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Morphological and Yield Attributes of Okra (*Abelmoschus esculentus* L. Moench) as Influenced by Vermicompost + NPK Nutrient Sources

Oroka, Frank Oke
Department of Agronomy, Delta Sate University, Asaba Campus, Delta State, Nigeria

ABSTRACT
The use of organic waste as alternative nutrient source in vegetable production has been a practice of farmers for ages. The aim of this study was to assess the relative efficiency of vermicompost, mineral fertilizer (NPK) or mixture of both on the morphological and yield attributes of okra. Field experiments were conducted in a crop farmer's field about 5km from the Teaching and Research Farm of the Delta State University, Abraka, (latitude 5^0 46'N and longitude 6^0 5'E) Nigeria Abraka Forest Farm Reserve, in early cropping (March-July) and late cropping (August-December) seasons of 2010, 2011 and 2012. The vermicomposts (VC) were prepared from organic wastes (mixtures of food wastes, vegetable clippings, fruit wastes, animal manures and other organic residues). The test crop was okra (var. NHAE 47-4). Six treatments, namely: control (no application), 100%NPK, 100%VC, 85%VC + 15%NPK, 50%VC+ 50%NPK and 15%NPK + 85%VC. The six treatments were arranged in a randomized complete block design with three replicates. Plant morphological characters studied were plant height, leaf number, internode length, shoot fresh weight, shoot dry weight and relative water content while number of pods per plant, pod yield per plant and harvest index were the yield attributes. Crop growth parameters such as plant height, leaf number and internode length tended to significantly ($P<0.05$) increase with higher quantity of vermicompost. The fresh and dry weights per plant significantly increased with addition of organic amendments in form of vermicompost into the soil. On the average 100%NPK recorded the highest relative water content, with 100% vermicompost indicating the least. The response of yield and yield components of okra to soil organic amendments was significant ($P<0.05$). The 100% vermicompost consistently gave higher number of pods per plant and pod yield per plant. The results showed that vermicompost alone and in mixture with NPK significantly increased the plant morphological parameters and yield and yield components.
Keywords: okra, yield, vermicompost, organomineral fertilizer, organic wastes

1. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the most important fruit vegetable crops cultivated and consumed throughout Nigeria. The fresh fruits are sold daily in the market confirming its value on the basis of land area volume and value (Olaniyi, 2010; Pathak, 2013). Okra is cultivated in home gardens and fields both during the dry and wet seasons covering a total land area of 1.5million hectares and about 27 million tons produced annually(FAO, 1998). The fresh tender fruits which are rich in proteins and high mucilage are used in thickening soups and stews in dried or boiled form. It is also an important source of iron, calcium and ascorbic acid (Udo and Akpan, 2002). In view of its role and high demand, efforts are being made to sustain and improve the production of okra. However a major limitation to achieving improved okra production is low soil fertility, particularly under continuous cropping. This implies that there is need to raise the soil fertility if okra yield increase is to be achieved.

Vegetables such as okra have been reported to have good response to different soil nutrients. The indiscriminate use of mineral fertilizers leads to soil nutrient imbalances in soils, resulting in soil properties detrimental to optimum crop growth and yield (Agboola 1982; Mishra and Singh, 2005). Supplementation of mineral fertilizers with organic manures is one of the options for exploiting the crop yield potential and countering the imbalance use of nutrients through chemical fertilizers alone. Vermicomposts made from municipal solid wastes is one of the potential and most important organic sources to supply macro and micronutrients to plants. The organic manure derived from the use of a combination of earthworms and microorganisms in the bio-oxidation and stabilization of organic material is termed vermicompost (Sivagama and Gandhi, 2013). The earthworms are the drivers of the process, and their activities help to alter and fragment the substrate, allowing for increased microbial activity and further decomposition (Dominguez, 1997).

Vermicompost is one of the best organic manure for increasing the crop yield. Besides, the biowastes for the production of the vermicompost are readily available in large quantities, hence a cheap source of organic soil amendment. Its use in vegetable production not only improves the soil physical properties, but also results in production of vegetable that is eco-friendly. As noted earlier (Sridhar, 2006), the solid waste in Nigeria is generated at the rate of about 0.43kg per head per day and rich in organic matter of about 60 to 80%. This

implies that there is great potential for organic fertilizer production in the country as a waste management strategy.

The role of organic manures in maintaining organic matter and raising crop yields had long been recognized (Karikari and Yayock, 1987; Sridhar, 2006). Increase in number of fruits and fruit yield with application of vermicompost in okra, tomato and chilli have been reported (Dhanalakshmi et al 2014). In a study on use of sewage sludge in combination with NPK and *Azotobacter*, Mishra and Singh (2005) observed significantly higher vegetative and yield attributes of okra with 2.5t sewage sludge NPK + *Azotobacter*. Earlier reports by Sanwal et al. (2007) indicated that the use of soil amendment under a humid environment significantly influenced the growth and pod yield of okra. The complementary use of poultry manure and NPK resulted in production of 21-58% more fresh pod yield than other nutrient sources have been observed (Olaniyi et al., 2010). In a similar study, Pathak , et al. (2013) also observed increased leaf number in guava with mix of phospho bacteria and vermicompost Increased leaf number. leaf area, plant vigour, plant height, stem girth, plant weight and dry matter percentage and marketable yield were reported in red amaranth (*Amaranthus tricolor L.*) when it was cultivated with 10 tons of vermicompost in combination with 100% of NPK Alam et al. (2007).
Vermicompost as an alternative strategy in soil nutrient management for improvement in vegetable production is yet to be extensively adopted in Nigeria. This research is therefore aimed at assessing the relative efficiency of vermciopost, mineral fertilizer (NPK) or mixture of both on the morphological and yield attributes of okra.

2. MATERIALS AND METHODS

Field experiments were conducted in a crop farmer's field about 5km from the Teaching and Research Farm of the Delta State University, Abraka, (latitude 5^0 46'N and longitude 6^0 5'E) Nigeria within the degraded Abraka Forest Farm Reserve, in early cropping (March-July) and late cropping (August-December) seasons of 2010, 2011 and 2012. The physico-chemical properties of the soil of the experimental farm were: particle size analysis (Bouycous method) 730gkg^{-1} sand, 130 gkg^{-1} silt and 140gkg^{-1} clay; pH in water = 5.2; 0.58g kg^{-1} total N (Kjedahl method), and 6.5gkg^{-1} organic carbon (wet dichromate oxidation method)

The vermicomposts were prepared from organic wastes. Substrates for the vermicompost include mixtures of food wastes, vegetable clippings, fruit wastes, animal manures and other organic residues collected from the local food market bins. Materials were chopped into small pieces and thoroughly mixed. Earthworms (*Lumbricus terrestris* L.) were introduced two weeks later. Vermicompost (VC) incubation period was 50 days. At maturation of the vermicopost, chemical properties were analysed using standard procedures as described by IITA (1979) and presented in Table 1.

Table 1. Chemical properties of vermicompost

pH	C %	Total N %	P %	K %	Ca %	Mg %	Na %	C/N %	Zn ppm	Pb ppm	Fe ppm	Cu ppm
7.5	31.6	1.41	1.36	0.55	0.57	0.27	0.11	22.4	30.5	4.01	19.6	13.8

*Data presented as mean values of three samp*les

The field experiment consists of six treatments, namely: control (no application), 100%NPK, 100%VC, 85%VC + 15%NPK, 50%VC+ 50%NPK and 15%NPK + 85%VC. The recommended rates of 4 t ha^{-1} and 400 kgha^{-1} were applied for 100% VC and 100% NPK respectively, while the other treatments varied with the corresponding percentages. Nutrients sources were applied in two equal splits (at planting and six weeks after planting). The organic manure (vermicompost) was broadcasted and worked into the soil by light hoeing before planting of seed at the rate of two seeds per hole. Seedlings were thinned to one seedling per hole after two weeks. The experimental layout was a randomized complete block design with the six treatments replicated thrice. The test crop was *Abelmoschus esculentus* L. Moench (var. NHAE 47-4).The crop spacing used was 60cm by 40cm within a plot size of 3m by 3m and total cropped area of approximately 0.036ha. In order to coincide with the early and late season cropping as practiced by farmers in the area, the experiment was repeated twice during each cropping year in March –July and August-December.

Plant morphological characters studied at maturity of crop were plant height (from base of stem at ground level to apex of shoot) , leaf number, internode length (distance between two nodes), shoot fresh weight, shoot dry weight and relative water content (percentage succulence) while number of pods per plant, pod yield per plant and harvest index were the yield attributes. Harvest index was derived from the ratio of the economic yield to the biological yield. Data in each year are presented as average of the early and late cropping seasons. Data were subjected to analysis of variance (ANOVA). Means were separated by the least significance difference (LSD) at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Morphological and Biomass attributes

Various components of plant growth measured were found to be significantly influenced by nutrient source treatments. Crop growth parameters such as plant height, leaf number and internode length tended to significantly (P<0.05) increase with higher quantity of vermicompost (Table 2). Relative to the control which had a decreasing trend with years of continuous cropping, the other treatments with soil nutrient amendment showed increase in plant height, leaf number and internode length. Organo-mineral amendment with 85% vermicompost showed the highest plant height, leaf number and internode length within the first two years, but by third year of cropping 100% vermicompost recorded highest performance in these parameters. On the average of three years, the order of plant height based on percentage of vermicompost in the soil amendments were: 100%VC > 85%VC+15%NPK > 50%VC+50%NPK > 15%VC+85%NPK >100%NPK > control. Use of organic sources has been reported to increase vegetative growth of vegetables and other crops (Abd EI-Kader et al.2010;Waziri et al, 2015).

Table 2. Morphological attributes of okra as influenced by nutrient sources

	Plant height (cm)			Leaf number			Internode length (cm)		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Control	66.4^{b}	64.8^{b}	63.5^{bc}	14.7^{c}	15.3^{b}	13.0^{d}	6.3^{b}	5.4^{c}	5.3^{c}
100%NPK	70.3^{b}	73.6^{b}	74.1^{b}	15.3^{c}	16.6^{b}	17.0^{c}	7.2^{ab}	7.5^{bc}	7.5^{bc}
100%VC	94.6^{a}	100.7^{a}	108.7^{a}	20.7^{ab}	24.3^{a}	28.7^{a}	8.6^{ab}	10.2^{a}	10.8^{a}
85%VC +15%NPK	101.2^{a}	102.3^{a}	106.5^{a}	22.3^{a}	23.6^{a}	26.3^{a}	9.2^{a}	9.8^{ab}	10.1^{ab}
50%VC +50%NPK	98.3^{a}	100.2^{a}	101.1^{a}	23.3^{a}	22.7^{a}	25.0^{b}	8.8^{ab}	9.8^{ab}	9.6^{ab}
15%VC +85%NPK	78.4^{b}	80.3^{b}	80.7^{b}	17.7^{bc}	18.3^{b}	18.7^{c}	8.0^{ab}	8.2^{ab}	8.4^{ab}
Mean	84.9	87.0	89.1	15.7	20.1	21.5	8.0	8.5	8.6
LSD (5%)	13.2	15.8	14.7	3.7	4.1	2.9	2.8	2.7	3.1

Means followed by the same letter on the same row are not significantly different at LSD (5%)

The fresh and dry weights per plant significantly increased with addition of organic amendments into the soil. The maximum dry weight per plant was consistently higher with 100% vermicompost within the three cropping years (Table 3). The control without any nutrient amendment showed a decreasing trend in fresh weight and dry weight throughout the three cropping years and recorded the least. No consistent trend in relative water content was observed in the okra plants. However, on the average 100%NPK recorded the highest relative water content, with 100% vermicompost indicating the least over the three cropping years. The higher percentage succulence of NPK is an indication of the higher dry matter production with continuous application of organic manures in vegetables.

Table 3. Biomass production attributes of okra as influenced by nutrient sources

	Fresh weight/plant (g)			Dry weight/plant (g)			% succulence		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Control	582.5^{d}	571.3^{c}	562.5^{c}	129.8^{c}	136.0^{c}	128.6^{e}	77.7^{a}	75.8^{a}	77.1^{a}
100%NPK	614.8^{cd}	630.2^{c}	642.8^{b}	135.3^{c}	138.0^{c}	139.9^{de}	78.0^{a}	78.1^{a}	78.2^{a}
100%VC	783.2^{a}	861.6^{a}	962.1^{a}	242.8^{a}	258.5^{a}	317.5^{a}	69.0^{b}	70.0^{a}	67.0^{b}
85%VC +15%NPK	794.3^{a}	840.3^{a}	940.8^{a}	227.5^{a}	234.9^{a}	271.6^{b}	71.4^{a}	72.0^{a}	71.1^{a}
50%VC +50%NPK	765.6^{ab}	810.6^{a}	903.6^{a}	202.5^{ab}	213.6^{ab}	231.1^{bc}	73.6^{a}	73.6^{a}	74.4^{a}
15%VC +85%NPK	680.6^{bc}	700.5^{b}	720.8^{b}	165.7^{bc}	172.6^{bc}	177.6^{cd}	75.7^{a}	75.4^{a}	76.1^{a}
Mean	703.5	735.8	788.8	183.9	192.2	211.1	74.2	74.2	74.0
LSD (%)	89.1	72.6	81.3	58.7	60.3	48.2	8.9	10.3	9.4

Means followed by the same letter on the same row are not significantly different at LSD (5%)

The results indicated that the development of vegetative characters in okra was enhanced as the relative proportion of the vermicompost applied in the soil was increased from 15% to 100%. The principal means of enhanced performance was through increased plant height and leaf production, which consequently enhanced shoot fresh weight and dry matter accumulation. Without any application of nutrient sources, native soil nutrient was sub-optimal for normal vegetative growth of okra, as indicated by the low vegetative, fresh/dry matter production in the control and decreasing trend of these parameters throughout the three cropping seasons. The observed increases in crop parameters following application of organic amendments may be due to the low soil fertility status of the soil which allowed for enhanced response of okra to applied organic nutrients. This findings support earlier reports which notes that soil enriched with vermicompost provides additional substances such as humic acid (17-36%) fluvic acid (13-30%) diverse microbial population that are not found in chemical fertilizers (Kale et al, 1992; Orlov and Biryukova, 1996) and nutrient depleted native soils. The increased dry matter in 100% vermicompost and higher levels of vermicompost in organo-minerals is an indication that organic matter accumulates more dry matter content in the shoot of the okra plants. Earlier studies also indicated

more accumulation of dry matter in okra and tumeric with organic based fertilization relative to synthetic fertilization (Sanwal 2007; Sivagama and Gandhi,2013). This is because vermicomposts also contains readily available plants nutrients such as nitrates, exchangeable phosphorus, and soluble potassium, calcium, and magnesium (Edwards et al., 1988) that can be absorbed by the plant and used in biomass accumulation.

3.2 Yield and components of yield

The response of yield and yield components of okra to soil nutrient amendments was significant (P<0.05), but most of the variance was accounted for by the large difference in number of pods between the control treatment with the least and the 100% VC and 85%VC +15%NPK (Table 4). The number of pods per plant and pod yield per plant increased with the relative percentage of vermicompost in the soil nutrient amendment. The 100% vermicompost consistently gave higher number of pods per plant and pod yield per plant. Harvest index (HI) showed no consistent trend with NPK or vermicompost-based soil amendment. The 15%VC +85%NPK was the least among the nutrient amendments; only higher than the control. On the average highest HI was observed in 85%VC +15%NPK. Increase in vegetative growth and yield of vegetables with application of organic manures and organo-minerals has been reported (Ndaeyo et al., 2003; Oroka, 2012). The better performance associated with complementary use of vermicompost + NPK over applying them alone could be due to synergistic effects (or greater effects of the mixture) on the crop. Similar results were reported in other studies (Olaniyi,et al. 2010). Significant increase in the number of fruit per plant and fruit yield with NPK and organo-minerals were reported in earlier studies (Ndaeyo et al., 2005; Olaniyi,et al. 2010). Significant increase in yield and components of yield in okra such as fruit length, fruit diameter, number of fruits per plant and individual fruit weight with the effects of different organic based materials has been observed (Ndaeyo et al., 2003).

Table 4. Pod yield and yield components of okra as influenced by nutrient sources

	No. of pods/plant			Pod yield/plant (g)			Harvest index		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Control	12.3^{c}	12.0^{c}	10.3^{c}	346.8^{c}	336.1^{d}	328.7^{c}	0.37^{b}	0.37^{b}	0.36^{b}
100%NPK	20.2^{ab}	21.3^{b}	22.6^{b}	557.8^{b}	581.3^{c}	590.5^{b}	0.48^{a}	0.47^{a}	0.48^{a}
100%VC	28.0^{a}	36.3^{a}	37.6^{a}	750.4^{a}	860.6^{a}	870.3^{a}	0.49^{a}	0.50^{a}	0.47^{a}
85%VC +15%NPK	28.3^{a}	36.0^{a}	36.3^{a}	752.1^{a}	854.6^{a}	863.1^{a}	0.49^{a}	0.50^{a}	0.48^{a}
50%VC +50%NPK	27.6^{a}	30.6^{a}	32.1^{ab}	686.3^{a}	741.2^{b}	802.5^{a}	0.47^{a}	0.48^{a}	0.47^{a}
15%VC +85%NPK	23.5^{ab}	24.1^{b}	26.7^{b}	560.7^{b}	589.3^{c}	600.6^{b}	0.45^{a}	0.46^{a}	0.45^{a}
Mean	23.3	26.7	27.6	609.0	607.2	676.0	0.46	0.46	0.45
LSD (5%)	3.1	6.3	9.5	110.7	98.2	109.5	0.07	0.06	0.06

Means followed by the same letter on the same row are not significantly different at LSD (5%)

100% vermicompost application gave lower vegetative and pod yield parameters during the first cropping year when compared with the 85% and 50% vermicompost. However in the second cropping and third cropping years the 100% vermicompost maintained higher vegetative, biomass and pod yield. This is corroborated by earlier reports by Dhanalakshm et al (2014) which noted that vermicompost being an already decomposed material, when continuously applied will supply the soil with more organic matter with stable organic compounds and macro and micronutrients that will result in improved crop performance.

4. CONCLUSION

The results showed that vermicompost alone and in mixture with NPK significantly increased the plant morphological parameters, such as such as plant height, leaf number and internode length. The number of pods per plant and pod yield per plant also increased with the relative percentage of vermicompost in the soil nutrient amendment. The present study has proved that the use of vermicompost derived from the conversion of organic biomass waste is an effective eco-friendly technology for managing municipal solid waste and sustainable vegetable crops.

REFERENCES

Abd EI-Kader, A.A., Shaaban, S.M and Abd EI-Fattah. M.S. Effect of irrigation levels of and organic compost on Okra plants (Abelmoschus esculentus) grown in sandy calcarious soil. Agriculture and Biology Journal of North America. 2010.

Agboola, A.A. Organic manuring and green manuring in tropical agricultural production system. In Non-symbiotic nitrogen fixation and organic matter in the tropics Symposia paper presented at the International Congress of Soil Science New Delhi. 1982; 198-222

Alam M.N., Jahan M.S., Ali M.K., Islam M.S. and Khandaker S.M.A.T. Effect of vermicompost and NPKS fertilizers on growth, yield and yield components of Red Amaranth (*Amaranthus tricolor L.*)., *Australian Journal of Basic and Applied Sciences*., 2007; 1**:**706 – 716

Dhanalakshmi, V.; K. M. Remia, R. Shanmugapriyan and Shanthi, K. Impact of addition of Vermicompost on Vegetable Plant Growth *International Research Journal of Biological Sciences*. 2014; 3(12), 56-61

Dominguez, J., Edwards, C.A. and Subler, S. A comparison of composting and vermicomposting. Biocycle, 1997; 4:57-59.

Edwards, C. A. and Burrows, I. The potential of earthworm composts as plant growth media. In Earthworms in Environmental and Waste Management Ed. C. A., Neuhauser, SPB Academic Publ. b.v. The Netherlands.1988, 211-220.

FAO. FAOSTAT Statistics Database 1998 (URL:http://apps.fao.org/default.htm) Retrieved 20th April,2015

IITA. Selected methods for soil and plant analysis No. 1 International Institute for Tropical Agriculture, Ibadan, 1979

Kale, R.D., Mallesh, B.C., Hubra, B. and Bagyara., D.J. Influence of vermicompost application on the available macronutrients and selected microbial populations in a paddy field Soil Biology and Biochemistry, 1992; 24:1317-1320

Karikari, S.K. and Yayock, J.Y. Organic fertilizer sources in Nigeria. In Proceedings National Fertilizer Seminar held in Port Harcourt Nigeria, October 28-30,1987

Khatun, M.F. Chodhury, M.A.H. Islam, M.S. Haider, S.M.S.and M.Z.A. Talukder. Effects of different leaf litters on growth and yield of Okra in Modhupur forest soil. International Journal of Experimental Agriculture. 2010;1 (1): 5-11.

Mishra, R.K. and Singh, G. Effect of sources of nutrients on performance of okra (*Abelmoschus esculentus* L. Moench) Sri Lankan Journal of Agricultural Sciences 2005, 42:52-57

Ndaeyo, N.U., Ndon,B.A., Ekpe,E.O., and Aiyelari, E.A. Growth and yield responses of soybean (Glycine max L. Merr) cultivars to NPKMg (12:12:17:2) fertilizer on an ultisol . In Proceedings 37th Annual Conference of the Agricultural Society of Nigeria, 2003

Ndaeyo, N.U., Ukpong, E.S. and John, N.M. Performances of okra as affected by organic and inorganic fertilizers on an ultisol In Proceedings 39th Annual Conference of the Agricultural Society of Nigeria, 2005; 206-209

Olaniyi, J.O, Akanbi, W.B. Olaniran, O.A. and Ilupeju, O.T. The effect of organo-mineral and inorganic fertilizers on the growth, fruit yield, quality and chemical composition of Okra. Journal of Animal and Plant Sciences, 2010; 9(1):1135-1140.

Orlov, D.S. and Biryukova, O. N. Humic substances of vermicomposts. Agrokhimiya, 1996,12: 60-67

Oroka, F.O. Comparative effects of municipal solid waste compost and NPK on the growth and marketable yield of *Celosia argentea* L. New York Science Journal 2012; 5(10): 34-38

Sanwal, S.K., K. Lakminarayana, R.K. Yadav, N. Rai, D.S. Yadav, and B. Mousumi. Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian Journal of Horticulture. 2007; 64(4): 444-449.

Sivagama Sundari, U and Gandhi, A. Effect of vermicompost prepared from different organic wastes on growth and yield of okra (*Abelmoschus esculentus* L. (Moench)) International Journal of Recent Scientific Research 2013, 4(5):568 - 571

Smith, M.A.K., Tolorun, T.P. and Adeniji, O.S. (2001) Effect of combined mulch and fertilizer on weed growth and okra (*Abelmoschus esculentus* L. Moench) yield in a humid rainforest tropical environment In Proceedings Annual Conference of the Agricultural Society of Nigeria, 2001;103-112

Sridhar, M.K.C. From urban waste to sustainable management in Nigeria: A case study In ed. Ivbijaro et al. Sustainable Environmental Management in Nigeria 2006; 337-367

Taylor, O.A. Preservation, storage and marketing of horticultural produce in Nigeria. Proceedings of the 14th HORTSON conference Ago-Iwoye, 1996; 9-13

Pathak D.V., Singh Surender and Saini R.S. Impact of bio-inoculants on seed germination and plant growth of guava, (*Psidium guajava*). *Glob. J. Wood Sci. Forest.Wildl*., 2013; 1(1), 015-017

Pathak D.V., Singh Surender and Saini R.S. Impact of bio-inoculants on seed germination and plant growth of guava, (*Psidium guajava*). *Global Journal Wood Science Forestry Wildlife* 2013 1(1), 015-017

Premsekhar, 1 M. and. Rajashree, V. Influence of Organic Manures on Growth, Yield and Quality of Okra. American-Eurasian Journal of Sustainable Agriculture, 2009; 3(1): 6-8

Udo, I.O and Akpan, E.A. Response of okra cultivars to investigation of flea beetle (Podagrica unifirma Jac. In southern Nigeria Journal of Sustainable Tropical Agricultural Research. 2002; 3:40-44

Waziri Mohammed Sadisu; Binta Aliyu Kyari; Musa Ibrahim; Bitrus Apagu; Bitrus Yunana; Mohammmed Nasir Askira & Ali Babagana Benisheikh (2015) Effect of different soil media on the rooting and growth of *Delonix Regia* stem cuttings in Maiduguri. International Journal of Innovative Agriculture & Biology Research. 2015; 3(1):6-11