, 6, 8, 10 AND 12 WEEKS AFTER PLANTING.

The effects of soil amendments on number of okra leaves are presented in Figure 2. From the figure, the applied treatments had significantly (P<0.05) effects on number of leaves throughout from 2 to 6 WAP, after which there was a reduction of leaf numbers from 6 to 12 WAP. The applications of 10 tons CM/ha continued to increase leaf number at a reduced rate up to 12 WAP, a probable case of nutrient depletion and age of plant. The plot treated with 10 tons/ha of chicken manure produced the highest number of leaves when compared with other treatments starting from the second week after planting till the eighth week after planting; the difference was significant (P<0.05) among the treatment means. Previous studies by Law-Ogbomo (2013); Omotoso and Shittu (2008); Babatola (2006) and, Adewole and Ilesanmi, 2011) had similar results.

At the 10 to 12 weeks after planting, the application of 10 tons/ha of chicken manure plus 400kg/ha of NPK (15:15:15) fertilizer gave a significant (P<0.05) higher value than the other treatments. It could be that nutrients (especially nitrogen) from the NPK (15:15:15) fertilizer complemented those of the chicken manure, which became more pronounced towards the end of the experiment, giving rise to more number of leaves (Adewole and Ilesanmi, 2011; Taiwo et al, 2002; Awe et al., 2006). Olatunji et al. (2012) also reported an increase in crop yield when chicken manure was used in combination with NPK (15:15:15) fertilizer.

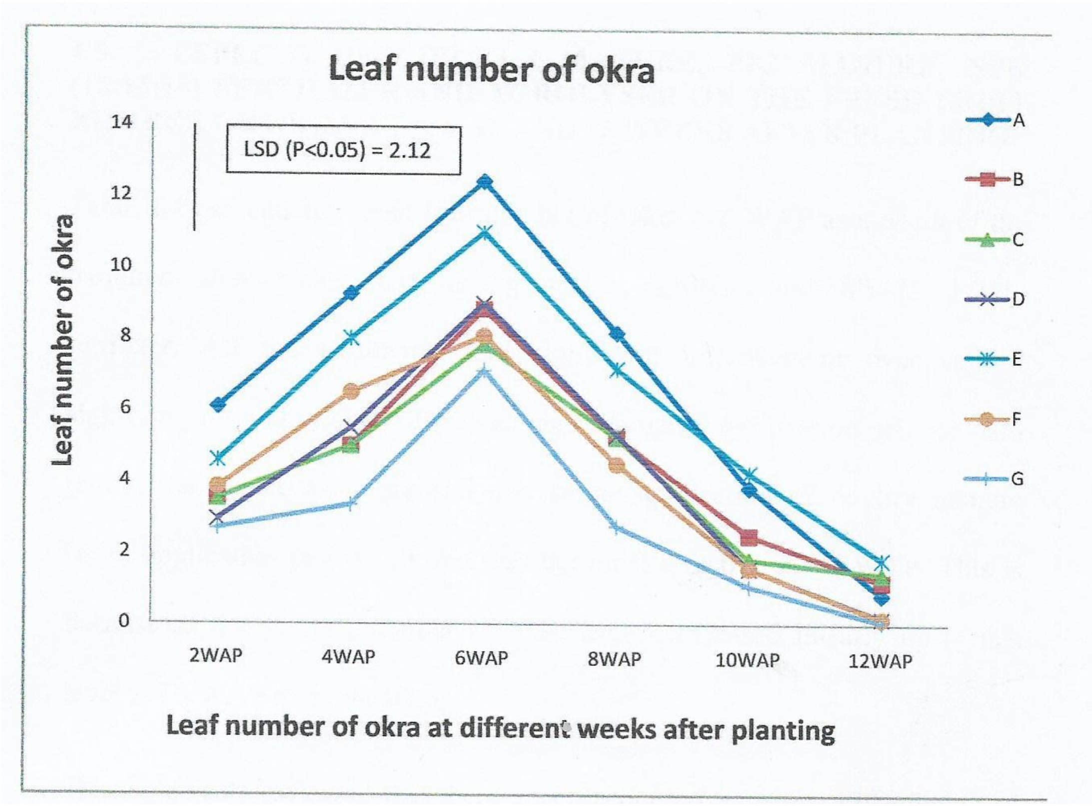

Figure 2: Effects of chicken manure pig manure, NPK (15:15:15) fertilizer and Agrolyser, on number of leaves of okra at 2, 4, 6,8,10 and 12 weeks after planting

WAP = Weeks after planting

(A) = 10 tons/ha of CM, (B) - 10 tons/ha of PM, (C) - 400kg/ha of NPK (15:15:15) fertilizer, (D) - 1 kg/ha of Agrolyser, (E) = 10 tons/ha €M/40Qkg/ha NPK (15:15:15) fertilizer, (F) =10 tons/ha PM/400kg/ha NPK (15:15:15) fertilizer and (G) = 0 ton/ha (control).

EFFECTS OF CHICKEN MANURE, PIG MANURE, NPK (15:15:15) FERTILIZER AND AGROLYSER ON THE FRESH FRUIT NUMBER OF OKRA AT 6, 8,10 AND 12 WEEKS AFTER PLANTING.

Table 4 presents the fresh fruit number of Okra and WAP as a result of the treatment with chicken manure, Pig manure, agrolyser and NPK (15:15:15) fertilizer. All the treatments had significant improvement over control signifying the importance of organic and inorganic fertilization soil for okra production. Table 4 showed that single application of poultry manure (CM) application rate of 10 tons/ha was the most effective at 10 WAP. This is because as the yields (Number of fresh fruits) increased linearly up to this level at 10 WAP of application.

The table 4 revealed that there was a progressive increase of number of fresh fruit of okra from 6 WAP to 10 WAP after which there was a decline in fruit number. This observation was attributed to the reduction in number of leaves produced by the okra per stand and due to the age of the plant. This underscores the importance of crop leaves in the production of fruit. Lack of active leaves limit the photosynthetic active radiation, which is important during the process whereby the plant manufactures its food and stores in the storage organs.

According to Table 4, the number of fruits per plant ranged from 7.63 for Agrolyser to 4.83 for control with a mean of 5.94. However, at 10 WAP,

10tons/ha CM followed by 10 tons/ha PM application significantly (P<0.05) increased the fresh number of okra (Table 4). At 10 WAP, higher fresh number of 9.67 and 8.30 per plot were recorded for 10 tons/ha CM followed by 10 tons/ha PM, respectively. Similar results were obtained by S.O. Omotoso and O.S. Shittu (2008); Babatola (2006); Law-Ogbomo (2013).

The results indicated that poultry manure at a rate of 10 tons CM/ha had the potential to improve number of okra yields significantly over control. This poultry manure rate may serve as an alternative to chemical fertilizer at the rate used in this study and may be recommended. From this study, it could be seen that, addition of 400 kg/ha of NPK to the 10 tons CM/ha did not result in significantly proportional increase in number of okra fruit at 6WAP.

The Pig manure contained more percentage nitrogen than the chicken manure (Table 2). But the chicken manure favoured more of vegetative growth in the okra than the Pig manure. This could be as a result of the rain washing some of the nutrients (e.g. Nitrogen) from the other treated plots (Pig manure plot, NPK plot, agrolyser plot, chicken manure + NPK etc) down the slope towards the plots treated with the chicken manure. It is known, that potassium and phosphorus are essential for fruiting and seed development. The agrolyser produced the highest number of fruit because it contained a high percentage of potassium than the rest. Potassium is very essential for maximum yields crop (Agbede, 2009).

Table 4: Effects of chicken manure, pig manure, NPK (15:15:15) fertilizer and Agrolyser on the fresh fruit number of okra at 6, 8, 10 and 12 weeks after planting.

Treatment	6WAP	8WAP	10 WAP	12 WAP	Mean
1 Otons/ha CM	5.11	8.37	9.67	3.00	6.53
1 Otons/ha PM	4.20	7.33	8.30	6.80	6.65
400kg/ha NPK	5.11	8.62	5.02	3.60	5.58
Agrolyser	8.38	10.82	6.53	4.80	7.63
1 Otons/ha CM +	4.19	6.04	7.40	2.80	5.11
400kg NPK 1 Otons/ha PM +	5.06	8.40	4.22	3.20	5.22
400kg NPK Control	4.44	9.55	3.34	2.00	4.83
Mean	5.21	8.45	6.35	3.74	
LSD $_{(0.05)}$	0.22	1.20	0.31	0.11	

WAP = Weeks after planting

EFFECTS OF CHICKEN MANURE, PIG MANURE, NPK (15:15:15) FERTILIZER AND AGROLYSER ON THE FRESH FRUIT (YIELD (G/PLOT)) WEIGHT OF OKRA AT 6, 8, 10 AND 12 WEEKS AFTER PLANTING.

The effect of different amendment of fertilizer application on fresh weight of Okra and WAP are shown in Table 5. The table reviewed that there was a progressive increase of fresh fruit of okra from 6 WAP to 10 WAP after which the fruit there was a decline in fruit weight. This observation was due to the reduction in number of fruit produced by the okra per stand as a result of age of the plant.

According to Table 5, the fresh fruits weight (g/plot) ranged from 18.55 g for 10 tons/ha CM + 400kg NPK to 9.25 g for control with a mean of 15.41 g.However, at 10 WAP, Agrolyser fertilizer followed by 10 tons/ha CM + 400kg NPK and 10 tons/ha PM + 400kg NPK application significantly (P<0.05) increased the fresh weight of okra (Table 5). At 10 WAP, higher fresh weight of 23.67, 21.32 and 20.67 g/plot were recorded for Agrolyser followed by 10 tons/ha CM + 400kg NPK and 10 tons/ha PM + 400kg NPK, respectively. Similar results were obtained by S.O. Omotoso and O.S. Shittu (2008); Babatola (2006); Law-Ogbomo (2013).

The yield obtained in the study is a reflection of the application of organic, inorganic fertilizer and their combinations to the soil nutrient. The observed differences among fertilizer types could be related to nutrient availability to okra plants and release patterns by the fertilizers. The reduced fruit yield produced from the control plots could be related to insufficient nutrient uptake as the plants have to rely on the native fertility of the soil. The yield analysis revealed that the fruit yield increase was due to number of fruits per plant. The highest fruit yield produced from Agrolyser followed by 10 tons/ha CM + 400kg NPK and 1 Otons/ha PM + 400kg NPK treated plots might be due to its cumulative effect of nutrients released by these treatments in the soil.

The average yield of okra in Nigeria was estimated at 5.00 t ha'1 (FAO, 2007). But with improved management practice, yield up to 10 t ha"1 are possible. The observed yield differences among treatments could be related to nutrient availability to crops and release patterns by the organic fertilizer. The fruit yield obtained in the study is a reflection of improvement in nutrient status of the soil as a result of fertilizer application.

Table 5: Effects of chicken manure, pig manure, NPK (15:15:15) fertilizer and Agrolyser on the fresh fruit (yield (g/plot)) weight of okra at 6, 8,10 and 12 weeks after planting

Treatment	6WAP	8WAP	10 WAP	12WAP	Mean
10tons/ha CM	15.25	13.40	18.45	8.39	13.87
10tons/ha PM	16.20	19.30	19.01	9.57	16.02
400kg/ha NPK	13.90	20.39	16.52	12.56	15.84
Agrolyser	13.30	21.09	23.67	10.10	17.04
10tons/ha CM	19.44	20.70	21.32	12.73	18.55
+ 400kg NPK 10tons/ha PM	14.60	20.43	20.67	13.48	17.29
+ 400kg NPK Control	9.92	12.80	11.73	2.55	9.25
Mean	14.66	18.30	18.77	9.91	15.41
LSD $_{(0.05)}$	4.03	5.17	2.01	6.43	

WAP = Weeks after planting

EFFECTS OF CHICKEN MANURE, PIG MANURE, NPK (15:15:15) FERTILIZER AND AGROLYSER ON THE ON THE NUTRIENT CONTENT OF OKRA.

The major limiting factor of crop production in the tropics is the deficiency of soil nutrient resulting from land degradation which affects the growth, nutrient content, and uptake of the plant. Low levels of nitrogen, phosphorus, potassium and organic carbon were observed in the soil used for the experiment and the finding corroborates with the earlier results (Omotoso and Shittu, 2008); they reported that most of Nigerian soil is deficient in nitrogen, phosphorus, and potassium even organic matter. Therefore, a sustainable method of improving the nutritional status of the soil was employed to enhance the growth and nutrient content of the plant. This could result from the nutritional benefits of poultry manure which include improvement of soil fertility, structure, water holding capacity, and organic matter.

The effect of the different treatments on the Nitrogen, Potassium and Phosphorus nutrient contents of the okra plants is presented in Table 4.6. The different treatments enhanced the uptake of all of the nutrients evaluated. These may have enhanced the availability, mobility and uptake of these nutrients. This agreed with the earlier work of Adewole and Ilesanmi (2011), where soil amendments was found to enhance the availability and uptake of nutritional quality of okra. Nutrient content of Okra was significantly (P<0.05) influenced by fertilizer application. lOt Pig manure + 400kg NPK followed by 10 tons/hachicken manure + 400kg NPK significantly (P<0.05) increased the nitrogen content of NPK in the Okra. The Phosphorus (7.75%), potassium (17.20%) and Potassium (18.52%) uptake in the okra were significantly (P<0.05) higher with the application of the lOt PM + 400kg NPK followed by lOt CM + 400kg NPK application, respectively relative to other treatments. This also agreed with the findings of Adewole and Ilesanmi (2011) and Taiwo et al (2002) that organic manure enhanced the uptake of P and several micronutrients, such as Zn, Fe, Mn and Cu.

After nutrients are absorbed by the roots, they are transported to other parts of the plants through the xylem (Omotoso and Shittu, 2008). However, lower values for N, P and K of these nutrients were obtained in the control. Previous studies by Awe et al (2006); Nweke et al., (2013); Gardner (2004) had similar result.

Higher content of P and K values were significantly obtained among the treatments. This actually means that the P and K from the chicken manure and Pig manure were readily absorbed by the plants when they were added to the soil. Phosphorus is needed for fruiting and could have been released by the organic manure (Dekissa et al., 2008; Sharma, 2004).

Table 6: Effects of chicken manure, pig manure, NPK (15:15:15) fertilizer and Agrolyser on the nutrient content of Okra

Treatment	Nitrogen ←	Phosphorus %	Potassium →
10tons/ha CM	4.95	15.62	16.35
10tons/ha PM	5.80	13.15	11.86
400kg/ha NPK	5.85	12.00	12.77
Agrolyser	4.15	11.10	16.48
1 Otons/ha CM + 400kg NPK	6.50	9.35	13.32
1 Otons/ha PM + 400kg NPK	7.75	17.20	18.52
Control	3.95	7.85	4.66
Mean	5.14	11.47	11.99
LSD (0.05)	0.95	1.27	0.44

Potassium is a primary plant nutrient that plays a major role in achieving the maximum economic yields in crops. Plants also absorb potassium in greater amounts than any other essential nutrient except nitrogen in most crops. In order for a crop to achieve its maximum yield potential, potassium is needed in large quantities (Tehran, 2007). Phosphorus is also associated with complex energy transformations in the plant and important in cell divisions. It is also the second most important and limiting plant nutrient after nitrogen (Olaitan and

Lombin, 1984). This could be that the addition of NPK fertilizer added to the chicken manure and Pig manure helped to add more nutrients to the soil and the nutrients were readily absorbed by the plants, thereby increasing the fresh fruit weight as observed (Babatola, 2006).

IV. Conclusion And Recommendations

CONCLUSION

This study examined the comparative effects of organic and inorganic fertilizer sources on the growth, yield and nutrient content of okra {Abelmoschusesculentus) in an ultisol at Umudike. The result of this study shows that the applications of organic and inorganic fertilizer sources were capable of improving crop yield and that okra responded well to the integrated nutrient application. There was statistical significance difference observed in number of leaves, plant height, fruit number fresh fruit weight and nutrient content of the major nutrient (NPK) in Okra. The values obtained indicated that the application of these treatments and their combination significantly increased these growth and yield component of okra.

The organic manures such as Chicken and Pig manures solely improved the height of okra (Abelmoschusesculentus) while chicken manure gave a better result in the number of leaves in the study area; the Agrolyser gave a better result of production of okra fruits, going by the number of fruits.

The organic materials (chicken and pig manures) in combination with NPK 15:15:15 gave a better result in terms of the fruit weight (yield). Also the nutrient concentration on the okra plant was significantly improved by amending degraded soil with the organic and inorganic fertilizer sources. However, the use of organic mineral significantly increased the plant nutrient uptake of N, P, and K in okra plant respectively compared to control treatment.

RECOMMENDATION

Since okra production is determined on the bases of fruit weight (yield) and number of fruits, the use of combination of both organic and inorganic fertilizers as well as the Agrolyser for profitable okra production is therefore recommended in the study area.

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