EFFECT OF ORGANIC MANURE MIXTURES AND NPK FERTILIZER ON THE GROWTH AND YIELD OF OKRA *(Ablemoschus esculentus L.)* IN OWERRI AREA OF IMO STATE, NIGERIA.

Okoli, N. A, Obiefuna, J. C, Ihejirika, G. O, Alagba, R. A, Keyagha, E. R, Adikuru, N. C. and Emma-Okafor, L. C.
Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State, Nigeria
Corresponding author's e-mail: amderealangel@yahoo.com

ABSTRACT
Soil acidity and infertility are the major constraints in crop production in Ultisols of Owerri area of Imo state, Nigeria. The experiment was conducted to determine the effect of mixture of poultry manure (PM) and palm bunch ash (PBA) on soil property, growth and yield of okra. The experimental design was Randomized Complete Block Design (RCBD) and treatments were replicated four times. The five (5) treatments consist of three rates of palm bunch ash (2, 4 and 6 t ha^{-1}) mixed with 5 t ha^{-1} of poultry manure, respectively 200 kg ha^{-1} of NPK 15:15:15 and the control (zero application of poultry manure and palm bunch ash). Results showed that the soil was acidic with pH of 5.0. Application of poultry manure-palm bunch ash mixture improved soil pH (6.77) and organic matter. Significant ($p \leq 0.05$) fresh pod yield followed this sequence: 5 t ha^{-1} PM + 2 t ha^{-1} PBA (7.02 t ha^{-1}) > 5 t ha^{-1} PM + 6 t ha^{-1} PBA (5.36 t ha^{-1}) > NPK (4.64 t ha^{-1}) > 5 t ha^{-1} PM + 4 t ha^{-1} PBA (3.99 t ha^{-1}) > 0 t ha^{-1} (2.70 t ha^{-1}). Therefore, for improved soil physico-chemical property and okra yield, mixture of 5 t ha^{-1} of poultry manure and 2 t ha^{-1} palm bunch ash is recommended as a liming material and fertilizer supplement.
Keywords: Okra, Poultry manure, Palm bunch ash, Soil reaction, Soil infertility

Introduction

Okra *(Abelmoschus esculentus L. Moench*), is a member of the Malvaceae family. It is a widely cultivated vegetable crop and very important in the diet of Nigerians. Okra is a valuable crop that provides an excellent income and generates other opportunities for small-scale farmers on the value chain of production, transportation, processing and marketing (Farinde *et al.,* 2007). Okra is a warm loving plant that performs optimally in well-drained fertile sandy loam soil with optimum nitrogen and potassium for improved growth and pod yield respectively (Majanbu *et al.* 1986).

Ultisols of Owerri West L.G.A of Imo state, Nigeria are acidic, low in mineral reserves with low cation exchange capacity and base saturation (Onweremmadu *et al.,* 2006). Consequently, intensive crop production requires the application of organic and inorganic fertilizers for improved crop yield.

The application of inorganic and organic fertilizers have been found to improve soil pH, total nutrient content, nutrient availability and crop yield (Ojeniyi, 2000). However, the use of inorganic fertilizer in Nigeria is limited because fertilizer distribution has become highly political, scarce and unaffordable by resource poor smallholder farmers (Ojeniyi *et al.,* 2007). The use of different organic manures individually have been reported as good alternatives to inorganic fertilizer for improved okra production in Nigeria (Tiamiyu *et al.,* 2012**;** Ojeniyi *et al.,* 2007). However, superior yield of okra has been reported using integrated application of different manure sources as such manures tend to complement the fertility strength of each manure. Nnah *et al.,* 2010, reported higher pod yield using a mixture of palm bunch ash and urea. Mixture of 5 t ha^{-1} of poultry manure and 5 t ha^{-1} of wood ash gave pod yield of 7.8 t ha^{-1} in okra (Agbede and Adekiya, 2012).

Therefore, there is the need for integrated application of poultry manure and palm bunch ash to produce an organic manure mixture, which can improve soil structure, fertility and productivity for okra production in heavily leached ultisol.

The objective of this work was to determine the effect of poultry manure-palm bunch ash mixtures and NPK fertilizer on the growth and yield of okra.

Materials and Methods

The experiment was carried out at the Teaching and Research Farm of Federal University of Technology, Owerri, which is located in the humid tropics of Nigeria (latitude 5° 27' N and 7° 02' E). The annual rainfall is about 2500 mm and is bimodal with peaks in July and September. The area is characterized by daily minimum and maximum temperatures 20^{o}C and 32^{o}C, respectively. In terms of geology and geomorphology, the predominant parent material from which most of the soils are formed is the Coastal Plain Sands popularly known as "Acid Sands" (Orajaka, 1975).

The experimental field measured 13 m x 10.5 m, giving a total size of 136.5 m^2. Raised beds, which were manually cultivated, were used and each bed measured 2.0 m x 2.0 m with 0.5 m alley between and within blocks. The experimental design was Randomized Complete Block Design (RCBD) and treatments were replicated four times. Each block consisted of 5 plots, giving a total of 20 experimental plots. The five (5) treatments consist of three rates of palm bunch ash (2, 4 and 6 t ha^{-1}) mixed with 5 t ha^{-1} of poultry manure, respectively, 200 kg ha^{-1} of NPK

15:15:15 and the control (zero application of poultry manure and palm bunch ash). Treatments were applied at land preparation and allowed for 1 week before okra seeds were planted.

The Okra variety (Awgu early) was collected from the NIHORT, Okigwe, Imo State. Four seeds of okra were planted (2 cm depth) per hole in August and thinned to two seeds per hill, at two weeks after planting. The viable seeds were spaced at 50 cm between rows and 30 cm within rows. Weeding was manually carried out at one month after planting (MAP). Harvesting was done at 7 days interval by hand picking. The following parameters were measured: plant height (cm), number of leaves, leaf area (cm^2), number of fruits, length of fruits (cm) and total fresh pod weight (g).

Laboratory Analytical Methods

Five soil samples were collected randomly from the experimental site at 0-20 cm depth before planting and on per treatment basis after harvest. Samples were analyzed for physico-chemical properties at the Crop Science Laboratory, Federal University of Technology, Owerri. Soil pH was analyzed by the use of pH meter (Hendershot *et al*., 1993), organic carbon was determined by Nelson and Sommers, 1982, organic matter values were obtained by multiplying total carbon with 1.724 (Van Bemmelen's correlation factor) (Nelson and Sommers, 1982), available phosphorus was determined according to the procedure of Olsen and Sommers (1990), total nitrogen was by microkjeldahl digestion technique (Bremner and Mulvaney, 1982), calcium and magnesium by Versenate titration method and potassium by flame photometer method. Poultry manure and palm bunch ash were analyzed for their nutrient status (pH, N, P, K, C, Ca, Mg and Na) using the same procedures as for the soil analysis.

Statistical analysis

Analysis of variance was done using Genstat 2011 software. The means were separated using Fisher's Least Significant Difference at 5% level of probability.

Results

The initial soil pH was highly acidic, with very low nitrogen and exchangeable cations. Poultry manure was alkaline (8.12), with high nitrogen (4.50%) and low potassium (15.50 cmol kg^{-1}). Palm bunch was alkaline (8.20), with low nitrogen content (1.10%) and have high potassium (440.64 cmol kg^{-1}) (Table 1). Plant height was not significantly affected by the treatments at 2, 4, 6 and 8 WAP (Table 2). Number of leaves was not significantly affected by the treatments at 2, 4, 6 and 8 WAP (Table 2). Leaf area was not significantly affected by the treatments at 2, 4 and 6 WAP (Table 3). Leaf area was significant at 8 WAP. Okra manured with 5 t ha^{-1} mixed with 6 t ha^{-1} of palm bunch ash produced largest leaf area (269.40 cm^2). Leaf area of Okra manured with NPK fertilizer (175.4 cm^2) was not significantly ($P \leq 0.05$) different from leaf area of okra produced without manure (158.30 cm^2). Days to 50% flowering was not significantly ($P \leq 0.05$) affected by the treatments (Table 3).

Pod length and number of pods were not significantly ($P \leq 0.05$) affected by the treatments (Table 4). Okra girth was significantly affected by the treatments. Okra manured with 5 t ha^{-1} mixed with 2 t ha^{-1} of palm bunch ash produced biggest pod girth (7.93 cm) while unmanured okra produced lowest pod girth (6.63 cm) (Table 4). Okra manured with 5 t ha^{-1} mixed with 2 t ha^{-1} of palm bunch ash produced significantly ($P \leq 0.05$) highest fresh pod yield (7.03 t ha^{-1}) which was not significantly different from the yield of okra manured with NPK fertilizer (4.74 t ha^{-1}) (Table 4). Unmanured okra produced lowest fresh pod yield (2.70 t ha^{-1}).

Post planting physico-chemical properties showed improved soil pH, available exchangeable cations, and organic matter (OM) in soils amended with poultry manure-palm bunch ash mixtures (Table 5). 5 t ha^{-1} of poultry manure mixed with 2 t ha^{-1} of palm bunch ash was the most efficient for soil acid neutralization. Soils amended with NPK fertilizer had increased soil acidity with reduced soil organic matter and organic carbon. Okra planted without manure further impoverished the soil.

Table 1: Physico-chemical characteristics of poultry manure, palm bunch ash and soil at planting

Element	Poultry manure	Palm bunch ash	Soil
Mg (cmol kg^{-1})	6.80	21.87	0.54
Na (cmol kg^{-1})	12.10	88.00	0.002
Ca (cmol kg^{-1})	36.40	68.00	2.20
K (cmol kg^{-1})	15.50	440.64	0.01
P (cmol kg^{-1})	4.80	38.20	3.64
% organic carbon	3.08	6.86	1.26
% organic nitrogen	4.50	1.10	0.02
pH in H_2O	8.12	8.20	5.00
Sand	0.00	0.00	89.50
Silt	0.00	0.00	7.02
Clay	0.00	0.00	3.48
Textural class	0.00	0.00	Sandy loamy

Table 2: Effect of organic manure mixtures and NPK fertilizer on okra plant height and number of leaves

Treatments	Plant height (cm)				Number of leaves			
(t ha^{-1})	2WAP	4WAP	6WAP	8WAP	2WAP	4WAP	6WAP	8WAP
0 PM + 0 PBA	5.88	9.99	22.54	53.08	5.00	9.58	7.55	7.99
5 PM + 2 PBA	6.38	14.25	37.75	78.00	5.17	11.50	6.75	8.83
5 PM + 4 PBA	7.30	11.40	25.50	67.58	4.92	9.92	7.50	9.83
5 PM + 6 PBA	6.43	11.67	30.59	66.17	5.00	10.33	7.33	10.92
NPK fertilizer	5.82	11.27	27.88	61.17	5.00	9.67	6.67	7.75
LSD $_{(0.05)}$	ns	ns	ns	ns	ns	ns	ns	ns

PM = Poultry manure PBA = Palm bunch ash

Table 3: Effect of organic manure mixtures and NPK fertilizer on okra leaf area (cm^2) and days to 50% flowering

Treatments	Leaf area (cm^2)				Days to 50% flowering
(t ha^{-1})	2WAP	4WAP	6WAP	8WAP	
0 PM + 0 PBA	13.82	55.90	130.00	158.30	35.00
5 PM + 2 PBA	16.87	93.10	214.00	243.10	30.00
5 PM + 4 PBA	12.78	62.30	163.00	214.40	34.33
5 PM + 6 PBA	13.03	74.30	194.00	269.40	32.33
NPK fertilizer	13.15	63.10	142.00	175.40	32.00
LSD $_{(0.05)}$	ns	ns	ns	61.66	ns

PM = Poultry manure PBA = Palm bunch ash

Table 4: Effect of organic manure mixtures and NPK fertilizer on okra yield and yield components

Treatment (t ha^{-1})	Pod length (cm)	Pod girth (cm)	Number of pods per plant	Pod yield (t ha^{-1})
0 PM + 0 PBA	5.63	6.63	4.67	2.70
5 PM + 2 PBA	6.98	7.93	7.08	7.03
5 PM + 4 PBA	6.12	7.03	5.25	3.99
5 PM + 6 PBA	6.95	7.45	5.67	5.37
NPK fertilizer	7.25	7.78	5.67	4.74
LSD $_{(0.05)}$	ns	0.88	ns	2.57

PM = Poultry manure PBA = Palm bunch ash

Table 5: Post planting soil chemical properties

Treatments (t ha^{-1})	pH in H_2O	%N	Ca	Mg	K	Na	Al + H	Al	% organic Carbon	% organic matter	P cmol/kg
					cmol kg^{-1}						
0 PM + 0 PBA	5.29	0.02	0.52	0.13	0.01	0.04	0.76	0.46	1.62	2.79	4.64
5 PM + 2 PBA	6.77	0.04	3.47	0.17	0.03	0.03	0.70	0.30	1.85	3.03	5.39
5 PM + 4 PBA	6.35	0.02	3.47	0.16	0.02	0.04	0.74	0.43	1.50	2.60	5.41
5 PM + 6 PBA	6.61	0.04	3.47	0.34	0.03	0.07	0.82	0.55	1.87	2.89	5.80
NPK Fertilizer	5.07	0.02	0.50	0.25	0.03	0.03	0.68	0.27	1.48	2.55	5.61

PM= Poultry manure PBA= Palm bunch ash

Discussion

The results of the pre-planting physico-chemical analysis of the Ultisol confirmed earlier reports of high acidity, low nitrogen content and low exchangeable characteristic of soils of Abia, Anambra and Imo states (FPDD, 1989).

The application at poultry manure mixed with palm bunch ash significantly improved the leaf area of okra at 8 WAP. This could be as a result of multi-nutrient release due to soil acid neutralization (Ibeawuchi *et al.,* 2009).

Fresh pod yield was higher in okra manured with 5.0 t ha^{-1} of PM + 2.0 t ha^{-1} of PBA and NPK fertilizer than in the unmanured okra and other treatments. The superior pod yield of okra manured with 5.0 t ha^{-1} of PM + 2.0 t ha^{-1} of PBA and NPK fertilizer in relation to other treatments could be attributed to the increased in N and K concentrations in the soil (Adjei-Nsiahand and Boahen Obeng, 2013; Agbede and Adekiya, 2012**;** Nnah *et al.,* 2010). Majanbu *et al.,* (1986) reported that N and K are the most important macronutrients that okra required for proper growth and pod production.

The post-planting soil chemical analysis showed an improvement in the soil chemical properties in soils amended with poultry manure-palm bunch ash mixtures (Okoli *et al.,* 2011). Application of poultry manure-palm bunch ash mixtures could have also resulted in increased microbial activity in the soil and increased organic matter production with its concomitant increased availability of soil nutrients such as N, P and K (Ojeniyi *et al.,* 2010) and subsequently high yield in okra (Adjei-Nsiah and Boahen Obeng, 2013). Soils amended with NPK fertilizer had increased soil acidity with reduced soil organic matter and organic carbon (Okoli *et al.,* 2011). Okra planted without manure further impoverished the soil.

Conclusion

Combined applications of poultry manure and palm bunch ash improved soil fertility status of ultisol by increasing soil organic matter , organic C, N, P, K, Ca and Mg. NPK fertilizer added only N, P and K nutrient elements and lowered soil organic matter content. Zero application of the manure mixture further impoverished the soil nutrients. The application of 5 t ha^{-1} of poultry manure mixed with 2 t ha^{-1} of palm bunch ash produced significantly ($P \leq 0.05$) highest fresh pod yield (7.03 t ha^{-1}) and is therefore recommended to farmers for improved yield of okra. Plant (PBA) and animal (PM) wastes can be combined, used as organic amendments and can also substituted for expensive and scarce NPK fertilizer in improving the fertility status of ultisol in Owerri area of Imo state, Nigeria.

References:

Adjei-Nsiah, S. and Boahen-Obeng, C. (2013). Effect of palm bunch ash application on soil and plant nutrient composition and growth and yield of garden eggs, pepper and okra. *International Journal of Plant & Soil Science*. 2(1): 1-15.

Agbede, T. M. and A. O. Adekiya (2012). Effect of wood ash, poultry manure and NPK fertilizer on soil and leaf nutrient composition, growth and yield of okra (*Abelmoschus esculentus*) *Emir. J. Food Agric*. 24 (4): 314-321.

Bremner, J. M and Mulvaney, C. S. (1982). Nitrogen trial. In: Page A. L, Miller, R. H. and Keeney, R. R. (eds). Methods of soil analysis. Part 2- Chemical and microbiological properties (2nd edtion). American Society of Agronomy. 9: 595-624.

Farinde, A. J, Owolarafe, O. K. and Ogungbemi, O. I. (2007). An overview of Production, Processing, Marketing and Utilization of Okra in Egbedore Local Government Area of Osun State, Nigeria. *Agricultural Engineering International: the CIGR E journal.* Manuscript No. MES 07 002. IX: 1-17.

FPDD (Fertilizer Procurement and Distribution Division of the Federal Ministry of Agriculture, Water Resources and Rural Development). (1989). Fertilizer use and management: practices for crops in Nigeria. Series No. 2. Ibadan, Nigeria: Bobma Publishers, 6-7p.

Hendershot, W. H, Lalande, H. and Duquette, M. (1993). Soil reaction and exchangeable acidity. In: Carter, M.R. (ed.). Soil sampling and methods of soil analysis, Canadian Soc. Soil Sci., Lewis Publishers, London, 141-145p.

Ibeawuchi, I. I, Obiefuna, J. C and Onweremadu, E. U. (2009). Effect of oil palm Bunch refuse ash rates on the ultisols of Owerri, Imo State, Southeastern Nigeria, Proceedings of the International Conference on Global Food Crisis.190-193.

Majanbu, I. S, Ogunlela, V. B. and Ahmed, M. K. (1986). Response of two okra varieties to fertilizer growth and nutrient concentrations as influenced by nitrogen and phosphorus application. *Fertilizer Res.* 8: 297-306.

Nelson, D. W. and Sommers, L. E. 1982. Total carbon, organic carbon and organic matter. In Page, A. L, Miller, R. H. and Keeney, R. R. (eds). Methods of soil analysis, Part 2- Am. *Soc. Agron*. Madison WI. 9: 539-579.

Nnah, M. B, Ikpe, F. N, Osakwe, J. A. and Mbonu, O. A. (2010). Influence of oil palm bunch refuse ash and urea on soil physic-chemical properties and okra yield in southeastern Nigeria. *Acta Agronomica Nigeriana*. 10. (2): 117-124.

Ojeniyi, S.O, Awanlemhen, B. E and Adejoro, S. A. (2010). Soil plant nutrients and maize performance as influenced by oil palm bunch ash plus NPK fertilizer. *Journal of American Science.* 6: 456-460.

Ojeniyi, S. O. (2007). Use of wood ash to improve soil fertility and performance of okra (*Abelmoschus esculentum*). *Production Agric. Technol.* 3 (2): 124-128.

Ojeniyi, S.O. 2000. Effect of goat manure on soil nutrient and okra yield in a rain forest area of Nigeria. *Applied Tropical Agriculture,* 5: 20-23.

Okoli, N. A, Obiefuna, J. C, Ibeawuchi, I. I, Ihejirika, G. O. and Alagba, R. A. (2011). Assessment of poultry manure fortified with Palm Bunch ash (POASH) for Cassava (*Manihot esculenta Crantz*) production in Southeastern Nigeria. *Acta Agronomica Nigeria.* Vol., 11, 1& 2: 88-97.

Olsen, S. R and Sommers, L. E. (1990). Phosphorus. In: Paige, A. L, Millers, R. H. And Keeney, R. R. (eds.) Methods of soil analysis. *American Society of Agronomy*, Madison, WI. 403-430.

Onweremadu, E. U, Opara, C. C, Nkwopara, U, Duruigbo, C. I. and Ibeawuchi, I. I. (2006). Yield response of a cowpea variety on ground seashells on Isohyperthermic Arenic Kandiudult of Owerri, Southeastern Nigeria. *Int. J. Soil Sci.*, 3: 251-257.

Orajaka, S. O. (1975). Geology. In: Nigeria in Maps: Eastern States, G. E. K. Ofomata (ed.). Benin City, Nigeria: Ethiope Publishing. 5-7p.

Tiamiyu, R. A, Ahmed, H. G. and Muhammad, A. S. (2012). Effect of Sources of Organic Manure on Growth and Yields of Okra (*Abelmoschus esculentus L.*) In Sokoto, Nigeria. *Nigerian Journal of Basic and Applied Science.* 20 (3):213-216.