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EFFECTS OF CATTLE-BASED (COW DUNG) AND PHOSPHATIC FERTILIZER ON THE YIELD OF OKRO (*Abelmoschus esculentus* (L) Moench) IN A DEGRADED ULTISOLS OF HUMID REGION, NIGERIA

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ABSTRACT
Field experiments were conducted in a degraded ultisols of Anwai in the 2011/2012 Cropping seasons. The aim was to study the effects of cattle-based manure and phosphorus fertilizer applied at the rate of 5tha^{-1} and 30kg/ha on the growth and yield of okro cv NHAe47-4. The experiment was a 1x4 factorial, laid out in a randomized complete block design with three replicates. Initial soil physico-chemical properties were carried to determine the nutrient potentials of the soil. The land measuring 120 x 80m^2 was made into plot sizes of 3 x 4m^2. 3-4 okro seeds were sown which was later thinned to one vigorous one at one week after planting. All routine agronomic practices were followed and data on growth and yield parameters collected at 8 and 16 WAP. The results of the study showed that the soil was sandyloam in texture, strongly acidic in nature with a pH of 5.3, low in organic matter (15.5 gkg^{-1}); total nitrogen (0.87 gkg^{-1}) and available phosphorus (5.35 mgkg^{-1}). There was a significant difference on plant height ($P \leq 0.05$) and non significant difference ($P > 0.05$) on the number of leaves and sterm girth of okro with the combined application of cow-dung and phosphorus fertilizer. Yield parameters determined at 16WAP also showed a significant effect ($P \leq 0.05$) on seed number and weight respectively. Pod weight was also significantly influenced by the various treatments. The results generally showed that the growth of okro could be best achieved with the combined application of cow-dung and phosphorus fertilizers on a degraded Ultisols of tropical environment.

KEYWORDS: Effects, cattle-based manure, phosphorus, degraded Ultisols.

INTRODUCTION

Soil degradation and nutrient depletion have become serious threats to agricultural productivity in Nigeria. The Ultisols of the humid region is one of the major soils that are extensively cultivated for various root, tuber and vegetable crops. Just like most tropical soils that are derived from the acidic parent materials which are poor in nutrients reserves, the Ultisols are strongly weathered, leached soils that are low in organic matter, total nitrogen and cation exchange capacity (Bationo and Mokwunye, 1991 and Egbuchua, 2007). They also belong to the acid-low fertility group of soils (Sanchez and Logan, 1992). The low nutrient contents of the soil reflect its kaolinitic, Fe and Al clay mineralogy. Because of the high extractable aluminium associated with ultisols, they are acidic in nature and nutrient impoverished (FMANR, 1996). The need to ensure high crop productivity and increased yield in an ultisols can only be made possible through the use of external inputs from different sources – organic and inorganic (Busari *et al.*, 2004 and Ramesh *et al.*, 2009).

In this part of the World, traditional poor resource farmers engaged in the practice of shifting cultivation which is stable and biologically efficient. However, the demand for more land arising from increase in population pressure had led to a drastic decrease if not complete disappearance of fallow periods. Another biological means of restoring soil productivity is the use of animal based organic sources such as cattle dung which has a reasonable high content of N, P and fibrous materials and devoid of pollution problems of heavy metals (Adetunji, 2004). The use of animal manure source is not without its shortcomings as the rate of nutrient released is very slow and nutrients in manure are not immediately available to plants (Edward, 1992). Mineralization is also slow thus a starter fertilizer in the form of inorganic fertilizer may be a useful supplement to manure. In Nigeria just like most sub-Saharan African region, the use of synthetic fertilizers in production is not common. One traditional reason among the poor resource farmers is that synthetic fertilizers in any form lead to early deterioration of their crops and make them highly susceptible to insect infestation. Studies by Katung *et al.*, (1996); Adetunji (2004); Azeez and Ramesh *et al.*, (2009) have shown that in soils that are strongly weathered and highly impoverished with low nutrient reserves, successful crop productivity can only be accomplished by the complimentary use of organic manures and mineral fertilizers. The two combinations have proven to be a sound soil fertility management strategy in many countries of the World. Apart from enhancing vigorous crop growth and yield optimally, all the minerals are supplied in small and large quantities (Havlin *et al.*, 2005). The practice also has a greater beneficial residual effect than can be derived from the use of sole source of manure (Ojeniyi, 2011).

Okro (*Abelmoschus esculentus* L) is an important vegetable crop that is widely consumed in the sub-Saharan Africa for making soup delicacy popularly called “okro

soup" that has a stretching characteristics enjoyed by both the rich and the poor especially in Nigeria. It is a very cheap source of vitamins, minerals and essential amino acid (Oliveria and Decarvalho, 1975). Poor soil fertility and use of unimproved local cultivars among other factors are responsible for low yield of the crop (Akin-Taylor, 1986). Because of the increasing demand of the crop in Europe, and America due to the growing number of Africans in Diaspora, it becomes necessary that the production of Okro in the humid environment should be intensified. The objective of this study therefore was to investigate the effects of cattle based organic manure and phosphorus on the yield of okro in a degraded ultisols and is commonly cultivated in the humid regions.

MATERIALS & METHODS

Field experiments were carried out at the Research and Teaching Farms of Anwai Campus of the Delta State University. The experimental site is located within latitude 06°14'N and longitude 06°49'E of the equator. The experiment was conducted during the 2011/2012 cropping seasons in a typical humid environment that is characterized by a bimodal rainfall pattern with peaks in July and September and an interrupted dry spell in August otherwise called (Harmattan). The annual mean rainfall is about 1,650mm; the mean annual temperature is 37.3°C and a mean relative humidity of 73.2% (NIMET, 2011). By nature of its geomorphological settings, the study area falls within the classification of Ancient metamorphic crystalline basement complex formation which are more acid than base (Egbuchua, 2007). They are essentially gneisses and pegmatites that gave rise to coarse-textured soils that are deficient in dark ferromagnessium minerals (Egbuchua, 2007).The topography is undulating with pockets of hills and land use is typically based on rainfed agriculture with root, tuber, spices, pulses and vegetables prominently cultivated. The vegetation is of rainforest origin but has been drastically reduced to derived savanna due to continuous use of the land.

Field studies

A land area measuring 120 x 80m^2 was selected for the study, prepared manually by clearing and marked out using basin formation according to the experimental layout. Plot sizes of 3 x 4m^2 were made and composite samples collected from the plots at 0-15cm depth in order to assess the initial phyisco-chemical properties of the soils.

Laboratory studies

The composite soil samples collected from the individual plots were air-dried in a room temperature of 27°C for three days, crushed and sieved using 2mm aperture. The parameters evaluated include the particle size distribution by hydrometer method (Gee and Bauder, 1986). The pH was determined using Pye Unican model MK2 pH meter in a 1:2:5 soil/water suspension ratio. Organic carbon was determined by Walkley-Black wet oxidation method (Nelson and Sommers, 1982). Total nitrogen was determined by micro-Kjeldahl distillation technique as described by Breminer and Mulvaney (1982). Available phosphorus was determined by Bray No. 1 method (IITA, 1979). Exchangeable potassium was determined by flame photometer, while cation exchange capacity (CEC) was determined by Amnonium acetate saturation method (Roades, 1982).The chemical analysis of the cattle manure use for the experiment was also evaluated using appropriate methods as described in the IITA manuals (1979).

Experimental Layout/Design

The experiment was a 1 x 4 factorial experiment in a randomized complete block design (RCBD) replicated three (3) times. The factors were okro variety NH_4A47-4 and 4 levels of soil amendments as:

Control (MoPo) =No cattle manure No phosphorus
(M_1Po) = Cattle manure no Phosphorus
(MoP_1) = No cattle manure phosphorus only
(M_1P_1) = Cattle manure + Phosphorus

Cattle manure and phosphours fertilizer in the form of triple super phosphate were applied as treatments. The cattle manure was applied at the rate of 5tha^{-1}, while the phosphorus fertilizer was applied at the rate of 30 $kgha^{-1}$. Both soil amendments were applied in two split doses a week before planting and six weeks after planting (WAP).

Okro variety NHAe47-A which is a short growing and high yielding variety with stout, deep green and good draw quality fruits was obtained from NIHORT (Nigerian Institute for Horticultural Crop Research). 3-4 seeds per hole were sown at a spacing of 0.5m x 0.3m and later thinned to one vigorous plant per stand. Weeding was done manually at sprouting at regular interval. The sprouted plants were fortnightly sprayed with cymbals starting from two weeks after seedling emergence.

Data Collection:

This was done at 8 and 16 WAP.

For the purpose of this, four plants were randomly tagged within the inner rows of each plot. Data collected includes plant height, number of branches, fresh pod yield and seed yield at harvest. Harvesting of fresh pods started at 8 WAP and continued at 4 days intervals for a period of 5 weeks. Fresh pod yield (t/ha) was computed by totaling the yield of 10 different pickings per plot and weighed. Seed yields were determined by allowing the fruits from four randomly tagged plants to air-dry on the plant and their seeds collected, weighed and seed yield (t/ha) calculated.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) by procedures of SAS (2000). Treatment means were compared using the least significant differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

Initial Soil Properties

The data on the initial physico-chemical properties of the soils used for the study is presented in Table 1.

TABLE 1: Initial phyisco-chemical properties of the soils used for the study

Parameters measured	Values obtained
Particle size fractions (%)	
Sand	85.0
Silt	9.6
Clay	4.4
Textural class	Sandyloam
pH (H_2O)	5.3
Organic matter gkg^{-1}	15.5
Total Nitrogen (gkg^{-1})	0.87
Avaible P ($mgkg^{-1}$)	5.35
Exchangeable K ($Cmolkg^{-1}$)	0.17
CEC ($Cmolkg^{-1}$)	10.13

The particle size fracture showed that the soils were sandy loam in texture and low in fertility as reflected by the low content of organic matter (15.5 gkg^{-1}), and total nitrogen (0.87 gkg^{-1}). Soil pH was strongly acid with a mean value of 5.3. The available phosphorus (P) and water soluble, potassium (K) with mean values of 5.35 $mgkg^{-1}$ and 0.17$cmolkg^{-1}$ were seemingly low based on the ratings of FMANR, (1996) for the ecological zone. The low fertility status of the soils is a true reflection of most ultisols of humid environment that are strongly weathered of low activity clay mineralogy and high acidity due to intense precipitation with its associated erosion and leaching in the environment.

Effects on growth parameters

There was a significant ($P \leq 0.05$) treatment effect. Plant height produced by using the combined application of cow-dung and phosphorus fertilizer was significantly higher (6.43cm) than the sole use of cow-dung (3.76cm), phosphorus (4.42cm) and the control (3.26cm). Soil amendment was not significantly different ($P > 0.05$) on both the number of leaves and stem girth of Okro, but significantly influenced on leaf area of okro (Table 3).

TABLE 3:Effects of soil amendments on Okro growth parameters

Treatments	Plant height (cm)	Number of leaves	Leaf area (cm^2)	Stem girth cm
Control (MoPo)	3.26	5	7.18	0.82
Poultry manure only (MiPo)	3.76	5	9.67	0.84
Phosphorus only (MoPi)	4.42	5	11.24	0.83
Poultry Manure and phosphorus combined (MiPi)	5.43	5	17.82	0.85
LSD ($P < 0.05$)	0.897	NS	1.005	NS

Means in a column followed by different letters are significantly different at 5% level of probability

The combined use of cow dung and phosphorus fertilizer gave a significant higher leaf area (17.82cm) than the sole use of other amendments and control (Table 3). Katung *et al.* (1996), Alasiri *et al.*, (2000), Okobobia *et al.* (2006) have variously reported significant increase in plant height and other growth and yield parameters of okro and other cucurbitaceae using combined application of organic and inorganic manure sources. However in related studies, Alasiri *et al.* (2000) reported a no significant effect on plant height of okro while working on some hydromorphic soils of Nigeria.

Effects on yield parameters

The various effects of soil amendments on yield parameters at 16 WAP is presented in Table 4.

TABLE 4: Effects of soil amendments on Okro (*Abelmoschus esculentus*) yield parameters 16WAP

Treatments	Number of seed/pod (g)	Seed weight/pod (g)	Pod weight (g)
Control (MoPo)	14a	0.58b	0.53c
Poultry manure only (MiPo)	16a	0.62a	0.64b
Phosphorus only (MoPi)	19a	0.65a	0.85a
Poultry Manure and phosphorus combined (MiPi)	25b	0.98ab	0.90a

Means in a column followed by different letters are significantly different at 5% level of probability

TABLE 5: Effects of soil amendment on soil chemical properties of Okro (*Abelmoschus esculentus*) 16 WAP

Treatments	pH (H_2O)	Org. Matter gkg^{-1}	Total N (gkg^{-1})	Ca →	Mg $Cmolkg_{-1}$	← K
Control (MoPo)	6.7	0.87	0.75	3.40	0.51	0.15
Poultry manure only (MiPo)	6.4	1.25	0.96	4.25	0.66	0.26
Phosphorus only (MoPi)	6.8	1.07	0.85	3.46	0.62	0.19
Poultry Manure and phosphorus combined (MiPi)	6.7	1.15	1.26	3.96	0.87	0.28
LSD ($P<0.05$)	0.55	0.28	0.23	0.59	0.12	0.07

Soil amendment was significant (P≤0.05) on seed number of Okro. The seed number produced by the combined use of cow-dung and phosphorus was significantly higher 25 g/pod when compared to sole application of phosphorus 19 g/pod, cow-dung 16 g/pod and control 14 g/pod respectively. Seed weight was also significant (P≤0.05). The seed weights produced by the combined use of cow-dung and phosphorous were 0.98 g/pod as compared to 0.65 g/pod, 0.62 g/pod and 0.58 g/pod respectively to sole application of phosphorus, cow-dung and control (Table 4). Pod weight was also significantly higher with combined application of cow-dung and phosphorus when compared to other treatments. Better okro performance generally obtained by the combined application of cow-dung and phosphorus could be attributed to nutrient release by cow-dung as complemented by phosphorus.
Likewise, phosphorus fertilizer application alone that produced higher pod and seed yield than the control may be due to usefulness of phosphorus nutrient in seed formation. In a similar study, Busari *et al.* (2004) reported the superiority of combined application of organic manure and phosphorus on the productivity and fodder quality of centrosema in an Alfisol of South-West Nigeria. The significant increase in various growth and yield parameters of okro with the combined use of cow-dung and phosphorus agreed with the findings of Okobobia *et al.*, (2006), Edmund and Okolie (2007) and Egwuatu *et al.* (2009). They reported that the complimentary use of organic and inorganic manures irrespective of applied crop species, have proven to be a sound soil fertility management strategy and also enhanced crop yield. These they attributed to the great beneficial residual effects than that which can be derived from sole use of either organic or inorganic manure sources. Adeoye *et al.,* (2004), Adekunle *et al.*, 2004, Adeniyan and Ojeniyi (2005) have reported enhanced crop growth, yield and quality of produce with combined application of organic and inorganic manures. These they attributed to synergistic effects of the combinations.

CONCLUSION

Soil degradation and nutrient depletion are among the major factors militating agricultural productivity in Nigeria and other sub-Saharan Africa. Sustainable crop production in the tropics is not possible with total dependence on chemical fertilizers due to problems associated with their users. Although crop production in the past depended on organic manure such as cow-dung, poultry waste etc but total dependence on it has its own limitations such as slow nutrient release and high C:N ratio. Thus, the key to sustainable soil fertility management especially in degraded Ultisols of the humid environment is the integrated application of organic and inorganic manures. In the study, the combined use of cow-dung and phosphorus significantly improved both growth and yield parameters of okro and thus proved very efficient than the sole use of other treatments.

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