Nigerian Journal of Soil Science
Journal homepage:www.soilsjournalnigeria.com

COMPARATIVE EFFECTS OF ORGANIC MANURES AND NPK FERTILIZER ON GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* (L.) Moench) ON ULTISOL

Nnah, M.B.[1], Isirima, C.B.[1], Ezekiel, P. O.[1] and Umesi, N.[2]
[1]*Department of Agricultural Education, School of Vocation Education, Federal College of Education (Technical), Omoku – Rivers State, Nigeria.*
[2]*Department of Integrated Science, School of Science Education, Federal College of Education (Technical), Omoku – Rivers State, Nigeria.*

ABSTRACT
Experiments were conducted at the Teaching and Research Farm of the Federal College of Education (Technical), Omoku – Rivers State; in the humid tropics of South-South Nigeria to study effects of organic manures (poultry manure, cow dung and palm bunch ash) and nitrogen - phosphorus - potassium fertilizer (15-15-15) on plant height, number of leaves, number of branches, leaf area, pod weight and dry matter of okra (*Abelmoschus esculentus* (L) Moench) during the late planting season of 2012 and early planting season of 2013. Organic manures were applied at 0 and 6 t ha^{-1} while NPKF was applied at 250 Kg ha^{-1}. Plant height and number of leaves were determined at 4 and 6 weeks after planting (WAP). Number of branches and leaf area were taken at 6WAP. Pod weight was determined at each harvest and cumulative taken at the eighth harvest while dry matter weight of plant was determined after harvest. Data obtained were subjected to ANOVA using the SPSS package. Organic manures and NPKF increased vegetative growth and pod yield relative to control. At 6 WAP in late planting season of 2012, NPKF had the highest height (40. 05 cm), followed by PM (35.18 cm), CD (27.88 cm), PBA (27.10 cm) and control (24.50 cm). The early planting season of 2013 also had NPKF (48.28 cm), PM (40.70 cm), CD (38.58 cm), PBA (30.88 cm) and control (26.85 cm). Pod weight indicated that CD (6.58 t ha^{-1}) > NPKF (4.92 t ha^{-1}) > PM (3.69 t ha^{-1}) > PBA (3.58 t ha^{-1}) and control (2.30 t ha^{-1}). NPKF encourages more vegetative growth than yield while CD and PM support more pod yield than vegetative growth. Application of CD at 6 t ha^{-1} is recommended for optimum production of okra on Ultisols.
Key words: okra, organic manures, fertilizer, growth, yield, comparative.

INTRODUCTION

Okra (*Abelmoschus esculentus* (L) Moench) is a flowering plant of the mallow family valued for its edible green fruits. It is grown and consumed as a vegetable crop in tropical countries (Fayemi, 1999). This fast growing vegetable is consumed in Nigeria with staple food products like garri, pounded yam, fufu, amala etc; because of its mucilaginous property. Okra plays a vital role in people's diet as it supplies vitamins and other essential nutrients. Nevertheless, the production of this crop is hampered by soil nutrient deficiencies. Fertilizer is often used to maintain soil fertility to overcome the nutrient deficiency problems. Inorganic fertilizers are highly appreciated by farmers because of their quick release of nutrients to crops, among other benefits. Inorganic fertilizers do not need certain time to be broken down or decomposed before usage because they contain nutrients that can be readily absorbed by plants (Makinde *et al.,* 2011). Among inorganic fertilizers, NPK fertilizers are designed to give plants the three major plant nutrients that the plants need in appropriate proportion and amount. The advantage of using inorganic fertilizers is that the nutrients are immediately available to plants and the exact amount of a given nutrient can be measured before feeding the plants (Stolton, 1997).

However, Ojeniyi (2000) noted that although the application of inorganic fertilizer has been found to improve crop yield and soil chemical properties such as pH, total nutrient content and nutrient availability, its continuous use is hindered by its scarcity, high cost, nutrient imbalance and soil acidity. Apart from the economic cost, the use of chemical fertilizers under continuous cultivation in the tropics is not adequate to sustain crop yield (Makinde and Ayoola, 2012). Their continuous application has been found to deplete soil organic matter (Madeley, 1990) and consequently, leading to reduction in crop yield and serious degradation and decline in soil productivity (Adeniran *et al.*, 2004). Organic fertilizers including poultry manure, cow dung, wood ash, green manure, among others; can be used to ameliorate soil fertility problems. The use of crop residues, organomineral fertilizers and other locally available plant nutrients for ameliorating problems of soil acidity have been emphasized in studies of fertility of tropical soils (Okon *et al.,* 2005).

Efforts have been made by researchers globally in finding possible shift from mineral fertilizers to organic fertilizers which are cheaper, readily available to farmers and could maintain soil physical and chemical properties without pollution effect (Senjobi *et al*. 2010). There is the growing interest in the use of organic manures due to health consideration the world over. Organic farming which does not involve the use of chemicals. Studies (Makinde and Ayoola, 2012) have shown that organic manures contain nitrogen, phosphorus, potassium and other essential nutrients. Also organic matter improve soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration. Ojeniyi (2007) found out that there was increase in the pod yield of okra with application of wood ash up to 8 t ha^{-1}. Likewise, Alasiri and Ogunkeyede (1999) reported that application of poultry manure at the rate of 10 t ha^{-1} gave the optimum seed yield of okra in Southwest Nigeria. Makinde and Ayoola (2012) found out that cow dung increased okra growth and yield at 20 t ha^{-1} in South-west Nigeria. Palm bunch ash was reported by Awodun *et al* (2007), to increase cob and grain yield of maize at 6 t ha^{-1} in South-West Nigeria.

Poultry manure is obtained in large quantities from poultry farms; cow dung is generated in large quantities from cattle farms and palm bunch ash is generated in large amount from oil palm mills. Among the conventional fertilizers, NPK is commonly used to fertilize vegetable farms in South-South Nigeria while among the organic manures, poultry manure, cow dung and palm bunch ash are commonly used for vegetable production. There is the need to compare the effectiveness and usefulness of these fertilizers on vegetable production. Therefore, the objective of this study was to compare the effect of mineral fertilizer and organic manures on the growth and yield of okra.

MATERIALS AND METHODS

Field Trials:

Field experiments involving poultry manure (PM), cow dung (CD) palm bunch ash (PBA) and NPK (15-15-15) fertilizer were conducted during the late cropping season of 2012 and early cropping season of 2013. They were done at the Teaching and Research Farm of the Federal College of Education (Technical), Omoku (05˚ 22′ N, 06˚ 40′ E) in the Rainforest zone of South-South Nigeria. The coordinate of the field plot was between Latitude 05˚ 22′ 692″ - 05˚ 22′ 699″ N and Longitude 06˚ 40′ 380″ - 06˚ 40′ 380″ E as length, and between Latitude 05˚ 22′ 698″ - 05˚ 22′ 692″ N and Longitude 06˚ 40′ 385″ - 06˚ 40′381″ E as width; on an elevation of 17.69 m (58 feet) above sea level. The soil was Typic paleudult derived from alluvial plain, and the top soil is sandy loam. The land had been under fallow for three (3) years, before the commencement of the trials, with weeds like *Panicum maximum, Chromolena odorata, Aspilia africana and Ageratum conyzoides* dominating the vegetation. The experiment was laid out in a Randomized Complete Block Design (RCBD). Beds were prepared on the plot and four treatments were applied at the levels of 0 and 6 t ha^{-1} for the organic manures; and 250 kg ha^{-1} of NPK 15: 15: 15 fertilizer. The application rate of NPK (250 kg ha^{-1}), poultry manure (6 t ha^{-1}), cow dung (6 t ha^{-1}) and wood ash (6 t ha^{-1}) were used as treatments, with three replications. Each plot size measured $16m^2$, separated by 1m distance. Variety of okra planted was NHAe-47-4. The seedlings were maintained at two (2) plants per stand (after thinning) at a distance of 0.6 x 0.6m. Each plot had a total of 72 plants equivalent to 27,778 plants per hectare. Organic manures were applied by broadcasting two weeks before planting for proper incorporation into the soil. NPKF was applied in split dosage at 1 and 4 weeks after planting (WAP). Manual weeding was done twice at 3 and 7 weeks after planting. Fifteen (15) plants were randomly selected per plot for determination of plant height, number of leaves, and number of branches and leaf area. Plant height and number of leaves were taken at 4 and 6 WAP, while number of branches and leaf area were taken only at 6WAP. Plant height was determined by the use of meter rule and leaf area by graphical method. Number of leaves and branches were by manual counting. All the fruits harvested per sample plant were used for determination of pod weight. Edible pods were harvested at 4 days interval and weighed. Pod weight was evaluated based on the cumulative number of pods at eight harvests. Dry matter yield (after harvest) per hectare (Kg) was also determined.

Soil Sampling, Soil and Organic Manure Analysis:

Before commencement of trials, surface (0-15cm) soil samples were collected using soil auger, bulked, air dried and sieved (2 mm) for routine analysis. Soil pH was measured with a glass electrode in a 1:2 soil water suspension in read with digital pH meter. Particle sizes of the samples were determined using the modified hydrometer method (Udo *et al.*, 2009) Organic matter was determined by dichromate oxidation method and total nitrogen by micro-kjeldahl method (Udo *et al.*, 2009). Available phosphorus was determined using Bray and Kurtz (Bray 1) approach; according *Udo et al.,* 2009. The concentrations of exchangeable calcium and magnesium were determined using the EDTA titration method. While the concentrations of sodium and potassium were determined by flame photometry method (Udo *et al.*, 2009). The organic manures were analyzed as described for the soil.

Statistical Analysis:

Statistical analyses were performed using SPSS statistical package for the analysis of variance (ANOVA). Means were compared by least significant difference at $p \leq 0.05$.

RESULTS

Physico-chemical analysis of the soils (table 1) revealed that they were sandy loam in texture with sand, silt and clay contents of 84, 10 and 6% in late planting, and 83, 12.9 and 4.1% in early planting. The Soils were acidic, low in organic matter, N, K, Ca and Mg (Table 1). Okra grows in all types of soils but thrives best in moist, friable, well-drained soils rich in organic matter (Agbede and Adekiya, 2012). The critical level of organic matter for crop production in Nigeria ecological zones is 3.0 % and the value for exchangeable Ca is 2.2 cmol Kg^{-1} (Akinrinade and Obigbesan, 2000). Analysis of the organic manures indicated that they have higher percentages of N, P, Ca, and Mg than the soils of the experimental sites (Table 1). Poultry manure is slightly richer in nutrient concentration than cow dung and palm bunch ash, nutrients released from the organic manures would contribute to improving nutrient availability to okra on the less fertile soils. The differences in their nutrient concentrations are minimal and the experiment will confirm their contributions to soil fertility.

The organic manures and NPKF increased plant height relative to the control (Fig. 1). The increase in all treatments at 4 WAP in late planting season of 2012 was significantly different. Nitrogen-phosphorus-potassium fertilizer treatment had the tallest plant followed by poultry manure, cow dung, palm bunch ash and control. Significant increase in heights was equally observed at 4 WAP in the early planting season of 2013. Apparently, NPKF had the tallest plant against PM, CD, PBA and control. The trend continued at 6WAP in both seasons. At 6WAP in late planting season of 2012, NPKF had the highest growth followed by PM, CD, PBA and control. The trend was the same in the early planting season of 2013.

Table 1: Physico-chemical composition of the experimental sites and organic manure properties

	Soil chemical properties		organic manure properties		
Composition	Late trial 2012 0 – 15cm	Early trial 2013 0 – 15cm	Poultry manure	Cow dung	Palm bunch ash
pH (H_2O) 1:2.5	4.90	5.20	6.40	6.60	8.80
Organic C (%)	1.08	1.35	12.85	22.30	15.40
Avail. P (Mg/g)	16.00	16.20	1.75%	1.10%	1.50%
Total N (%)	0.05	0.08	2.58	1.42	1.15
Exch. K (cmol kg^{-1})	0.16	0.19	2.49%	2.60%	29.17%
Na (cmol kg^{-1})	0.26	0.32	0.22%	0.62	0.85%
Mg (cmol kg^{-1})	0.18	1.30	0.78%	0.62%	3.80%
Ca (cmol kg^{-1})	0.26	2.32	10.68%	4.72%	7.85%
Sand (%)	84.00	83.00			
Silt (%)	10.00	12.90			
Clay (%)	6.00	4.10			
Textural class	Sandy loam	Sandy loam			

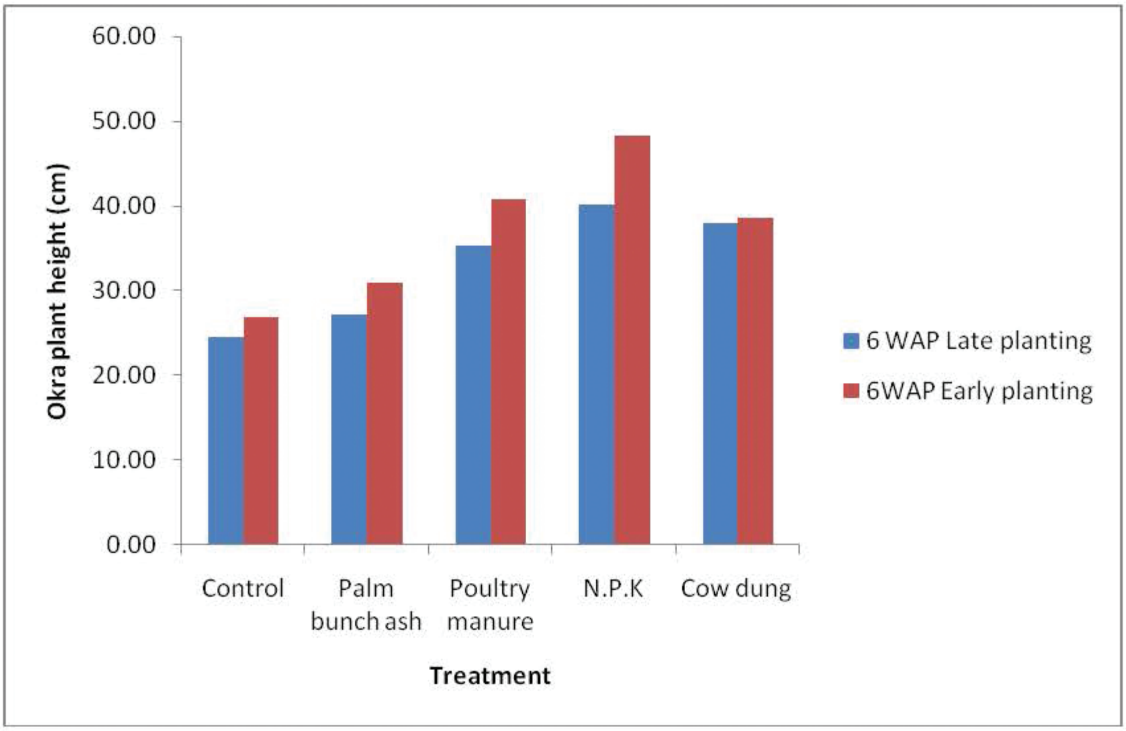

Fig. 1: Effect of treatments on height/plant @ 6WAP.

The effect of treatments on number of leaf per okra plant in the experiment showed that the parameter increased in others relative to the control. There was no significant difference in the number of leaf among the various treatments. This observation could be attributed to the high nutrient status of the organic manures and NPKF. There was a balance in the N: K of the soil amendments which gave the plants reasonable growth rate and relatively the same number of leaves (Table 2).

The effect of treatments on number of branches of okra plants revealed that there was increased number of branches relative to the control. The number of branches obtained from each treatment in the late planting season of

Table 2: Effect of treatments on the number of leaves of okra plants @ 4WAP and 6WAP

Treatment	4WAP		6WAP	
	Early planting	Late planting	Early planting	Late planting
Control	9.24^{b}	8.92^{c}	9.08^{ab}	9.11^{b}
Palm bunch ash	11.45^{a}	11.13^{a}	13.06^{a}	12.51^{a}
Poultry manure	11.80^{a}	11.93^{a}	13.72^{a}	12.82^{a}
N.P.K. F	12.96^{a}	12.7^{a}	14.43^{a}	14.56^{a}
Cow dung	12.29^{a}	11.53^{a}	12.93^{a}	12.49^{a}

Mean values followed by same letter(s) in the column are not significantly different ($p \leq 0.05$).

Table 3: Effect of treatments on leaf area of okra plants @ 6WAP

Treatment	Leaf area 2012	Leaf area 2013	Mean leaf area
	←	cm	→
Control	70[e]	72[e]	72[e]
Palm bunch ash	125[b]	131[b]	128[b]
Poultry manure	99[d]	119[c]	109[d]
NPKF	160[a]	166[a]	163[a]
cow dung	111[c]	118[c]	114.5[c]

Mean values followed by same letter(s) in the column are not significantly different ($p \leq 0.05$)

2012 is as shown in table 3. Similarly, the results of the treatment effect on number of branches on okra in the early planting season of 2013. Furthermore, leaf area results show that treatments increased the parameter relative to the control. The mean increase in the leaf area was highest in treatments with NPKF followed by CD, PM and PBA. (Table 3). This could be attributed to quick release of nutrients by NPKF. Mineral fertilizers are noted for their fast release of nutrients for absorption by plants than the organics.

The results of the cumulative yield of okra (t ha^{-1}) showed that treatments increased pod yield relative to control. Cow dung recorded the highest fruit yield per hectare in the late planting season (6.87 t ha^{-1}) followed by NPKF (4.88 t ha^{-1}), poultry manure (3.75 t ha^{-1}), palm bunch ash (3.60 t ha^{-1}) and control (2.40 t ha^{-1}). The results of the early planting season showed a similar trend. Cow dung gave the highest yield (6.27 t ha^{-1}) followed by NPKF (4.95 t ha^{-1}), poultry manure (6.63 t ha^{-1}), palm bunch ash (3.58 t ha^{-1}) and control (2.20 t ha^{-1}) (Fig. 2).

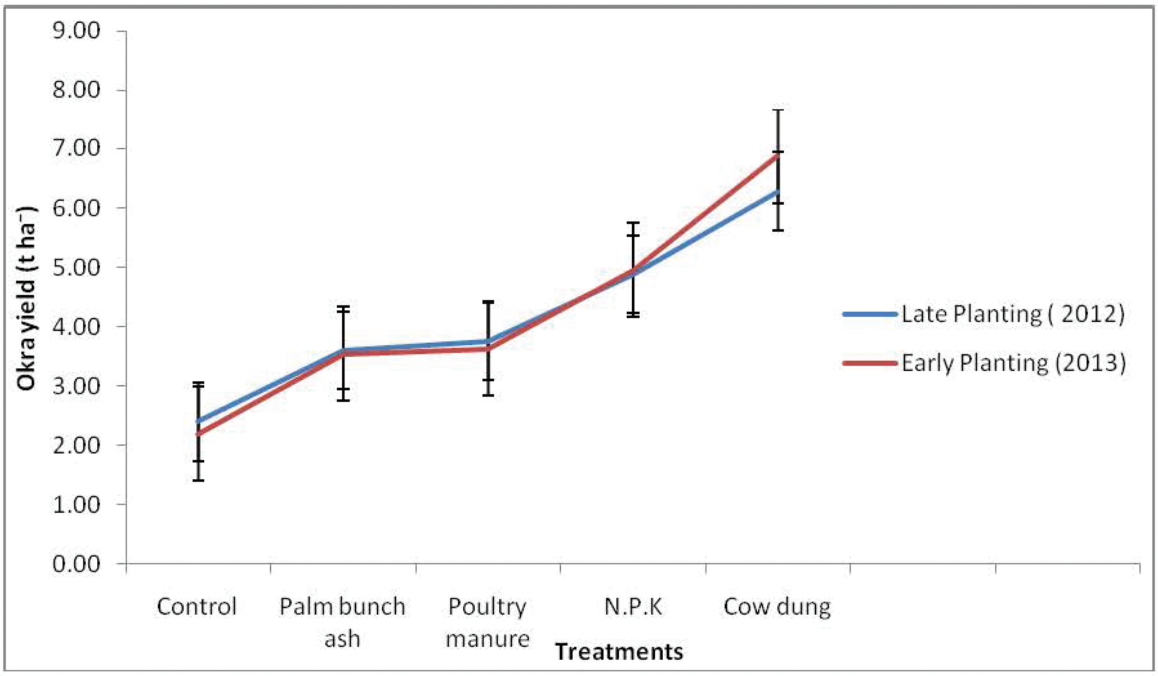

Fig. 2: Effect of treatments on the cumulative yield of okra (t ha⁻1)

The effect of the various treatments on dry matter yield is shown in Table 4. Dry matter yield increased across the treatments relative to the control. The highest dry matter yield recorded in the late planting season was in NPKF (8000), followed by poultry manure (7500), cow dung (6000), palm bunch ash (4500) and control (2000). In the early planting season, okra dry matter yield increased thus: NPKF (8500), cow dung (7000), poultry manure (6000), palm bunch ash (5500) and control (2500). There was a significant effect of the treatment on the dry matter content of the crop.

DISCUSSION

Okra plant heights were generally taller in other treatments compared to the control which indicates a release of nutrients from the organic manures and NPK fertilizer. Hence, all treatments increased growth relative to the control. The increase was significant from the 4WAP to 6WAP of both seasons. This study confirms that application of NPK fertilizer and organic manures enhance soil fertility status. It was found among the organic manures that poultry manure gave the highest height per plant. This could be attributed to increased microbial activities and mineralization of soil nutrients induced by the poultry manure addition. This is confirmed by the properties of the poultry manure.

The finding that the organic manure and NPK fertilizer increased okra vegetative growth and pod yield is consistent with low nutrient status of the soil obtained before the commencement of the experiment. The soil had low organic C, N, P, K, Ca and Mg status prior to the commencement of the trial. This observation is consistent with the fact that soil amendments and /or fertilizer is of key importance to the cultivation of okra on Ultisols of the humid tropics. The soil amendments used in this experiment had sufficient nutrients to increase the growth and yield of okra but suffice to say that poultry manure had higher of N and P than the other treatments. This could be responsible for the better performance of okra on soils amended with poultry manure than cow dung and palm bunch ash. Okra growth was more favoured with poultry manure compared to cow dung and palm bunch ash. It supported growth and development of more leaves than the others. This is in line with the observations of Agbede and Adekiya (2012), and Makinde and Ayoola (2012), who reported that poultry manure increased okra vegetative growth more than cow dung when compared on Alfisols of South-west Nigeria. Previous studies observed that poultry manure has more N that supports more of vegetative growth of crops (Oladotun, 2002). The growth of okra was at its optimum in the 6th week before flowering and fruiting. The nutrients applied were more available for utilization by the crop at this period for growth. By the 8th week growth is marginal and would not be appropriate for studies as the plant would have entered its production stage.

Okra pod yields were lower with poultry manure, relative to cow dung and palm bunch ash due to vegetative growth that has been more. This could be attributed to more of the plants photosynthesis which favoured vegetative growth and less of pod development. The peculiar higher N content of the poultry manure could be responsible for this. Cow dung and palm bunch ash contain high N content but they seem not released early enough compared to poultry manure. The nutrients were rather released during the pod formation stage. The high P: N ratio in poultry manure seems not to favour pod development of okra. Growth in plots applied with cow dung were not excessive therefore, formation of pods were higher. The observation is consistent with Makinde and Ayoola (2012), who compared poultry manure and cow dung on okra growth and yield on Alfisols of South-West Nigeria.

Interestingly, cow dung equally gave higher pod yield than NPK fertilizer in both trials. This could be attributed to other micro-nutrients present in cow dung (and other organic manures) but absent in NPK fertilizer. It has been observed that organic manures enhanced the release of trace elements when applied to the soils (Olayinka and Adebayo, 1993). Organic manures in addition to the major nutrients equally have secondary and other micro-nutrients which contribute in no small measure to okra pod formation. Besides, containing the secondary and micro-nutrients the time of release of these nutrients is another factor. Organic manure show greater capacity to retain nutrients in form that can easily be taken up by plants over a long period of time. The application of organic manures has the advantages of residual effect, improvement of biological and physical properties. Inorganic fertilizers are noted for their quicker release of nutrients compared to organic manures which release them slowly. The quick release of nutrients by inorganic fertilizers could result in leaching problem. Therefore, the early release of nutrients for okra growth was the rationale for cow dung producing more pods than NPK fertilizer. In term of vegetative growth NPKF ranked the highest followed by poultry manure before cow dung and palm bunch ash. The production of okra was more favourable in the early planting season than in the late planting season. This is attributable to favourable climatic conditions. Cultivation of okra in the late season required supplementary water through irrigation. This may affect growth and performance of the crop as the actual amount of water needed by the plant was not determined.

CONCLUSION:

This study has proved that although organic manures are rich sources of soil nutrients for the production of okra, cow dung gave better pod yield comparatively. It shows that poultry manure supported vegetative growth compared to palm bunch ash and cow dung but less pod yield compared to cow dung. For optimum yield of okra pods with balanced vegetative growth cow dung should be applied at 6 t ha^{-1}.

REFERENCES

Adediran, J.A., Taiwo, L. B., Akande, M. O., Sobulo, R. A. and Idowu, O.L. (2004). Application of organic and inorganic fertilizer for sustainable maize and cowpea yields in Nigeria. *J. Plant Nutrition*, 27(7): 1163-1181.

Agbede, T. M. and Adekiya, O. (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.

Akinrinde, E. A. and Obigbesan, G .O. (2000). Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. *Proceedings of 26th Annual Conference of Soil Science Society of Nigeria, Ibadan.* pp279-288.

Alasiri, K. O. and Ogunkeyede, O.O. (1999). Effects of different levels of poultry manure on seed yield of okra. P*roceedings of the 25th Annual Conference of Soil Science Society of Nigeria*, Benin City, Nigeria, pp. 102-105.

Awodun, M.A., Ojeniyi, S.O., Adeboye, A. and Odedina, S.A. (2007). Effect of oil palm bunch ash on soil and plant nutrient composition and yield of maize. *America-Eurasian*

Journal of Sustainable Agriculture 1(10): 50-54.

Fayemi, P. O. (1999). *Nigerian Vegetables,* Heinemann Educational Books Nigeria Plc: Ibadan.

Madeley, J. (1990). The organic cycle In: *African Farming and Food Processing:* May/ June. Alain Charles Publishing Ltd., London, pp: 22. National Fertilizers Company of Nigeria Limited (NAFCON), Port Harcourt, 1994, June News Digest.

Makinde, E. A. and Ayoola, O.T. (2012). Comparative Growth and Yield of Okra with Cowdung and Poultry Manure. *American-Eurasian Journal of Sustainable Agricultur*e, 6(1): 18-23, 2012.

Makinde, S.O., Usilo, M.I., Makinde, A. and Ayeni, S. (2011). Comparative effect of mineral fertilizers and organic manures on growth, nutrient content and yield of *Chorcorus olitorus* and *Celosia argentina*. *Research Journal of Botany* 6(4): 150-156.

Ojeniyi, S. O. (2000). Effect of goat manure on soil nutrients contents and okra yield in rainforest area of Nigeria. *Applied Tropical Agriculture* 5: 20-23.

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.

Okon, P.B., Ojeh, J. S. and Amalu, U. C. (2005). Effect of rice husk ash and phosphorus on some properties of acid sands and yield of okra. *Communications in Soil Science and Plant Analysis*. Volume 36, numbers 7 & 8. P.833-845.

Oladotun, A.O. (2002). Managing manure as a fertilizer; *Saskatchewani, Agriculture, Food and Rural Revitalization.*, pp: 5.

Olayinka, A. and Adebayo, A. (1993). The effect of loading rates of sawdust on plant growth, plant nutrient uptake and soil chemical properties. *Nigerian Journal of Soil Science* 4: 101-111.

Udo, E. J., Ibia T.O., Ogunwale, J. A., Ano, A. O. and Esu, I. E. (2009). *Manual of Soil, Plants and Water Analysis.* Sibon books ltd., Lagos Nigeria. pp: 17.

Senjobi, B.A., Ande, O.T., Senjobi, C.T., Odusanya, O.A. and Ajilore, O.D. (2010). Effects of Organic Amendments on the Growth and Performance of *Celosia argentea* on an oxic Paleusalf in South Western Nigeria. *Journal of Agricultural Biotechnology and Sustainable Development*. 2(8):142-150.

Stilton, S. (1997). Ecology and farming. Int. Mag. IFOAM, 15: 35-37.