International Journal of Advances in Scientific Research
ISSN: 2395-3616 (Online)
Journal DOI: 10.7439/ijasr
Research Article

Effect of compost, cow dung and NPK 15-15-15 fertilizer on growth and yield performance of Amaranth (*Amaranthus hybridus*)

Sanni K.O*

Department of Crop Production and Horticulture, Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria

***Correspondence Info:**
Sanni, K. O.
Department of Crop Production and Horticulture
Lagos State Polytechnic, Ikorodu, Lagos State, Nigeria.
E-mail: sunny_kenny2000@yahoo.com

Abstract

Nigerian soils are generally low in fertility and enhanced crop yield is only possible through external use of organic and inorganic fertilizers. The present study was carried out under field condition at Teaching and Research Farms, Lagos State Polytechnic, Ikorodu to evaluate effects of compost, cow dung and NPK 15-15-15 fertilizer amendments on the growth and yield performances of *Amaranthus hybridus*. The obtained results indicated that all treatments significantly achieved an increment in morphological parameters (numbers of leaves stem girth, leaf area and plant height) and fresh weight yield comparing with the control. The best results in terms of these characters were obtained in the following order Cow dung > compost > NPK 15-15-15 and control. Post soil analysis shows that all the treatments reduced the soil pH from 6.20 to a range between 5.58-5.68 and available phosphorus, magnesium, organic carbon, total nitrogen and CEC increased significantly compared with control plot. Results suggest that the use of cow dung and composts has potential to improve the growth and yield of amaranth and improves the soil physiochemical properties in the study area.
Keywords: *Amaranthus hybridus*; amendments; morphological parameters; Post soil analysis.

1. Introduction

Deficiencies in micronutrients such as vitamin A and iron in developing countries are widespread and have negative consequences for children's growth and development [1]. Therefore there is a need for people to grow green vegetables like amaranths to supply the body with such nutrients. The vegetable is accredited with possession of high nutritional values of essential nutrients like calcium, phosphorous, iron and other important components such as vitamins C, fiber, carbohydrate, fat and a high calorific value [2].

Amaranthus hybridus species is one of the plants often considered as the most important green leaf vegetable in Nigeria. The crop is predominantly produced in Nigeria by resource-poor farmers and compound gardens where it is intercropped with arable starchy staples to produce enough food to satisfy their dietary and cash requirements and to minimize the risk of crop failure [3].

Nigeria is the largest producer and consumer of amaranth [4] and its production has been plagued with an array of factors including incidence of insect pest, decreasing soil fertility and quantity of manure required for optimum crop productivity [5][6]. The low fertility status of the soil necessitated the need for external fertilizer input. The use of fertilizer (organic or inorganic) supplements the soil with nutrients, especially nitrogen for succulent green leafy growth [7]. Farmers in Nigeria rarely use inorganic fertilizer due to scarcity and cost, hence the dependence on cheaper organic sources of nutrients.

Animal manure is known to be effective in maintenance of adequate supply of organic matter in soil, with improvement in soil physical and chemical condition and enhanced crop performance [8], poultry, cattle, sheep and pig manure has been found to improve soil fertility and crop yield [9][10]. Ewulo[11] reported that addition of poultry and cattle manure to soil lead to increase in soil PH, Organic Carbon, Nitrogen, Phosphorus, Calcium, Potassium, Magnesium, Sodium and CEC. Therefore the aim of this study is to assess the effect of cow dung, compost and inorganic fertilizer (NPK) on the growth and yield of amaranth and on chemical properties of the soil.

2. Materials and Methods

2.1 Experimental location and design

The field study was conducted at the Teaching and Research Farm, Lagos State Polytechnic, Ikorodu, Nigeria; geographically located within latitude 6° 37' 0" North, 3° 31' 0" East. It has an

altitude of 50m above sea level with total annual rainfall ranges between 1670mm – 2200mm and mean temperature between 25°C - 32°C, and relative humidity between 65 – 68% [12]. The experiment was laid out in Randomized Complete Block Design (RCBD) with four treatments (200 kg/ha^{-1} NPK 15-15-15 fertilizer, 200 kg/ha^{-1}compost, 25 t ha^{-1}cow dung and control), replicated three times getting a total of twelve experimental plots, each experimental plot having a dimension of 5 m x 1 m with 0.5 m discard between plots. The site was disc ploughed and harrowed before seedbeds were marked and demarcated. Seedbeds were levelled using hand tools to provide a medium fine tilth for the growth of the *A. hybridus*.

2.2 Crop establishment and treatment

The seed of *A. hybridus* cultivated was obtained from National Horticultural Research Institute NIHORT) Ibadan, Nigeria. Sowing of the seed was done by broadcasting on well prepared seedbed to serve as nursery and covered with palm frond to provide shade for the emerging seedlings. Two weeks after sowing, the seedlings were transplanted to a well-constructed seedbed at a spacing 30cm × 30cm [13]. All agronomic practices such as weeding, irrigation and insect pest control were carried out as at when due.

2.3 Soil sampling and analysis

A composite sample of the soil was taken randomly (0-20cm) using soil auger before the commencement and after the experiment to determine the soil fertility status before and after the experiment. Soil pH was taken using digital pH meter. Soil organic carbon was determined by the Walkley Black Modified method, while exchangeable base cations Ca, Mg, K, Na, Mn, Cu, Zn and Fe were determined by the Mehlich-3 extraction procedure [14]. Available P was determined using Bray-1 method [15] and Total nitrogen was analyzed by the Technicon AA II method [16]. Particle size distribution was determined with a hydrometer [17] using sodium hexa meta-phosphate as the dispersing agent.

2.4 Data collection

Five plants were randomly sampled and tagged per plot to determine growth parameters at 3, 4, 5 weeks after transplanting (WAT). The leaf growth parameters were measured on all the leaves on each plant and the average was obtained and used for data analysis. The leaf width of all the tagged plants from the plots was measured using a 30 cm rule. This was measured from one end of the leaf to the other end (in the middle position of the leaf length). Plant height was measured using a measuring tape to determine the distance from the soil surface at the base of the leaf to the apex of the leaf. The leaf length was determined by meter rule from the leaf stalk to the leaf apex; while stem girth was determine using digital Vernier caliper. The number of leaves was measured quantitatively by counting. Harvesting was done by cutting the plant at 10cm above soil surface was done at 5 WAT. The fresh shoot and leaves were weighed using digital weigh balance.

2.5 Data analysis

Data collected were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Science (SPSS Inc., 2011). Significant treatment means were separated by Least Significant Difference (LSD) test at p<5% [18].

3. Results

3.1 Soil physio-chemical properties

The chemical properties of the soil used for the experiment before and at harvest are presented in Table 1. The soil was sandy loam in texture, slightly acidic and low in total N, exchangeable K, Ca, Mg and available P. The low nutrient status of the soil indicates that it needs additional nutrient for optimal *A. hybridus* performance. Hence, application of nutrients from organic and mineral fertilizers was justified. Post cropping soil analysis revealed that the soil pH across various treatment drop from 6.20 to a range between 5.58-5.87 making the soil acidic in nature. Available P, C.E.C, %C and Total N increased slightly in all treatments except control plot. Magnesium (Mg) increased in compost and cow dung treated plots but reduced in N.P.K treated and control plots. Calcium (Ca) reduced in all treatments, but was highest in compost treated plots. Potassium (K) increased in control plots, but was reduced in others. Application of organic and inorganic fertilizers equally increases the soil bulk density.

Table 1: Post experiment soil analysis

		Post experiment soil analysis			
Sample code	**Pre- soil**	**N.P.K**	**Compost**	**Cow dung**	**Control**
pH (H_2O)	6.20	5.63	5.76	5.87	5.58
Ca (cmol/kg)	2.67	1.61	1.83	1.81	1.53
Na (cmol/kg)	0.78	0.76	0.77	0.73	0.70
K (cmol/kg)	0.25	0.21	0.23	0.27	0.18
Mg (cmol/kg)	1.17	1.15	2.64	2.97	1.04
H^+	0.10	0.12	0.10	0.11	0.10
C.E.C	4.97	5.06	5.19	5.30	4.93
Av. P (ppm)	4.04	4.18	4.32	4.81	3.82
% C	1.77	1.98	2.09	3.11	1.43
Total Nitrogen	0.18	0.32	0.28	0.26	0.12
Bulk density	1.39	1.41	1.45	1.63	1.40
Sand (%)	71.3	69.8	72.4	71.9	70.5
Clay (%)	13.8	14.8	12.6	15.7	13.8
Silt (%)	14.9	15.4	15.0	12.4	15.7
Textural class	Sandy Loam				

3.2 Treatment effect on growth parameters of *Amaranthus hybridus*

Growth attributes of *A. hybridus* was significantly enhanced with the application of organic and inorganic fertilizers. At 3 weeks after transplanting (WAT) the order of performance for plant height, stem girth, number of leaves, leaves width and leaves length was compost > cow dung > control and NPK. While, at 4 and 5 WAT the order of performances due to the soil amendment agents was cow dung > compost > NPK and control.

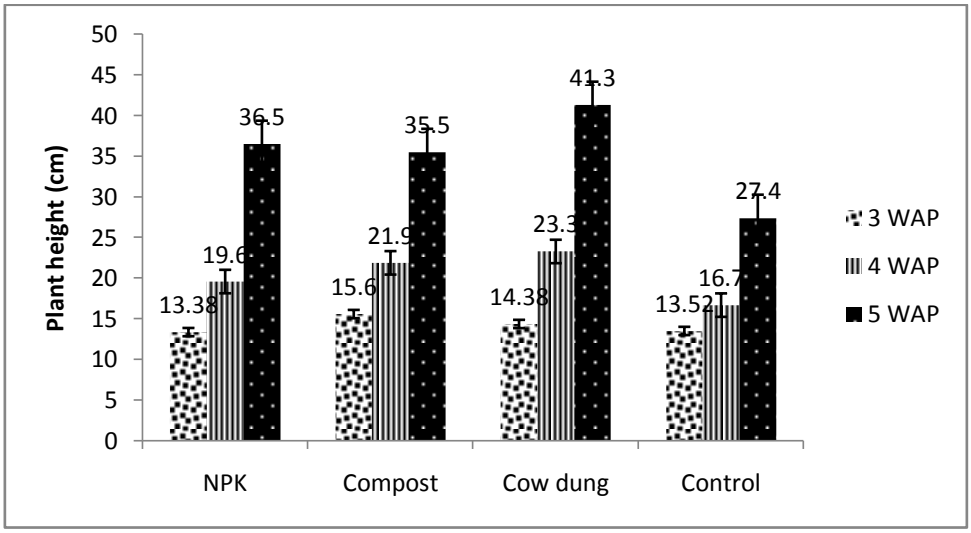

Figure 1: Plant height (cm) at 3, 4 and 5weeks after sowing (WAS).

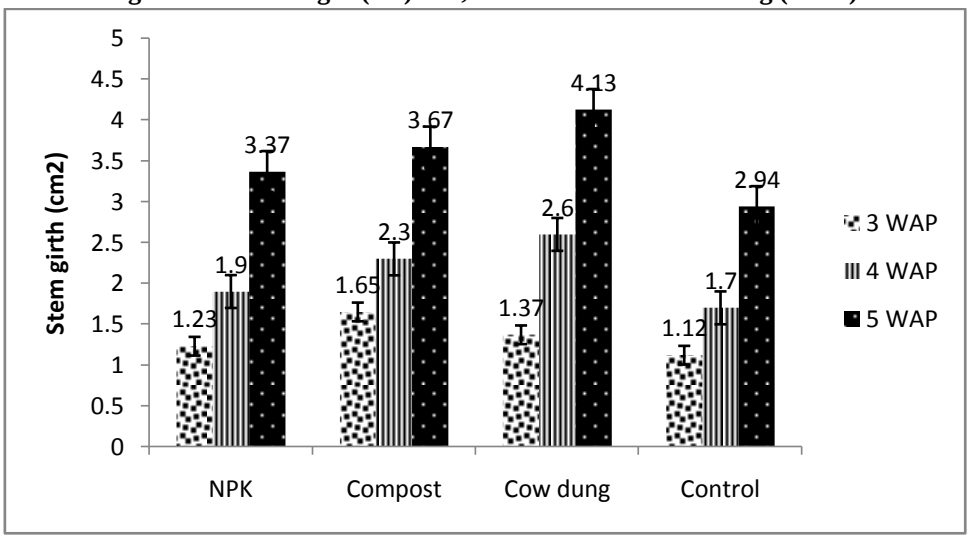

Figure 2: Stem girth (cm) at 3, 4 and 5 weeks after sowing (WAS).

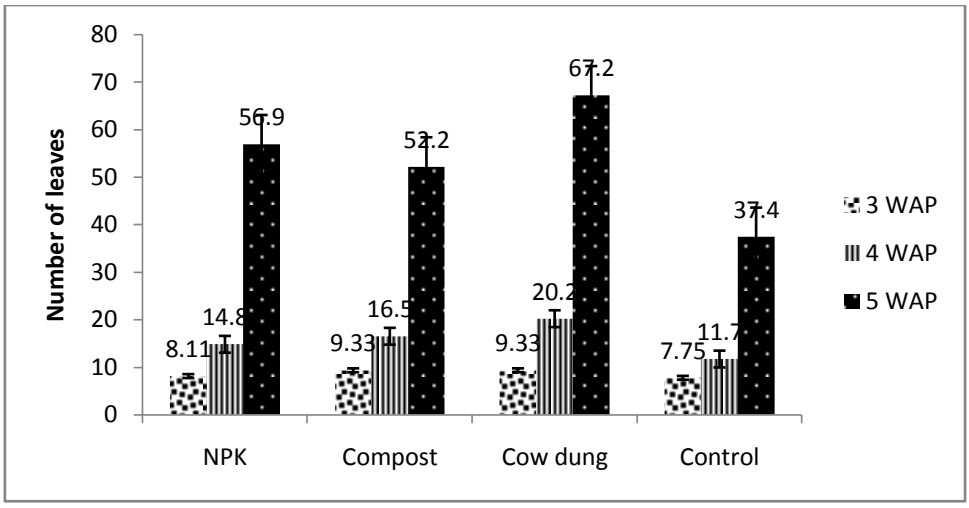

Figure 3: Number of leaves (cm) at 3, 4 and 5 weeks after sowing (WAS).

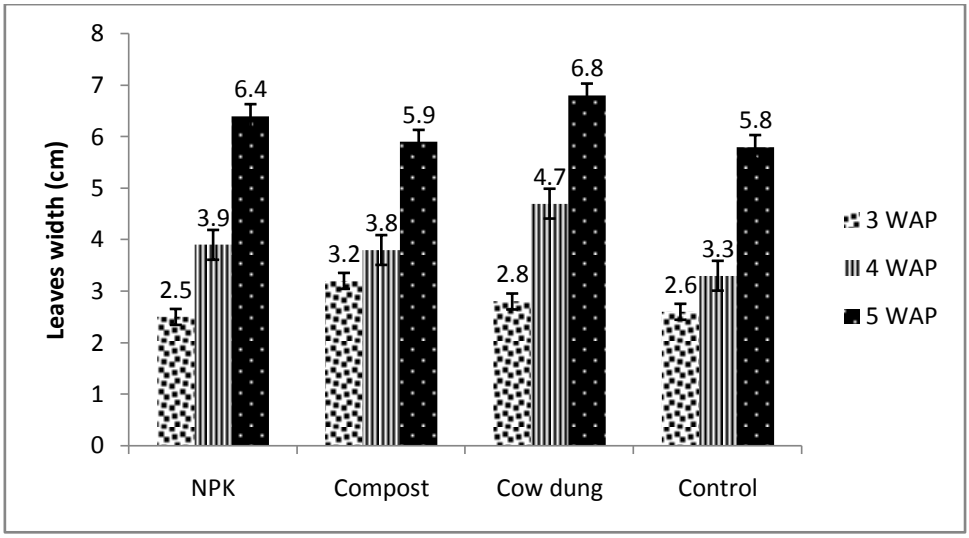

Figure 4: Leaf width (cm) at 3, 4 and 5 weeks after sowing (WAS).

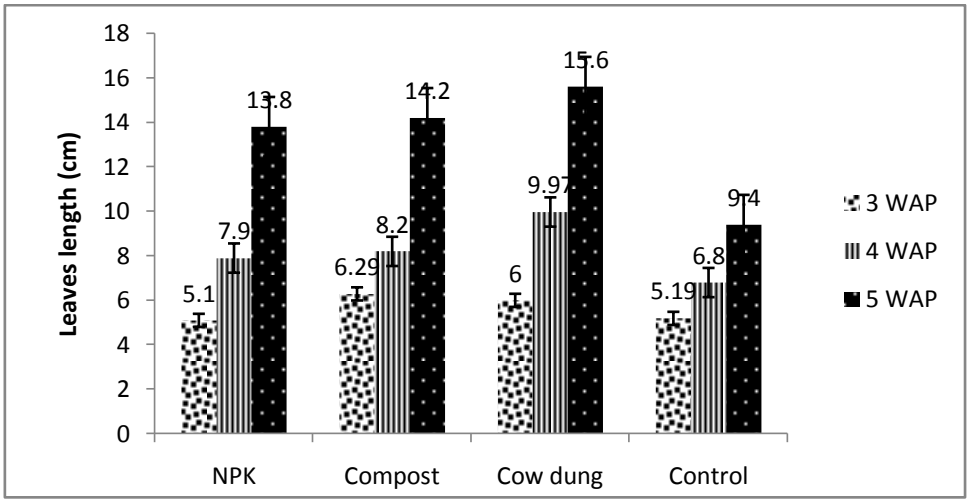

Figure 5: Leaf length (cm) at 3, 4 and 5 weeks after sowing (WAS).

3.3 Treatment effect on yield parameter of *Amaranthus hybridus*

3.3.1 Fresh weight (kg ha^{-1})

Addition of organic and inorganic fertilizer significantly affected the yield of *A. hybridus* (Figure 6) result from the study showed that Cow dung treated plots had the maximum yield (82.02 kg ha^{-1}); followed by NPK 15-15-15 treated plots with a yield of 63.0 kg ha^{-1} and *A. hybridus* grown in control plots had the minimum yield (28.48 kgha^{-1})

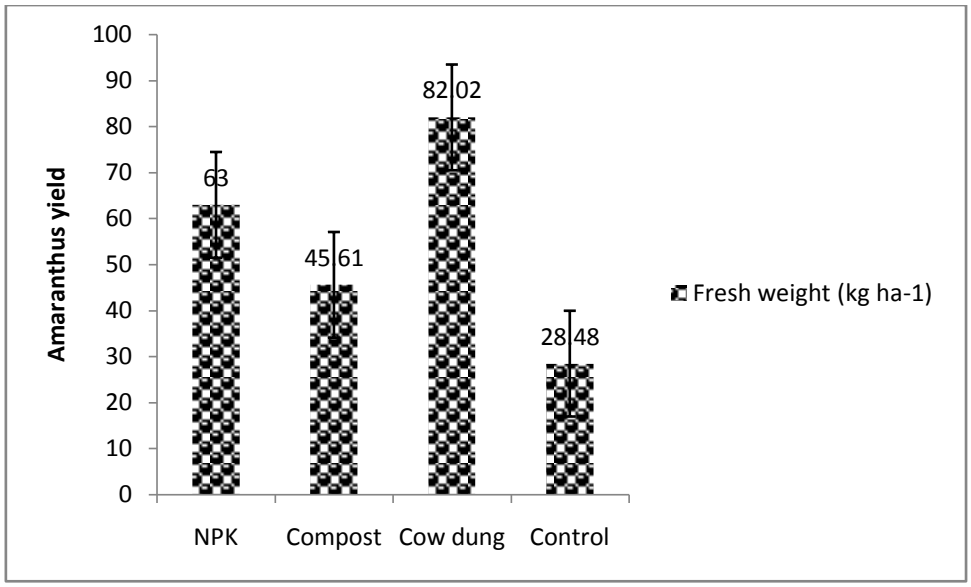

Figure 6: Fresh weight of plant at harvest (kg ha^{-1})

4. Discussion

The productivity of many African soils is normally limited by N and P deficiency which is a major constraint to small holder vegetable producers in sub-Sahara Africa. Continuous cropping without an input of organic or inorganic fertilizer is common practice in many tropical and subtropical countries. The low soil nutrient status of the experimental site could be attributed to the previous continuous cropping without manure application thereby justifying the site for the research. Results from this study indicated that the growth and yield of *A. hybridus* respond positively to the amendment of the soil with the addition of NPK 15-15-15, compost and cow dung compared to control. Tindall [19] reported that amaranthus require soils with high organic content, and adequate mineral nutrients favoured the production of higher plant height. The increases in growth rate can also be attributed to the role of phosphorous in physiological metabolic functions in plant tissues [20].

Plant height is an important component that helps to determine plant growth. The increase in height of *A. hybridus* plants amended with organic and inorganic fertilizers is probably due to release of nutrients which promoted vigorous plant growth through efficient photosynthesis [21]. An optimum plant height is claimed to be positively correlated with productivity of plants [22]. The treatment significantly affects the vegetative performance of *A. hybridus* positively. Changes in the number of leaves are bound to affect the overall performance of amaranth as the leaves serve as photosynthetic organ of the plant [23]. Increased in leaf area in soil amended with organic fertilizer could probably be attributed to N availability which promoted leaf area during vegetative development and also helped to maintain functional leaf area during the growth period [24].

Addition of cow dung greatly improved the yield of *A. hybridus* in this study compared to NPK 15-15-15 fertilizer and this confirms the findings of Xu *et al* [25] who revealed that the yield and quality of leafy vegetables grown with organic fertilizers grew better and resulted in a higher total yield than those grown with synthetic fertilizers and Olowoake *et al* [29] who tested the effect of cow dung on the growth of maize and reported that the effect of cow dung on maize was very close to the manuring effect of NPK fertilizer. The performance of the crops could be as a result of the high content of nitrogen, phosphorus and potassium contained in cow dung [26]. Application of organic fertilizers probably increased nitrogen in the soil which positively affected leaf fresh weight and quality of the leaves because nitrogen stimulates plant vegetative growth and increases leaf area; as a result increment in the leaf area increases the rate of plant photosynthesis and thus higher leaf quality and leaf weight. This is in line with the findings of different studies elsewhere on spinach [27]. The consistency poor performance of *A. hybridus* grown in control plots and those planted with low N amendment source revealed that when nutrients are available in adequate amount, plants tends to grow at their optimum potential. These nutrients deficient were probably the limiting factor of plant growth and productivity in control treatment.

The low soil nutrient status of the experimental site could be attributed to the previous continuous cropping without manure application thereby justifying the soil amendment to enhance the performances of the crop. The result clearly indicated that organic fertilizers do not affect soil physical properties spontaneously. The low nitrogen level

recorded in all the treatment could be attributed to high rate of mineralization of NPK fertilizer that makes the N readily available and easily leach out. Hence, the application of inorganic fertilizers does not always improve soil organic matter which is a store house for nutrients.While the low N observed post-harvest might be as a result of N uptake for the growth and development of the plant. The higher organic matter content in the plot treated with cow dung and compost relative to other treatment plots agreed with previous observation of Esawy *et al* [28] on the increase in organic matter as a result of addition of rice straw compost. The available P contents increased more than in NPK fertilizer or control pots. This reflects the high level of P available in the cow dung and compost used. This finding corroborates the work of Olowoake and Adeoye [29] who found that compost increase soil organic carbon, N, P and K. The increases in soil organic carbon, N, P, and K observed after harvest in soils treated with cow dung, and compost might be as a result of the slow rate in which their nutrients are released into the soil. Therefore, the crop could not make use of these nutrients due to its short vegetative life cycle. The cumulative effects of inorganic fertilizers in causing an increase in soil acidity at the end of the experiment confirms the findings of Devaney [30] and Mae-Wan Ho [31] who opined that addition of inorganic fertilizers increases soil acidity. The increase in soil acidity observed in soil fertilized with cow dung and compost might be due to perhaps low calcium content or its slow release of the nutrient content. In all the amended soils the pH still falls within the pH range of 5.5-7.5 reported by Raemaekers [32] as optimum for Amaranthus production.

5. Conclusion

Results obtained from the study shows that cow dung treated plots significantly enhanced *A. hybridus* growth and yield compared to control, the increases in growth and yield rate can be attributed to the role of phosphorous present in the manure in physiological metabolic functions of the plant tissues. It therefore concluded that application of 25 t ha^{-1} cow dung is recommended to vegetable farmers in order to bring about increased growth and yield of *A. hybridus* and improve soil chemical properties in the study area.

References

[1] Aphane, J., M.L. Chadha and M.O. Oluoch, 2002. Increasing the consumption of micronutrient-rich foods through production and promotion of indigenous foods. Proceedings of the FAO-AVRDC International Workshop. Arusha, Tanzania, March 5-8, Hosted by AVRDC-Regional Center for Africa (Ed.), Thomas Kalb.

[2] Badra T. Lagos spinach in pulses and vegetables. In: Williams JT (ed) London, Chapman and Hall, 1991; pp 131-163.

[3] Akinyemi, S. O. S. and Tijani-Eniola, H. Effects of cassava density on productivity of productivity of plantain and cassava intercropping system. *Fruits* 1997; 50: 17-23.

[4] Ogedegbe ABO, Ezeh AE. Effect of variety and nutrient on insect pest infestation of *Amaranthus spp. J. Appl. Sci. Environ. Manage.* 2015; 19 (2) 251-256.

[5] Lucas, E.O., Ojeifo, I.M. Partitioning of dry matter and nutrients in two varieties of amaranths. *African Journal of Agricultural Science* 1985; 12(1/2): 39-48.

[6] Adeyemi, M.O., Fakore, M.A., Edema, A.O. Effect of poultry manure and cutting height on the performance of *Amaranthus hybridus*. *Nigerian Journal of Agronomy* 1987; 2(1):12-20.

[7] Olufolaji, A. O. and Dimakin, M. J. Evaluation of yield components of selected amaranth cultivars of selected agrochemicals and cultivars. *Annals of Applied Biology* 1988; 112 (9): 161-167.

[8] Ikpe, F. N. and J. M. Powel. Nutrient Cycling Practices and Changes in Soil Properties in the Crop-Livestock Farming Systems of Western Nigeria, West Africa. *Nut. Cyc. Agro- ecosystem.* 2002; 62:37-45.

[9] Adeniyan, N.O. and Oyeniyi, S.O. Comparative and effectiveness of different levels of poultry manure with NPK fertilizer residual soil fertility uptake and yield of maize *Journal of Agriculture* 2003; 2:191-197.

[10] Ojeniyi, S.O and Adeyboyega. Effect of combined use of urea and goat manure dung on Celosia. *Nigeria Agriculture Journal* 2003; 34: 87-90.

[11] Ewulo, B. S. Effect of Poultry and Cattle Manure on Sandy Clay Loam Soil. *Journal of Animal and Veterinary Sciences.* 2005; 4: 839-841.

[12] LASPOTECH Meteorological station. Lagos State Polytechnic, Ikorodu 2014.

[13] Sanni, K.O. and Adesina, J.M. Response of water hyacinth manure on growth attributes and yield of *Celosia argentea* L (Lagos Spinach). Journal of Agricultural Technology 2012; 8(3): 1109-1118.

[14] Mehlich, M. Mehlich-3 soils test extractant: A modification of the Mehlich 2 extractant. *Comm. Soil Sci. Plant Anal.* 1984; 15: 1409-1416.

[15] Okalebo, J. R., K. W. Gathua., P. L. Woomer. *Laboratory methods of soil and plant analysis: A working manual* 2002 (2nd Ed) TSBFCIAT and SACRED Africa, Nairobi, Kenya.

[16] IITA (1982) Automated and Semi Automated Methods for soil and plant analysis. Manual series No. 7. Published by International Institute for Tropical Agriculture (IITA), Ibadan-Nigeria.

[17] Bouyoucos, G. J. 1962. Hydrometer methods improved for making particle size analysis of soils. Soil Science Society of America Proceeding 26: 464-465.

[18] Gomez KA and Gomez AA. 1984. Statistical Procedures for Agricultural Research. 2nd ed. John Wiley and Sons Inc, New York, USA.

[19] Tindall H.D. Commercial vegetable growing: Oxford Tropical Handbook. Oxford University Press 1975.

[20] Ojo OD. and Obigbesen GO. Optimum rate for grain Amaranth production. Proceedings of the 25th annual conference of soil science society of Nigeria. Benin 1999: 192-196.

[21] Iqtidar, H. Ayyaz, K. M. and Ahmad, K. E. Bread Wheat Varieties as Influenced by Different Nitrogen Levels. Journal Zhejiang University Science 2006; 7(1): 70-78.

[22] Saeed, I. N., K. Abbasi and M. Kazim. Response of maize (*Zea nmays*) to nitrogen and phosphorus fertilization under agro-climatic condition of Rawalokot Azad Jammu and Kashmir. *Pak. J. Biol. Sci.* 2001; 4:53-55.

[23] Ayodele, O. J. Soil fertility management for the production of fruits and vegetables in South Western Nigeria. *Acta Hort.* 1983; 128:237-242.

[24] Cox, W. J. Kalonge, S., Cherney, D. J. R. and Reid, W. S. Growth Yield and Quality of Forage Maize under Different Nitrogen Management Practices. *Agronomy Journal*, 1993; 85(2): 341-347.

[25] Xu, H. L., Wang, R., Xu, R. Y., Mridha, M. A. U., and Goyal, S. Yield and Quality of Leafy Vegetables Grown with Organic Fertilizations, *Acta Horticulturae*, 2005; 627: 25-33.

[26] Reyhan, M. K. and Amisalani, F. Studying the relationship between the vegetation and physicochemical properties of soil: Case study, Tabas region, Iran. *Pak. J. Nutr.*, 2006; 5: 169-171.

[27] Guiser, F. Effect of Ammonium Sulphate and Urea on NO_3- and NO_2 -Accumulation, Nutrient Contents and Yield Criteria in Spinach, *Scientia Horticulturae*, 2005; 106(3):106 330-340.

[28] Esawy M, Mahmoud I, Paul R, Nouraya A, Mohamme E. 2009. Rice Straw Composting and its Effect on Soil Properties. http://findarticles.com/p/article s/mi_7510/is_200907/ai_n39231352.

[29] Olowoake, A. A. and Adeoye, G. O. Influence of differently composted organic residues on the yield of maize and its residual effects on the fertility of an Alfisol in Ibadan, Nigeria. *Intl. J. Agric. Env. Biotech* 2013; 6(1): 79 - 84.

[30] Devaney E. 2010. Environmental Effects of Chemical Fertilizers. http://www.ehow. com/facts_envt-effects fert.html.

[31] Mae-Wan Ho, 2010. China's Soils Ruined by Overuse of Chemical Fertilizers. http://www.isis.org.uk/chinasSoilRuined.php.

[32] Raemaekers, H. Romain. Crop production in tropical Africa. Directorate General for International Cooperation, Ministry of Foreign Affairs. External Trade and International Cooperation, Brussels, Belgium, 2001; 403-407.