Comparative efficacy of organic manures and urea fertilizer on growth and yield of okra (*Abelmoschus esculentus* (L) Moench)

[1]Aniefiok E. Uko, [1]*Emmanuel B. Effa and [2]Jessica E. Effiong
[1]*Department of Crop Science, University of Calabar, Calabar.*
[2]*National Biotechnology Development Agency (NABDA), Abuja*
***Corresponding Author:emmaeffa@yahoo.com.*

Abstract

Two year field study was conducted to evaluate effects of organic manures and urea on growth and yield of okra at University of Calabar Teaching and Research Farm, Calabar, in 2009 and 2010, using randomized complete block design (RCBD) having eight treatments; 10 t ha-^{1} of poultry manure (PM), 10 t ha-^{1} cow dung (CD), 200 kg ha^{-1} urea fertilizer (UF), 5 t ha-^{1} PM + 5 t ha-^{1} CD + 100 kg ha^{-1} UF, 5 t ha-^{1} PM + 5 t ha-^{1} CD, 5 t ha-^{1} PM + 100 kg/ha UF and 5 t ha-^{1} CD + 100 kg ha^{-1} UF with three replications. Data collected for growth and yield was subjected to analysis of variance at 5%. Means were compared using Duncan Multiple range Test at 0.05 probability. Results showed that application of 5 t ha-^{1} PM + 5 t ha-^{1} CD + 100 kg ha^{-1} UF significantly increased plant height, number of leaves at 6 and 8 weeks after planting (WAP), stem girth at 8 WAP and leaf area index at all sampling periods. Highest okra pod yield was recorded at application of 5 t ha-^{1} PM + 5 t ha-^{1} CD + 100 kg ha^{-1} UF.

Keywords: Efficiency, growth, okra, organic manures, urea, yield

Introduction

Okra (*Abelmoschus esculentus* (L) Moench) is an important vegetable crop cultivated throughout the tropical, subtropical and warm temperature regions of the world (Schippers, 2000)). Okra cultivation is rapidly expanding across different ecological zones of Nigeria in recent times due to its wide acceptability in diets and its economic potential to farmers. Okra is a good source of vitamins, protein and minerals for human diets (Adebisi *et al*., 2007). It is used in various kinds of soups, sauces and thickenings on account of the mucilage content, which is also suitable for both medicinal and industrial applications (Markose and Peter, 1990).

Inorganic fertilizers unlike organic fertilizers are usually quick-release formulae making nutrients rapidly available to plants. They release nutrients to plants immediately after application and exact amount of a given nutrient can be measured before feeding plants (Stolton, 1997). However, the continuous use of inorganic fertilizers on tropical soils may result to low soil pH, loss of organic matter, nutrient imbalances, deficiency of macro and micronutrients culminating in the low yield of crops (Ojeniyi, 2000; Ojeniyi, 2002; Adediran and Banjoko, 2003; Osundare, 2004; Mbah *et al*., 2004).

Scientific studies have shown that organic wastes are effective as manures for enhancing yield and nutrient status of many vegetables and grain crops (Adediran *et al*., 2003; Ikpe and Powell, 2003, Moyin-Jesu, 2003; Ojeniyi *et al.*, 2007). Organic manures can lead to sustainable cropping through enhanced nutrient recycling and improvement of soil physical properties including soil structure, water holding capacity, aeration and drainage (Bhakiyathu *et al.*, 2005). They are known to increase soil pH, improve soil nutrient availability (Ano and Agwu, 2005; Ewulo, 2005), stabilize nutrients applied to the soil (Baquerol and Rojas, 2001), while ensuring a slow but steady release of nutrients to plants as well as activates soil microbial biomass (Belay *et al.*, 2001).

Poultry manure contains high percentage of nitrogen, potassium and phosphorus for the healthy growth of plants (Adediran and Banjoko, 2003; Ewulo, 2005). Omotosho and Shittu (2008) found that poultry manure (PM) at the rate of 4 t ha^{-1}gave significantly higher okra fruit yields. They also found that addition of PM to the soil produced better and healthier okra plants and thereby improved significantly the growth, yield and nutrient contents of okra. According to Makinde *et al.* (2011), the nutrient composition of poultry manure was higher than cow dung; thus poultry manure could release more nutrients to the soil for uptake by plants than cow dung.

Nevertheless, mixing organic and inorganic fertilizers is viewed as a sound soil fertility management strategy in many countries. Combined application apart from enhancing crop yields has a greater beneficial residual effect that can be derived from the use of either organic or inorganic fertilizers. Agboola *et al*. (1982) observed that combined use of organic and inorganic fertilizers is the best means of augmenting available nutrient contents of tropical soils. Combination of urea with poultry manure was reported to increase leaf yield of *Celosia argenta* (Babatola and Oyedummade, 1992).

The combinations of inorganic and organic fertilizers application in soil have been used to increase okra production (Olaniyi *et al*., 2010; Akande *et al*., 2010). Makinde *et al*. (2011) reported that maize (*Zea mays* L.) yield obtained from application of a combination of synthetic fertilizer and organic manure was higher, compared to that from manure alone. Akande *et al*. (2003) reported that combined use of ground rock phosphate applied in combination with poultry manure significantly improved growth and yield of okra compared to application of each consecutively. Akanbi *et al.* (2005) reported that the combined application of 4 t/ha of maize straw compost and N mineral fertilizer at 30 kg/ha improved plant growth and gave higher tomato yields than other combinations. Organic manures can be used to provide nutrition to okra and attain yields that generally are comparable to that obtained with mixtures of organic and mineral fertilizer. However, comparable level of productivity can be achieved with a lowered level of mineral fertilizer combined with manures. It is common to see the resource poor farmers (in most parts of Nigeria who may not be able to afford or have access to inorganic fertilizers) resort to the use of sole organic manures or combine them with other organic fertilizers and/or inorganic fertilizers for fertilizing their crops in order to reduce the cost of applying inorganic fertilizer alone.

In spite of its economic importance, the productivity of okra is still abysmally low, hampered by problems such as pests and diseases which are accentuated by other factors as soil type, seed quality, deficiency in knowledge of cultural practices, lack of appropriate fertilizers which have resulted in a decline in yields of okra (Saidu *et al.*, 2012: Christo and Onuh, 2005). It is therefore economical to balance organic and inorganic nutrient sources for higher crop yields. The present study was conducted to examine the relative efficacy of different organic manures or their combinations with other organic manures and/or inorganic fertilizers on yield performance of rain fed okra on acid soils.

Materials and methods

Site information: A two year field experiment was conducted in 2012 and 2013 at the Teaching and Research Farm of the University of Calabar, Nigeria on lat 4.5 - 5.2^0 N and longitude of 8.0 - 8.3^{0}E, about 39m above sea level. The area is characterized by a bimodal rainfall pattern that ranges from 3,000 – 3,500 mm, mean annual temperature range of 27^{0}C to 35 ^{0}C and relative humidity between 75 - 85% (NIMET, 2010). The soil is repeatedly cropped, year in year out due to continuing trials and in the previous year, maize was grown on the site.

Soil sampling and analysis: Random soil samples were collected from the experimental site at 0-30 cm depth prior to application of treatments and planting. Samples were air-dried, bulked and a composite sample analysed for physico-chemical properties using suitable methods.

Experimental design

The experimental design adopted for the study was the randomized complete block design (RCBD) having eight treatments in all. These were 10 t ha^{-1} Poultry manure (PM), 10t ha^{-1} Cow dung (CD), 200kg ha^{-1} Urea fertilizer (UF), 5t ha^{-1} Poultry manure + 5t ha^{-1} Cow dung (½ PM + ½ CD) , 5t ha^{-1} Poultry manure + 5t ha^{-1} Cow dung + 100kg ha^{-1} urea (½ PM + ½ CD + ½ UF), 5t ha^{-1} Poultry manure + 100kg ha^{-1} Urea (½ PM + ½ UF,) 5t ha^{-1} Cow dung + 100kg ha^{-1} Urea (½ CD + ½ UF) , and the Control where no fertilizer treatment was applied. These were replicated three times giving a total of 24 experimental plots

Sources of experimental material

Cow dung was sourced from the University of Calabar feedlot with animals of various age ranges in the holding area, with dry grass as bedding material. Poultry manure was obtained from the broiler unit of the same farm. The manures were cured by spreading them out in the shade for two weeks before field application. The okra seeds of variety NH40 were obtained from National Institute for Horticultural Research and Training (NIHORT), Ibadan, Nigeria.

Field planting and maintenance

Two seeds of okra were sown per stand at a spacing of 60 cm x 60 cm into a previously ploughed and harrowed field on April 20th of both years. They were later thinned to one per stand giving a plant population of 173,611 plants ha^{-1}. Experimental plots measured 2.5 m x 2.5 m (6.25 m^2)with a net plot size of 1.5 m x 2.0 m (2.4 m^2), respectively.

Data collection and analysis

Plants were sampled every two weeks starting from 3 weeks after planting (WAP) and data collected on growth variables such as plant height, stem girth, number of leaves and branches and leaf area using the formula: $Y= -3.616 +0.604x_1 +0.882x_2$ (where X_1 = length x breath of leaves and X_2 = number of leaves) using method described by Musa and Usman (2016), while yield data were taken for the number of days to 50% flowering, number of fruits/plant, pod length, fruit girth and fresh pod yield. Data collected were subjected to a two –way analysis of variance (ANOVA) at 5% level of significance following procedures outlined by (Snedecor and Cochran, 1967). Significant means were compared using the Duncan Multiple range Test (DMRT at 0.05 probability level.

Results and discussion

Organic manures and urea applications resulted in significant increases in plant height, number of leaves, leaf area index and stem girth of okra at 3, 5, 7 and 9 weeks after planting (WAP) in both years. Table 3 shows that at 3 WAP application of 200 kg ha^{-1}of urea fertilizer increased plant height though not significantly different from the plants fertilized with combinations of5 t ha-^{1} each of poultry manure (PM), cow dung (CD) plus 100 kg ha^{-1} of Urea fertilizer (UF), 5 t ha-^{1} of PM plus 100 kg UF (12.20cm) and 5 t ha-^{1} of CD plus 100 kg ha^{-1} UF. However, combining 5t ha-^{1} each of PM and CD plus 100kg of UF resulted in significantly taller plants when compared to those fertilized with 10 t ha-^{1} of PM and CD whereas the control plots where no fertilizer was applied at all had significantly ($p \leq 0.05$) the shortest plants compared to every other fertilizer treatment.

At 5WAP in 2009, combined application of 5 t ha-^{1} each ofPMand CD plus 100 kg ha^{-1}of UF did not differ significantly from application of 200kg ha^{-1} urea in terms of plant height but it differed significantly compared to every other fertilizer treatments and the control. While in 2010, application of 200 kg ha^{-1} of UF significantly increased plant height compared to every other fertilizer treatment either singly or in combined application and the control. At 7 and 9 WAP okra plants fertilized with a combination of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1}of UF grew significantly taller when compared to all other fertilizer treatments and the control.

Okra plants fertilized with 200 kg ha^{-1} of UF produced more leaves (5.83) at 3 WAP in 2009 (Table 4) although not significantly higher compared to the number of leaves produced when a combination of 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1}of UF (5.33), 5 t ha-^{1} of PM plus 100 kg ha^{-1}UF (5.00) and 10 t ha-^{1} PM (4.83) were applied. Fertilization with 200 kg ha^{-1}of urea however, significantly produced more leaves compared to combination of 5 t ha-^{1} of CD plus 100 kg ha^{-1} UF, 5 t ha-^{1} each ofPM and CD and 10 t ha-^{1} CD . Similar trend of result was obtained at 3 WAP in 2010 except that 5 t ha-^{1} of PM plus 100 kg ha^{-1}UF did not share the same level of significance as 100 kg ha^{-1}UF. At 5 WAP in 2009, combined application of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF resulted in significantly more leaves when compared to all other fertilizer treatments and the control. In 2010 however, single application of 200 kg ha^{-1} urea, significantly increased the number of leaves produced above other treatments. At 7 and 9 WAP in both years, okra plants fertilized with a combination of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF increased significantly in number of leaves when compared to all other fertilizer treatments and the control. The sole application of urea fertilizer at the rate of 200 kg ha^{-1} promoted rapid plant development during the first five weeks of growth. However, from the seventh week and upwards, the sole poultry manure and cow dung as well as their different combinations with different ratios of urea continued to sustain and increase plant development.

The leaf area of okra significantly increased with the application of 200 kg ha^{-1} urea at 3 and 5 WAP in both years of study, when compared to other fertilizer treatments and the control (Table 5). At 5 and 9 WAP, however, okra plants that received the combined application of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF had significantly higher leaf area index compared to other fertilizer treatments, followed closely by combined application of 5 t ha-^{1} of PM plus 100 kg ha^{-1} UF while the control consistently had the least leaf area index. Nutrient supply to crops either as sole application or from combined sources significantly affected most of the plant attributes investigated in the study.

Makinde *et al*. (2011) and other researchers have agreed that organic manure applied sole or in combination with inorganic fertilizers enhanced the general growth, shoot biomass and yield of crops. Adediran and Banjoko (2003); Ewulo, (2005) and Omotosho and Shittu (2008) have additionally found that addition of PM to the soil produced better and healthier okra plants and thereby improved significantly the growth, yield and nutrient contents of okra. Increase in plant height is an important character directly linked to the reproductive potential of plants with respect to fodder, grain and fruit yield (Omotoso, 2007).

Table 6 shows that okra fertilized with 200 kg ha^{-1} UF had significantly higher stem girth at 3 WAP in 2009 and 2010 when compared to those that received other treatment regimes. It also had the highest stem girth at 5 WAP in 2009 although not significantly different from the stem girth produced when 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1}of UF were applied together. However, the increase in stem girth became significantly higher when compared to other fertilizer treatments and the control. At 7 WAP in both years the combined application of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF resulted in wider stem girth, although not significantly wider than the resultant stem girth when 200 kg ha^{-1} UF, 5 t ha-^{1} of PM plus 100 kg ha^{-1} of UF and 10 t ha-^{1} of PM were applied. A similar trend was observed in the performance of okra at 9 WAP in 2009. Combined application containing 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1} of UF had the widest stem girth which was not significantly higher than that produced by the application of 10 t ha-^{1} of PM, 5 t ha-^{1}ofPM plus 100 kg ha^{-1} of UF and 200 kg ha^{-1} UF. At 9 WAP in 2010, the combined application of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF significantly increased stem girth when compared to other fertilizer treatments and control. The complementary application of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} urea gave significantly higher values for most of the yield attributing factors such as pod length, number of fruits per plant, pod diameter or fruit girth, and fresh pod yield compared to all other treatment combinations. Except for the number of pods plant^{-1}, where ½ (PM+CD) gave statistically similar pod length as ½ (PM+CD+UF), ½ (PM+UF) and ½ (CD+UF), all other variables measured attained maximum manifestations when okra plants were fertilized with ½ (PM+CD+UF) combination.

The lengthening of the nodes resulted in corresponding higher number of leaves which directly enhanced leaf area and leaf area index of the plants respectively. Higher number of branches had implications for higher LAI and photosynthetic efficiency, due to leaf proliferation and the presentation of larger leaf surface area. Also, increased branching resulted in higher flowering and increase of fruit bearing points. An improvement in solar capture obviously would enhance photo-assimilates production, leading to increased fertility of the crops, hence lower number of days to 50% flowering. Additionally, higher rates of assimilates partitioning to the pods may have enhanced the higher number as well as larger fruit size of okra as recorded in the study.

The effects of organic manure and fertilizer on the number of days to 50 % flowering, number of fruits per plant, length of pods, fruit girth and fresh pod yield (t ha-^{1}) are presented in Table 7. The effects of the fertilizer treatment did not significantly influence the number of days to 50 % flowering, even though the plants from control plots took the least number of days to attain 50 % flowering. The result also shows that in 2009, a combined application of 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1}of UF resulted in the highest number of fruits per plant, statistically similar to the number of fruits produced when 5 t ha-^{1} of PM plus 100 kg ha^{-1}of UF, 5 t ha-^{1} ofPM plus 5 t ha-^{1} ofCD, 5 t ha-^{1} ofCD plus 100 kg ha^{-1} of UF and 10 t ha-^{1} of PM were applied. In 2010, a similar trend of results were observed, 5 t ha-^{1} ofPM plus 100 kg ha^{-1}of UF in a combined application produced 8.33 fruits per plant which was similar to 5 t ha-^{1} ofPM plus 100 kg ha^{-1}of UF with 7.53 fruits, 10 t ha-^{1} of PM (7.47 fruits), and 5 t ha-^{1} of PM plus 5 t ha-^{1}

ofCD (7.33 fruits). Okra plants in the control plots in both years had significantly the least number of pods per plant. Also in both years, okra plants in the plots fertilized with a combination of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1}of UF had significantly longer pods compared to other fertilizer treatments and the control

The fruit girths were larger for okra fruits fertilized with a combination of 5 t ha-^{1} each of PM and CD plus 100 kg ha^{-1} of UF in both years. In 2009 however, these were not significantly different from those fertilized with 5 t ha-^{1} PM plus 100 kg ha^{-1} UF, 10 t ha-^{1} PM and 5 t ha-^{1}PM. Whereas in 2010, the fruit girth of okra fertilized with 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1}of UF was significantly higher than all other fertilizer treatments except for those treated with 5 t ha-^{1}ofPMplus 100 kg ha^{-1} of UF.

In 2009, okra fertilized with the 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1} of UF combination had significantly higher fresh fruit yield (2.46 t ha^{-1}) than all other fertilizer treatments except for those treated with 5 t ha-^{1}ofPM plus 100 kg ha^{-1}of UF. In 2010, a significantly higher increment in fresh fruit yield was obtained (2.57 t ha^{-1}) when okra was fertilized with a combination of 5 t ha-^{1} each ofPM and CD plus 100 kg ha^{-1} UF when compared to all other fertilizer treatments. The performance of okra could be attributed to the fact that addition of manure increases soil water holding capacity which meant higher nutrient availability for the crops (Costa *et al*., 1991). According to Saidu *et al*. (2012), mineral fertilizer nutrients enhance establishment of crops while nutrients from organic manure mineralization promoted yield when both fertilizers were combined.

The complimentary combination of ½ (PM+CD+UF) indicated that there was conferred nutrient advantage from mineral and organic fertilizers. While organic manure acts in improving both physical and biological properties of soil, inorganic fertilizer gave a flush of nutrients due to prompt mineralization thereby boosting growth and yield. These results agree with those of Anburani and Manivannan (2002), who reported that combination of organic and inorganic fertilizers, increased the leaf area index, flowering and yield of okra which according to Olaniyi *et al*. (2010) and Akande *et al*. (2010), can be used to increase both growth and yield of crops.

Conclusion

Okra variety NH40 was fertilized with eight treatment regimes of sole organic and inorganic fertilizers and their combined application as follows; 10t/ha of poultry manure (PM) 10t/ha cow dung (CD), 200kg/ha urea fertilizer (UF), 5t/ha PM + 5t/ha CD + 100kg/ha UF, 5t/ha PM + 5t/ha CD, 5t/ha PM + 100kg/ha UF and 5t/ha CD + 100kg/ha UF. Plant height and number of leaves significantly increased at 6 and 8 weeks WAP with the application of 5 t ha^{-1} + 5 t ha^{-1} PM + 5 t ha^{-1} CD + 100kg UF, which also increased stem girth at 8 WAP and leaf area index at all growth stages. Application of UF significantly increased growth and yield often above control. The highest okra pod yield was however obtained from plots treated with 5 t ha^{-1} PM + 5 t ha^{-1} CD + 100 kg UF.

References

Adebisi, M. A., Akintobi, D.C.A. & Oyekale, K. O. (2007). Preservation of Okra Seed Vigour by Seed Treatment and Storage Containers. *Nigerian Journal of Horticultural Science*, 12: 1 – 7.

Adediran, J. A. & Banjoko, V. A. (2003). Comparative effectiveness of some compost fertilizer formulations for maize in Nigeria. *Nigerian Journal of Soil Science*, 13: 24-49.

Adediran, J. A., Taiwo, L.B. & Sobulo, R. A. (2003). Organic wastes and their effect on tomato (*Lycopersicum esculentus*) yield. *African Soils*, 33: 99-116.

Agboola, A. A., Obigbesan, G. O. & Fayemi, A. A. (1982). Effect of organic matter (farm yard manure), lime and phosphorus fertilizer on the yield of cowpea. FAO Soil Bulletin., 27: 339-339.

Akanbi, W. B., Akande, M. O. & Adediran, J. A. (2005). Suitability of composted maize straw and mineral nitrogen fertilizer for tomato production. *Journal of Vegetable Science*, 11 (1): 57-65. DOI: 10.1300/J484v11n01.

Akande, M. O., Oluwatoyinbo, F. I., Adediran, J. A., Buari, K. W. & Yusuf, I. O.(2003). Soil amendments affect the release of P from rock phosphate and the development and yield of okra. *Journal of Vegetable Crop Production*, 9(2):3–9.

Akande, M.O., Oluwatoyinbo, F. I., Makinde, E.A., Adepoju, A. S .& Adepoju, I. S. (2010). Response of Okra to Organic and Inorganic Fertilization. *Nature and Science*, 11(8): 260 – 266.

Anburani, A. & Manivannan, K. (2002). Effect of integrated nutrient management on growth inbrinjal(*Solanumme longena* L.) cv. Annamalai. *South Indian Horticulture*, 50(4-6): 377-386.

Ano, O.A. & Agwu, J. A. (2005). Effect of animal manure on selected soil chemical properties. *Journal of Soil Science*, 15: 14-19.

Babatola, J. O. & Oycdummade, E. E. A. (1992). Influence of organic manures and urea on nematode pests of *Celosia argenta*. *Nematology Mediterranea*, 20: 237-239.

Baquerol, J. E. & Rojas, L. A. (2001).Interaction effects of organic materials and lime on grain yield and nutrient acquisition of three maize varieties grown in an Oxisol of the Colombian eastern plains. In: *Horst et al*. (Eds.), Plant nutrition-Food security and sustainability of agro-ecosystems. 982-983, Netherlands, Kluwer Academic Publishers.

Belay, A., Classens, A. S., Wehner, F. C. & De Beer, J. M. (2001). Influence of residual manure on selected nutrient elements and microbial composition of soil under long term crop rotation. *South African Journal ofPlant and Soil*,18:1-6.

BhakiyathuSaliha, B., Krishnakumar, S. & Natarajan , S. K. (2005). Response of Rice Crop to Organic manuring in high pH soil. *Asian Journal of Plant Sciences, 4: 524-526*. DOI:10.3923/ajps.2005.524.526

Christo, E.I. & Onuh, M.O. (2005). Influence of plant spacing on the growth and yield of okra (*Abelmuschus esculentus* L. Meonch). *Proceedings of the 39th Conference of the Agricultural Society of Nigeria*, (ASN`05), Benin, pp: 51-53.

Cooke, G. W. (1980). *Fertilizer for Maximum Yield*. 1st Edn. London, Granada Publishing Ltd.

Costa, F. C.,Hernadez, G. C. & Polo, A. (1991). *Residuosorganicosurbanicos in manejoyutilizacion CSIC Munica* . pp.181.

Ewulo, B. S. (2005). Effect of poultry and cattle manure on sandy clay loam soil. *Journal of Animal Veterinary Science*, 4: 839-841.

Fuchs W., Rauch, K. & Wiche, H. J. (1970). Effect of organic fertilizer and organo mineral fertilizing on development and yield of cereals .*Abrecht- Thaer arch*, 14: 359-366.

Ikpe, F. N. & Powell, J. M. (2003). Nutrient cycling practices and changes in soil properties in the crop livestock farming systems of Western Niger Republic of West Africa. *Nutrient Cycling and Agroecosystems*, 62: 37-45.

Makinde, E. A. & Ayoola, A. A. (2008). Residual influence of early season crop fertilization and cropping system on growth and yield of cassava. *American Journal of Agriculture and Biological Sciences*, 3(4): 712-715.

Makinde, O. S., ImisuUsilo, M., Adeyinka M E. & Samuel, A L. (2011). Comparative Effect of Mineral Fertilizers and Organic Manures on Growth, Nutrient Content and Yield of *Chorcoruso litorus* and *Celosia argentea*. *Research Journal of Botany,6: 150-156.***DOI:** 10.3923/rjb.2011.150.156.

Markose, B. L. & Peter, K. V. (1990). Okra. Review of researches on vegetable and tuber crops. Technical Bulletin 16. Kerala Agricultural University Press, Mannuthy, Kerala, 109 pp.

Mbah, C. N., Mbagwu, J. S. C., Onyia, V. N. & Anikwe, M. A. N. (2004). Effect of application of biofertilizers on soil densification, total porosity, aggregate stability and maize grain yield in a dysticleptosol at Abakaliki. *Nigerian Journal of Science and Technology*, 10:74-85.

Moyin-Jesu, E.I. (2003). Incorporation of agro-industrial biomass and their effects on growth and nutrient content of four successive crops of amaranthus. *Journal of Tropical Agricultural Science*, 26: 49-58.

Musa, U. T. & Usman T.A. (2016). Leaf area determination for Maize (*Zea mays* L.) and okra (Abelmoschus esculentus L.) crops using linear measurements. *Journal of Biology, Agriculture and Healthcare*, 6(4): 103 – 111.

NIMET (2010). Weather Report.Nigerian Meteorological Agency, Margaret Ekpo International airport, Calabar.

Nwajiuba, C. & Chimezie, P. (2000). The use of livestock wastes in soil fertility regeneration in Imo state of Nigeria. *Proceedings of the 1st Annual Conference of the College of Agriculture and Veterinary Medicine,* 2000, Abia State University, Nigeria, pp: 137-140.

Obi, C. O., Nnabude, P. C. & Onucha, E. (2005). Effect of kitchen wastes compost and tillage on soil chemical properties and yield of okra (*Albemoschus esculentus*). *Nigerian Journal of Soil Science*, 15: 69-76.

Ojeniyi , S.O., Awodun, M.A. & Odedina , S.A. (2007). Effect of Animal Manure Ammended Spent Grain and Cocoa Husk on Nutrient Status Growth and Yield of Tomato. *International Journal of Agricultural Resources, 2: 406-410.***DOI:**10.3923/ijar.2007.406.410

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

Ojeniyi, S. O. (2002). Soil Management, Natural Resources and Environment. Adeniran Press. Ibadan, pp3.

Olaniyi, J. O., Akanbi, W. B., Olaniran, O. A. & Ilupeju, O. T. (2010). Effects of organo-mineral and inorganic fertilizers on growth, fruit yield, quantity and chemical composition of okra.*Proceedings of the 3rd International Conference on AgriculturalScience*.elewa.org/agriculture.

Omotoso, S.O. (2007). Effect of NPK fertilizer rates and method of application on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) at Ado-Ekiti Southwestern, Nigeria.*International Journal of Agricultural Research*, 2: 614-619. DOI: 10.3923/ijar.2007.614.619.

Omotoso, S.O. &Shittu, O.S. (2008). Soil Properties, Leaf Nutrient Composition and Yield of Okra (*Abelmoschus esculentus* (L.) Moench) as Affected by Broiler Litter and NPK 15:15: 15 Fertilizers in Ekiti State, Nigeria. *International Journal of Agricultural Research, 3: 140- 147.*DOI: 10.3923/ijar.2008.140.147.

Osundare, B. (2004). Effect of different companion crops and fertilizer types on soil nutrient dynamics and performance of cassava.*Nigerian Journal of Soil Science*, 14: 13-17.

Saidu.A, Abayomi, Y. A. &Aduloju, M. O. (2012).Evaluation of complementry use of organic and Inorganic fertilizers on the performance of upland rice O*ryza sativa* L.).*International Journal of Advances in Biological Research*, 2(3): 487-491

Schippers, R.R. (2000). African Indigenous Vegetables.An Overview of the Cultivated Species. Natural Resources Institute/ACP-EU Technical Centre for the Agricultural and Rural Cooperation, Charham, UK.,Wagenigen, The Netherlands.

Snedecor C. W. & Cochran W. G. (1967) *Statistical methods*, Iowa StateUniversity Press, USA; 507pp.

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

Table 1: Physical and chemical properties of the soil

	Year	
Soil properties	**2009**	**2010**
Particle size analysis (%)		
Sand	77.2	80.1
Silt	11.9	9.65
Clay	10.9	10.25
Soil textural class	Sandy loam	Sandy loam
Chemical composition		
pH	5.30	5.25
Organic matter (g/kg)	1.30	1.58
Total Nitrogen “	0.07	0.14
Available P (mg/kg)	36.5	29.29
Na (cmol/kg)	0.29	0.09
K “	0.14	0.12
Ca “	1.33	1.69
Mg “	0.23	0.66
ECEC “	4.80	3.06
Base Saturation (%)	50.41	52.56

Table 2. Meteorological information for Calabar in 2009 and 2010

Month	Mean temperature (^{0}C)	Total Rainfall (mm)	Relative Humidity (%)	Sunshine (Hrs)
2009				
April	32.1	150.5	84	3.0
May	31.6	308.9	84	4.4
June	30.2	218.4	87	2.2
July	28.0	507.3	92	1.7
August	28.1	507.3	92	1.0
2010				
April	33.1	130.4	83	5.2
May	31.5	306.5	85	4.4
June	29.8	611.3	88	3.2
July	28.8	384.0	90	1.8
August	28.2	406.7	91	1.8

. **Source**: Nigerian Meteorological Unit (NIMET) Margaret Ekpo International Airport, Calabar

Table 3. Effects of organic manures and urea fertilizer on plant height of okra in 2009 and 2010

	Plant height (cm)							
Treatment	**3 WAP**		**5 WAP**		**7 WAP**		**9 WAP**	
	2009	**2010**	**2009**	**2010**	**2009**	**2010**	**2009**	**2010**
Poultry manure (PM)	10.27bc	9.27bc	16.67c	16.00c	33.67b	34.00bc	76.10b	74.97b
Cow dung (CD)	9.10cd	8.43bc	13.67e	14.67e	28.00d	29.00e	67.33cd	69.67c
Urea fertilizer (UF)	13.33a	13.00a	19.23ab	20.00a	32.33bc	31.67de	63.33d	60.00d
½ PM+ ½CD	11.30b	9.17bc	16.33cd	16.33c	30.67c	32.33cd	72.33bc	70.33c
½PM+ ½UF	12.20ab	10.87ab	18.00bc	16.67c	34.33b	35.00b	78.33ab	77.67a
½CD + ½UF	11.90ab	10.63ab	15.33de	15.67d	32.00c	31.00de	64.00d	66.67c
½PM+½CD+ ½UF	12.97ab	12.67a	21.00a	18.33b	39.20a	40.33a	79.00a	80.33a
Control	8.03d	7.87c	11.33f	11.00f	23.33e	22.67f	44.00e	45.00e

Means followed by the same alphabet within the column are not significantly different based on DNMRT at 5% probability level. Note: ½ PM= half the quantity of poultry manure, ½ CD = half the quantity of cow dung and ½ UF = half the quantity of urea fertilizer.

Table 4. Effects of organic manures and urea fertilizer on number of leaves of okra in 2009 and 2010

Treatment	Number of leaves							
	3 WAP		5 WAP		7 WAP		9 WAP	
	2009	2010	2009	2010	2009	2010	2009	2010
Poultry manure (PM)	4.83ab	5.33ab	15.67bc	15.00bc	21.83bc	22.17bc	41.80b	42.80bc
Cow dung (CD)	4.13bc	4.47cd	14.33c	14.33d	19.67c	20.33bc	39.67b	40.33c
Urea fertilizer (UF)	5.00a	6.33a	16.67b	19.67a	21.00bc	19.67c	41.67b	40.67c
½ PM+ ½CD	4.33b	4.60bc	15.33bc	14.67cd	22.00bc	21.33bc	41.00b	41.33bc
½PM+ ½UF	5.33a	4.93b	16.33b	15.67bc	23.87b	22.53b	42.67b	44.00b
½CD + ½UF	4.57b	4.50b	15.87bc	15.33bc	22.50b	22.50b	42.00b	42.33bc
½PM+½CD+ ½UF	5.83a	5.50ab	20.17a	16.33b	25.30a	25.80a	46.00a	47.67a
Control	3.67c	3.33d	10.00d	11.00e	13.33d	13.33d	31.33c	30.00d

Means followed by the same alphabet within the column are not significantly different based on DNMRT at 5% probability level.
Note: ½ PM= half the quantity of poultry manure, ½ CD = half the quantity of cow dung and ½ UF = half the quantity of urea fertilizer.

Table 5: Effects of organic manures and urea fertilizer on leaf area of okra in 2009 and 2010

Treatment	Leaf area							
	3 WAP		5 WAP		7 WAP		9 WAP	
	2009	2010	2009	2010	2009	2010	2009	2010
Poultry manure (PM)	64.00c	64.93bc	89.33c	96.00bc	775.67bc	769.67b	1103.33b	1185.00b
Cow dung (CD)	58.67e	59.67ef	71.33d	73.00d	697.00d	698.00c	894.33c	868.00d
Urea fertilizer (UF)	75.67a	75.67a	125.33a	126.67a	763.00bc	730.67bc	973.33c	890.67d
½ PM+ ½CD	59.87de	60.53de	86.67cd	90.33c	716.33cd	721.67bc	993.00c	1004.67cd
½PM+ ½UF	64.33c	64.00bc	95.67c	92.33bc	788.33b	786.67ab	1110.00b	1153.33bc
½CD + ½UF	62.67cd	62.13cd	81.00cd	86.33c	711.33cd	720.00bc	1011.67bc	1056.00bc
½PM+½CD+ ½UF	68.33b	67.67b	106.00b	105.33b	843.33a	838.67a	1386.67a	1416.67a
Control	37.67f	37.67f	59.33e	61.33d	505.33e	404.00d	570.33d	603.67e

Means followed by the same alphabet within the column are not significantly different based on DNMRT at 5% probability level.
Note: ½ PM= half the quantity of poultry manure, ½ CD = half the quantity of cow dung and ½ UF = half the quantity of urea fertilizer.

Table 6. Effects of organic manures and urea fertilizer on stem girth of okra in 2009 and 2010

Treatment	Stem girth (cm)							
	3 WAP		5 WAP		7 WAP		9 WAP	
	2009	2010	2009	2010	2009	2010	2009	2010
Poultry manure (PM)	2.60b	2.40b	3.51bc	3.87ab	4.80ab	5.00ab	6.00ab	6.13b
Cow dung (CD)	2.23cd	2.08c	2.82cd	2.89c	3.87c	4.10c	5.17b	5.43b
Urea fertilizer (UF)	3.60a	3.50a	4.73a	4.70a	4.93ab	4.97ab	5.30b	5.57b
½ PM+ ½CD	2.27c	2.14bc	2.90cd	3.15bc	4.13bc	4.43bc	5.43b	5.66b
½PM+ ½UF	2.67b	2.47b	3.60bc	3.93ab	4.77ab	4.98ab	6.08ab	6.23b
½CD + ½UF	2.35bc	2.20bc	3.00cd	3.78bc	4.53ab	4.57bc	5.63b	5.83b
½PM+½CD+ ½UF	2.93b	2.72b	3.97ab	4.02ab	5.30a	5.40a	7.10a	7.43a
Control	1.90e	1.63d	2.40d	2.03d	2.97d	3.05d	3.55c	3.63c

Means followed by the same alphabet within the column are not significantly different based on DNMRT at 5% probability level. Note: ½ PM= half the quantity of poultry manure, ½ CD = half the quantity of cow dung and ½ UF = half the quantity of urea fertilizer.

Table 7. Effects of organic manures and urea fertilizer on okra

Treatment	Number of days to 50% flowering		Number of fruit plant $^{-1}$		Length of pods (cm)		Fruit girth (cm)		Fresh pod yield (t ha-^{1})	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Poultry manure(PM)	37.00a	37.67a	7.17ab	7.47ab	8.80bc	9.33b	7.23ab	7.17b	1.93cd	2.28b
Cow dung (CD)	37.00a	37.00a	5.87c	6.87b	7.20d	8.03c	6.10c	6.67b	1.73de	1.76c
Urea fertilizer (UF)	38.33a	38.67a	6.93bc	6.70b	7.37d	7.87c	6.48bc	6.55b	1.75d	1.78c
½ PM+ ½CD	38.00a	38.00a	7.23ab	7.33ab	7.57cd	7.90c	6.89bc	6.74b	2.10bc	2.10b
½ PM+ ½UF	38.00a	38.33a	7.30a	7.53ab	9.17b	9.83b	7.33ab	7.43ab	2.27ab	2.30b
½ CD+ ½UF	38.00a	38.00a	7.20ab	7.10b	7.73c	8.13c	7.10ab	7.11b	2.20b	2.20b
½PM+½CD+½UF	39.33a	39.33a	7.98a	8.33a	11.37a	11.93a	8.01a	8.23a	2.46a	2.57a
Control	36.00a	36.00a	3.70d	4.07c	5.90e	6.03d	4.22d	4.50c	0.78f	0.75d

Means followed by the same alphabet within the column are not significantly different based on DNMRT at 5% probability level. Note: ½ PM= half the quantity of poultry manure, ½ CD = half the quantity of cow dung and ½ UF = half the quantity of urea fertilizer.