Influence of Goat and Pig Manure on Growth nd Yield Potential of Okra (*Abelmoschus esculentus* L. Moench) in Ikorodu Agro-Ecological Zone of Nigeria

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Abstract: Food security is a major issue in the developing nations as a result of marginal soil fertility and low input levels causing declining crop yields. A trial was conducted to evaluate the influence of 5 and 10t ha^{-1} goat and pig manure on soil chemical properties, growth and yield of okra at the Teaching and Research Farms of Lagos State Polytechnic, Ikorodu humid rainforest agro-ecological zone of South Western Nigeria. The trial was laid out in a Randomised Complete Block Design (RCBD) with five replications. Treatments consist of 5t ha^{-1}, 10t ha^{-1} of goat and pig manure respectively. There was also control treatment (plots with no addition of neither goat nor pig manure). Data collected on growth and yield components were subjected to Analysis of Variance (ANOVA). Application of goat and pig manure positively influenced ($P<0.05$) okra plant height, number of leaves, stem girth. Number of harvested pods, fresh and dry pods weight were significantly ($P<0.05$) different compared to control. The result showed that application of 5t ha^{-1} goat manure resulted in improved okra growth and yield performances, while additional higher level of goat and pig manure at 10t ha^{-1} did not result in corresponding increase in the growth and yield of okra. The result also showed that addition of goat and pig manures brought about improvement in soil chemical properties; soil pH, total N, available P, organic matter, exchangeable cations and cation exchange capacity were improved. Application of goat and pig manures could be used for soil management as it improves soil nutrient status and could be used for sustainable okra production in the study area.
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Introduction

A number of factors that are responsible for the low yield of crop have been ascribed to several constraints. Among them, low organic matter content, poor fertility status, imbalanced use of high analysis chemical fertilizers accompanied by restricted use of organic manures that made the soils not only deficient in secondary and micronutrients, but also deteriorated the soil health (Akbari *et al*., 2011).

Nutrients supplied exclusively through chemical sources, though enhances yield initially, but the yields are not sustainable over the years. Application of mineral fertilizer continuously on the soils was found to reduce soil pH, microbial populations and activities, organic matter content, buffering capacity and cation exchange capacity of the soils (Olomilua, *et al*., 2007), application of chemical fertilizers can also lead to potassium deficiency even with complex fertilizers including K (Wapa and Oyetola 2014). It is necessary therefore to look for another alternative way of improving the soil properties and quality for sustainable agriculture. Organic manures could ameliorate these adverse effects of inorganic fertilizers. It is a reservoir for various essential elements, a source of cation exchange capacity and soil buffering, and is a large geochemical reservoir of carbon (Bohn *et al*., 2001).

Indigenously available organic sources of nutrients have enhanced the efficiency and reduced the requirements of chemical fertilizers (Bhat *et al*., 2007). Organic manures improved the soil physical, chemical and biological properties and also increase the efficiency of the applied nutrients especially in light soils (Pandey *et al*., 2007).

Okra (*Abelmoschus esculentus* L. Moench) is an important and popular vegetable crop cultivated in Nigeria for its mucilaginous content. The importance of okra as a vegetable crop lies in its 'drawing quality' that aids easy consumption of bulky staple foods like Gari, Fufu and pounded yam (Agbogidi and Nweke, 2005). They are boiled or fried and eaten as vegetable. They can also be cut into pieces, dried and/or powdered and stored for use in soups during the dry season when fresh Okra fruits are scarce (Sanni *et al* 2015). Despite its nutritional value, its optimum yield (2-3t ha^{-1}) in the tropical countries is low partly because of continuous decline in soil fertility (Abdul-El-kader et al., 2010). Being a short duration vegetable crop, its growth, yield and quality are largely influenced by the application of fertilizers. Okra requires proper and sufficient N and K for

regular fruiting and subsequent pickings (Premsekhar and Rajashree, 2009). Farmers in the study area have been observed to be reluctant in the use of fertilizers on their farms because okra is grown as a tertiary crop - just as source of soup. Therefore, the aim of this experiment was to study the effects of Goat and Pig manure on okra production in Ikorodu agro-ecological zone of Nigeria.

Materials and methods

The experiment was carried out on a piece of land measuring 546m^2 located at Horticultural section of the Teaching and Research Farms, Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria (Latitude 6°S 25'N and longitude 30°E). The land has been under cultivation of arable crops for many years with occasional fallow period. The site was covered by a weed spectrum of guinea grass (*Panicum maximum),* milk weed (*Euphorbia heterophylla)* and siam weed *Chromolaena odorata*. The vegetation was ploughed and harrowed

Soil samples were collected from surface (0-20 cm) using soil auger. Fifteen (15) samples were randomly collected across the experimental plot, thoroughly mixed and a representative composite sample was taken before the experiment. After harvest three (3) soil samples were collected from each plot, thoroughly mixed and neatly packed and carried in new polythene bags. The soil samples were air-dried, crushed separately using wooden mortar and pestle and passed through 2 mm sieve; each sample was analyzed for some selected properties of the soil.

The pH was determined using a digital electronic pH meter using 1:2 (soil: water) suspension. Ammonium acetate (NH4Ac) was used to leach 10 g of the soil sample. The Calcium content was obtained through titration, Magnesium by atomic absorption spectrophotometer, Potassium and Sodium content by flame photometry and total Nitrogen by the micro-kjeldahl method. The particle size analysis was done by hydrometer method (Olaniyi and Ajibola, 2008). The final soil nutrient analysis was carried out at the end of the experiment as done in the initial soil analysis.

The experiment was laid out in Randomised Block Design with five (5) treatments (control, 5t/ha pig manure, 10t/ha pig manure, 5t/ha goat manure and 10t/ha goat manure) replicated thrice. Goat and Pig manure were applied two weeks before planting. Seeds of NHAE-47-4 okra variety obtained from Lagos State Agricultural Input Supply Agency, Ikorodu were sown at 2 seeds per hole at a spacing of 60 x 40cm and later thinned to one seedling per stand in a 4m x 3m plot with 1m discard. Plots were weeded manually with hoe and hand pulling at frequency required. Insect pests were controlled by application of cypermethrin at the rate of 40ml in 15 litres of water using CP 15 Knapsack sprayer. Spraying commenced at 3 weeks after planting and at 1 week interval until 50% flowering.

Five plants were selected per plot at random and were tagged for determination of plant growth and yield attributes. Data were collected on plant height, number of leaves, stem girth, number of fruits, fresh fruit weight and dry fruit weight. Data collected on various growths and yield parameters were subjected to analysis of variance procedures using appropriate statistical package and means separated using the Duncan Multiple Range Test (DMRT) at 5% probability level (Gomez and Gomez, 1984)

Results and discussion

The result of the soil analysis carried out before the commencement of the experiment is presented in table 1. It was shown that the soil was sandy loam in texture with high proportion of sand (71.70%). This implies that basic cations such as Ca, K, Na and Mg would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Wapa and Oyetayo, 2014). The soil was slightly acidic in pH (6.25) and low organic carbon, total nitrogen and available P were also low in the soil. Low organic carbon and organic matter in the soil of the experimental site was probably as a result of high proportion of sand content of the soil. Furthermore, the low N levels observed in the soil can be attributed to continuous cropping and increased land use intensity. Based on FAO (1984) ratings, nutrient contents of the soil were within the low rating scale (Mafongaya *et al*. (2003). The low soil OC, N, P, K, Mg status and its acidic nature are expected to benefit from application of goat and pig manure (Table 1).

The effects of goat and pig manure on plant height, number of leaves and stem girth are indicated in Tables 2-3. Plant growth was markedly influenced by application of goat and pig manure at different levels as observed from the better plant height, stem girth and number of leaves compared to the control. The best growth characteristics were recorded under 5t ha^{-1} of both manure at 4, 6 and 8 weeks after planting and the least growth and development was recorded in the plot with no addition of manure. The okra growth rate increased progressively with the age of the plant. The increase in height, girth and number of leaves due to application of goat and pig manure confirmed the role of organic manure in promoting vigorous vegetative growth in crops.

Increase in okra growth might probably be due to the greater supply of N with efficient utilization for cell multiplication and enlargement and formation of

nucleic acids and other vitally important organic compounds in the cell sap (Chandravanshi and Singh, 1974; Simons, 1982). The number of days to 50% flowering was significantly improved by the applications of pig and goat manure (Table 3) compared to control. Flower developments started at 34 DAP in plots receiving 5 and 10t ha^{-1} goat manure treatment. While plots that received 5 and 10t ha^{-1} pig manure flowered at 35.80 and 36.40 DAP respectively and plots which do not received manure application flowered at 37 DAP. Adequate supply of nitrogen and phosphorus play vital role in various metabolic processes which resulted in increased flowering and fruiting thereby improving pods per plant due to favourable effect of these nutrients on growth parameters.

Table 1. Soil properties at experimental site prior to cropping and chemical properties of manure

Parameters	value	goat manure	pig manure
Physical characteristics			
Sand %	71.70		
Silt %	11.60		
Clay %	16.70		
Textural class	sandy loam		
pH (H_2O)	6.25		
pH (KCl)	5.20		
Organic carbon (meq / 100g)	0.57	0.76	0.85
Total N (%)	0.06	38.43	26.89
Available P (mg.kg -1)	26.0	7.67	5.35
Exchangeable cations (c.mol.kg-1)			
Mg^{2+}	5.60	11.87	8.20
Ca^{2+}	6.40		
K^{+}	0.06	5.62	4.80
Na^{+}	0.13		
Fe (ppm)		13.21	11.07
Mn (ppm)		21.8	28.10
Exchangeable acidity	2.14		

Table 2. Effects of goat and pig manure on okra plant height and number of leaves weeks after planting

	Plant height (cm)			no of leaves		
Treatments	4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
Gt m 5t/ha	13.30^{a}	18.40^{a}	48.14^{ab}	3.40^{a}	5.80^{a}	14.94^{a}
Gt m 10t/ha	12.24^{b}	18.42^{a}	40.84^{cd}	3.40^{a}	5.40^{ab}	11.98^{b}
Pg m 5t/ha	11.12^{c}	15.44^{b}	50.66^{a}	3.00^{ab}	4.40^{bc}	10.00^{cd}
Pg m 10t/ha	10.20^{d}	14.30^{c}	36.14^{d}	3.00^{ab}	3.60^{cd}	9.50^{de}
Control	$9.30d^{de}$	11.72^{cd}	43.64^{bc}	3.00^{ab}	3.40^{d}	9.48^{e}

NB: Gt m = goat manure, Pg m = Pig manure

Table 3. Effects of goat and pig manure on okra stem girth development weeks after planting and number of days to 50% flowering

	Stem girth (cm^3)			50% flowering
Treatments	4 WAP	6 WAP	8 WAP	days after planting
Goat manure 5t/ha	1.00^{a}	2.94^{a}	4.26^{a}	34.20^{a}
Goat manure 10t/ha	0.90^{ab}	2.70^{b}	3.69^{b}	34.60^{a}
Pig manure 5t/ha	0.84^{b}	2.26^{c}	2.82^{c}	35.80^{b}
Pig manure 10t/ha	0.74^{bc}	1.92^{d}	2.56^{d}	36.40^{b}
Control	0.56^{d}	1.84^{e}	2.16^{e}	37.40^{c}

The okra fruit yield and yield components (number of harvested pods, fresh pods weight and dry pods weight) produced were significantly ($P \leq 0.05$) affected by the applied treatments (Table 4). The highest pods yield was recorded from the plots treated with 5t/ha^{-1} of goat manure, followed by 10t ha^{-1}. Heaviest okra pods fresh and dry weight were recorded from plot amended with 5t ha^{-1} goat manure, followed by 10t ha^{-1}; while the least okra

pods yield and yield components were recorded for okra plant in plot with no manure application.

Babu *et al.* (2001) also confirmed increased crop yields due to application of organic manures (FYM, green manure and press mud) as compared to control. This significant response might be due to better availability and translocation of nutrients as well as optimum plant vigour, which favoured the portioning of the photosynthates resulting in increased fruit weight. Sharma (2004) observed that organic manure improves number of pod, size, fruit weight and fruit yield when manure is correctly applied at the required amount. The observed improvement in the yield of okra could be linked to the ability of the goat and pig manure to increase soil organic matter content and also the changing of chemical composition of the soil. Leng (2006) attributed yield increase resulting from addition of organic manure to increase in cation exchange capacity (CEC) and to increase in water holding capacity; when organic manure is applied in sufficient quantity to the soil it can supply all the necessary primary and secondary nutrients required for crop growth and yield.

Adequate supply of nitrogen and phosphorus play vital role in various metabolic processes which resulted in increased flowering and fruiting thereby improving pods per plant due to favourable effect of these nutrients on growth parameters. The better efficiency of organic manures might be due to the fact that organic manures especially FYM would have provided the micronutrients such as Zn, Cu, Fe, Mn, and Mg in an optimum level (Premsekhar and Rajashree, 2009).

The results of the study showed that the treatments are capable of improving crop yield. The significant effected due to goat and pig manure application could be attributed to easy solubilisation effect of released plant nutrient leading to improved nutrient status of the soil the results obtained were in agreement with the findings of Sanwal *et al*., (2007) and Premsekhar and Rajashree (2009) in which they reported that higher yield response of crop due to organic manure application. The result obtained from this study is in contrary with the findings of Ojeniyi and Olumilua (2006) who obtained highest number of pods with the application of 10t ha^{-1} of pig manure. Also with Aliyu (2000) and Onwu *et al*., (2008) who opined that increase in growth with increased organic manure rates.

Table 4. Effects of goat and pig manure on number of harvested pods, fresh and dry weight of pods

Treatments	no of pods	fresh weight of pods	dry weight of pods
Goat manure 5t/ha	18.20^{a}	1.30^{a}	0.26a
Goat manure 10t/ha	15.60^{b}	1.03^{c}	0.21^{c}
Pig manure 5t/ha	11.60^{d}	0.97^{d}	0.19^{d}
Pig manure 10t/ha	12.40^{cd}	1.25^{b}	0.24^{b}
Control	1.80^{e}	0.76^{e}	0.15^{e}

Table 5. Soil properties of the experimental site prior at crop harvesting

Parameters	control	goat manure 5t/ha	goat manure 10t/ha	pig manure 5t/ha	pig manure 10t/ha
Physical characteristics					
Sand %	71.70	74.70	78.00	75.00	71.00
Silt %	11.60	10.00	5.00	10.00	10.00
Clay %	16.70	15.30	17.00	15.00	19.00
Textural class	sandy loam	sandy loam	sandy loam	sandy loam	sandy loam
pH (H_2O)	6.25	6.25	6.90	6.20	6.95
pH (KCl)	5.20	5.50	6.05	5.65	6.35
OC (meq / 100g)	0.12	4.52	1.19	5.36	3.45
Total N (%)	0.02	0.33	0.11	0.39	0.26
Avail P (mg.kg -1)	12.87	21.75	16.80	21.37	13.66
Exchangeable cations (c.mol.kg-1)					
Mg^{2+}	0.87	4.40	5.60	0.80	3.20
Ca^{2+}	1.74	5.60	8.00	2.40	4.80
K^{+}	0.03	0.51	0.20	0.50	0.23
Na^{+}	0.08	0.09	0.43	0.04	0.48
Total exch acidity	3.10	0.20	0.10	0.30	0.10

Addition of goat and pig manures brought about improvement in soil chemical properties; soil pH, total N, available P, organic matter, exchangeable cations and cation exchange capacity were improved (Table 5). Application of goat and pig manures could be used for soil management as it improves soil nutrient status and could be used for sustainable production of crops. In support of this, Ano and Agwu (2006) had reported that animal manure increased soil pH and macronutrient of soil. The reduction in exchange acidity in plots that received organic manure suggests the ability of manure to supply calcium to the soil (Cooper and Warman, 1999). Akande *et al*., (2003) reported that application of organic materials could ameliorate slightly acidic tropical soil to improve crop production. Organic manure also increased soil organic matter, nitrogen, pH, phosphorus and cation exchange capacity (Adeniyan and Ojeniyi, 2003; Ayeni *et al* 2008).

The results obtained from the study shows that okra responded well to the application of 5t ha^{-1} of pig and goat manure. The application of pig and goat manure will improve soil organic matter and nutrient availability and high yield. In light of the foregoing, application 5t ha^{-1} of pig and goat manure is recommended for enhance and sustainable okra production in the study area.

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