# Effects of Organic, Organomineral and NPK Fertilizer Treatments on Fresh and Dry Matter Yield of *Amaranthus Cruentus* L on Soil Types in Lagos, Nigeria

*[1]Makinde E.A.,[1]Oluwa O.K., [1]Oke,A.O and[2]Duyile P.O

*[2]Department of Botany, Lagos State University, Ojo Lagos, Nigeria. leye_sam@yahoo.com

**ABSTRACT:** Field experiment was conducted at two locations in Lagos State, Ikorodu (Orthic Luvisol) and Lagos State (LASU) Ojo Campus (Dystric Fluvisol) to investigation the effects of organic, organomineral and NPK fertilizer treatments on the yield of *Amaranthus cruentus L.* Eight fertilizer treatments: Control (no fertilizer), Pacesetter's Grade B (PGB) 100 %, PGB + NPK (75:25), PGB + NPK (50:50), Kola Pod Husk (KPH) 100 %, KPH + NPK (75:25), KPH + NPK (50:50) and NPK (100 %). Residual effects of fertilizers were assessed in the second and third planting periods. All the experiments were arranged in a randomized complete block design in four replications. Parameters assessed include plant height, number of leaves fresh and Dry Matter Yield (DMY). Data were analyzed using ANOVA. The yields obtained were in the order of KPH + NPK (75:25) > PGB + NPK (75:25) > KPH (100 %) > PGB + NPK (50:50) > KPH + NPK (50:50) > PGB (100%) > NPK (100%) > control. Compared to the control, application of KPH + NPK (75:25) and PGB + NPK (75:25) had significantly ($p< 0.05$) higher DMY (200.1 % and 250.2 %) at Ikorodu and LASU respectively. This was because soils in Ikorodu (sandy clay loam) have high retentive capacity ) than that of LASU (sandy loam). At Ikorodu, KPH + NPK (75:25) was the best while at LASU, PGB + NPK (75:25) was optimum. [New York Science Journal 2010;3(4):12-17] (ISSN 1554 – 0200).

**Keywords** NPK 15:15:15, shoot yield, shoot dry weight, shoot fresh weight, residual effects

## 1. Introduction

Yield of *A. cruentus* is in the range of 4 to 14 tonnes per hacter green weight (Campbell and Abbott, 1982). However, *A. cruentus* yields of 40 t/ha have been reported (NRC, 1984). Fertilization, especially with nitrogen, is one of the major factors influencing yield, although few, fertility trials for amaranths have been done and there is little data for different growing regimens or locales. Olagunju (1991) obtained an average Dry Matter Yield (DMY) of 1.5 tonnes per hectare from an experiment conducted in University of Ibadan, Nigeria. Denton and Olufolaji (2000) reported yield of 1.5 – 2 tonnes per hectare. Farm residues are made up of various forms of crops residues, weeds, sugar cane trash, water hyacinth, grasses and legumes that are left on the farm after crop harvest. According to Tollesa (1999) these farm residues when returned to the soil are a major source of nutrients and organic matter, which play important roles in the physical, chemical and biological environment of the soil. An extensive survey of locally available organic materials used as manurial sources has been reported. These include cowpea husk, yam peelings, rice straw, oil palm waste (male inflorescence), shelled maize cobs, sugarcane trash, cocoa husk, kola husk, groundnut husk, plantain and orange peelings, amongst others (Titiloye *et al.*, 1985). Positive effects of the use of various farms wastes, on various types of crops, include maize, vegetables, tubers, and tree crops, have been reported (Adebayo and Akanni, 2002). Weeds such as *Chomolaena odorata* and grasses such as Napia grass have been used on coffee (Obatolu, 1991) and water hyacinth usage on vegetables has been documented (Adeoye *et al.*, 2001).

Crop residue, such as kola pod husk will supply nutrients to the soil when it is applied to the soil as crop residue. It is also a good source of micronutrient to soil. Though, nutrient content of the wastes/by-products of kolanut depends on the nutrient content of the soil or fertilizer application to the soil; this is directly proportional to the nutrient available to the crop when added to the soil as organic manure (Ipinmoroti *et al*., 2006).

Municipal wastes are commonly referred to as urban or city wastes embraced the totality of garbage, refuse and other discarded materials, that could be in solid form or in the liquid state. There is a large deposit of municipal wastes in Nigeria major cities (Sridhar *et al.,* 1995) and some state governments in Nigeria and Universities are trying to convert the wastes into organic fertilizers.

This study was therefore, set up to investigate the effects of two organic materials: kola pod husk and Pacesetter Grade B organic fertilizer used alone or in combination with NPK 15:15:15 on the yield of *A. cruentus* in two ecological areas of Lagos State. The organic materials were chosen because they are locally available.

## 3 Materials and Methods

### The Study Area

There were two study sites, namely Ikorodu farm settlement and Lagos State University (LASU) Ojo Campus. The two locations belong to two soil types Ikorodu (Orthic Luvisol) and LASU (Dystric Fluvisol) (FAO, 1992). Ikorodu is located in the rain forest area of south west, Nigeria ($6^0$ 37'N; $3^0$ 53'E) and the altitude is about 15.50 meters above sea level; LASU is located at Ojo in Badagry Division of Lagos State of Nigeria. It is located at the swamp forest area of southwestern Nigeria. ($6^0$27'N; $3^0$130'E and the altitude is about 6.1 meters above sea level). The dominant vegetation of Lagos State is the swamp forest consisting of the fresh water and mangroves, swamp forest both of which are influenced by bi-modal rainfall pattern with peaks in July and October ranges from 1584.5 to 1605.91 mm.

### Sample Collection

Organic materials used were Kola Pod Husk (KPH) and Pacesetter Grade B fertilizer (non fortified sorted city refuse wastes plus cow dung, PGB). The KPH was obtained from the Kola processing unit of Cocoa Research Institute of Nigeria (CRIN) and PGB fertilizers was obtained from the Pacesetter Organomineral Fertilizer Plant at Bodija, Ibadan. The KPH was oven dried at $70^oC$ to constant weight and milled to pass through 2mm sieve before analyzing. The test crop was *Amaranthus cruentus* variety (ED 82/1019) early maturing type. The optimum N requirement (67.5 kg N $ha^{-1}$) for *Amaranthus cruentus* (Makinde, 2007) was used to amend the organic fertilizer at a ratio of 3:1, organic for 75:25 mixture and at 1:1 organic for 50:50 mixture level. The field experiment was set up at Ikorodu and LASU. In these sites, eight fertilizer treatments were used; (i) Control (no fertilizer), (ii) KPH (100%), (iii) KPH + NPK (75:25), (iv) KPH + NPK (50:50), (v) PGB (100%), (vi) PGB + NPK (75:25), (vii) PGB + NPK (50:50), (viii) NPK (100%).

### Experimental design

The experiment was laid out in a randomized complete blocks design (RCBD) with 4 replications using two different soil types. The two organic materials were used solely as organic fertilizer and also mixed with N.P.K. to formulate OMF. The N.P.K (15:15:15) fertilizer was applied separately at the rate of 450 kg/ha obtained as optimum value for the two soil types. This treatment supplied 67.5 kg N/ha to the soil; and was used to amend the organic fertilizer at a ratio of 3:1 (organic: inorganic) for 75:25 mixture and at 1:1 (organic: inorganic) for 50:50 mixture level. Plastic pots (64) were filled with soil, labelled and the seeds were sown in four planting holes at two seeds per hole in each pot.

Two weeks after sowing *A. cruentus* seeds were thinned to one plant per hole to give a total of four plants per pot. After 5 weeks of growth, the *A. cruentus* plants were harvested by uprooting .The harvested *A. cruentus* plant were oven dried at $70^0C$ to constant weight. The experiment was repeated without any fertilizer application at the second and third planting periods.

### Data Collection

Data were collected on the plant fresh and dry matter yield.

### Chemical Analysis

Pre-cropping chemical analysis of the experimental soil was carried out before land preparation and repeated at the first, second and third harvest to determine the nutrient status of the soil. The soil samples were air dried, crushed

and sieved to pass through 2 mm sieve after which they were analyzed for total N using macro kjeldahl procedure as described by Jackson (1958). Available phosphorus was by the Bray 1 method as described by Bray and Kurtz (1945). Exchangeable acidity was determined by the titration method as outlined in IITA manual series. No. 1 (IITA, 1979); Exchangeable K, Ca and Mg were determined by extraction with 1M ammonium acetate at pH 7.0 and the amount of K and Ca in the filtrate were determined using a Corning Flame Photometer with appropriate filter. While Mg was determined using a Perking-Elmer Atomic Absorption Spectrophotometer (AAS). Effective cation exchangeable capacity (ECEC) of the soil samples was determined by summation of all cations and the exchangeable acidity together.

**Data Analysis**

Analysis of variance was carried out on data collected and means separated using Duncan's multiple range test.

**4 Results**

The soil at Ikorodu was less acidic pH (6.1) compared with that of LASU (pH 5.3). In addition, the soil at Ikorodu had higher organic carbon and N content compared to that of LASU (Table 1). The available P was similar at the two locations. Exchangeable bases at Ikorodu was twice that of Ojo while exchangeable acidity at LASU was half that of Ikorodu. However the micronutrient content was similar.

The Grade B organic fertilizer contained more N than KPH (Table 2). The carbon content in PGB was less than that of KPH. The P and K in KPH were more than that of PGB. Calcium, Mg and micronutrients contents of the two fertilizers were similar.

**Effects of different fertilizers on shoot fresh weight and Dry matter yield at first cropping**

At Ikorodu, soil treated with KPH + NPK (75:25) mixture produced significantly ($P< 0.05$) higher shoot fresh weight (50.90 t $ha^{-1}$) than other treatments. At LASU, PGB + NPK (50:50) mixture produced significantly ($P < 0.05$) higher shoot fresh weight (66.45 t $ha^{-1}$) than other treatments except, PGB + NPK (75:25) mixture that produced 50.55 t $ha^{-1}$ (Table 3). At Ikorodu, plant treated with KPH + NPK (75:25) mixture produced significantly ($P<0.05$) higher shoot dry weight (5.35 t $ha^{-1}$) than sole application of NPK (2.13 t $ha^{-1}$). At LASU, it was PGB + NPK (50:50) mixture that produced significantly ($P<0.05$) higher shoot dry weight (7.75 t $ha^{-1}$) than sole application of NPK (1.08 t $ha^{-1}$) (Table 1).

Table 1: Effects of different fertilizers on yield of *A.cruentus* at 6 WAS at first field cropping at Ikorodu and LASU soils

| | Ikorodu | | | | | | | LASU | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatments | Yield (t $h^{-1}$) | | Nutrient uptake ($mgkg^{-1}$) | | | | | Yield (t $ha^{-1}$) | | Nutrient uptake ($mgkg^{-1}$) | | | | |
| | SFW | DMY | N | P | K | Ca | Mg | SFW | DMY | N | P | K | Ca | Mg |
| Control | 10.80d | 1.57b | 4.39d | 0.39c | 3.19d | 1.55d | 1.33d | 0.37d | 0.07d | 0.13d | 0.05d | 0.15d | 0.19d | 0.07c |
| PGB (100%) | 25.80c | 3.04ab | 9.55c | 3.77b | 11.49c | 5.47b | 3.77bc | 42.40ab | 4.95ab | 22.48b | 6.86ab | 30.68b | 54.85ab | 16.85b |
| PGB+NPK (75:25) | 36.60b | 3.8ab | 15.88bc | 2.50b | 28.76ab | 3.93cd | 3.95bc | 50.55a | 5.53ab | 28.09ab | 7.85ab | 40.25ab | 69.13ab | 21.70at |
| PGB+NPK (50:50) | 35.50b | 3.85ab | 17.40b | 2.06b | 24.18b | 6.10ab | 2.00c | 66.45a | 7.75a | 39.22a | 12.09a | 56.73a | 96.72a | 30.22a |
| KPH (100%) | 35.90b | 4.00ab | 15.52bc | 6.36a | 33.52a | 8.80ab | 6.80b | 27.20b | 2.65b | 14.86b | 3.99b | 19.46bc | 33.06b | 10.47c |
| KPH+NPK (75:25) | 50.90a | 5.35a | 22.36a | 6.25a | 34.66a | 10.60a | 10.8a | 34.70a | 4.20b | 27.17ab | 7.78ab | 27.74b | 45.6ab | 17.95b |
| KPH+NPK (50:50) | 34.20b | 3.89ab | 15.63bc | 5.52ab | 25.44b | 2.17bc | 6.69b | 34.38b | 4.02b | 22.32b | 5.70ab | 21.27bc | 25.21b | 7.07cd |
| KPH (100%) | 14.50d | 2.13b | 8.93c | 2.04b | 5.35cd | 1.91c | 2.85c | 8.20b | 1.08c | 2.63c | 1.27c | 4.02c | 2.76c | 1.36d |

KPH = Grade B: KPH = Kola pod husk; NPK = NPK 15:15:15

Means having the same letter(s) in the same column are not significantly different at 5%.

**Shoot Fresh Weight**

Soil previously treated with KPH + NPK (50:50) mixture significantly (P<0.05) produced more shoot fresh weight (41.27 t $ha^{-1}$) than soil treated with sole NPK 15:15:15 (13.52 t $ha^{-1}$) and control (10.36 t $ha^{-1}$) at Ikorodu. At LASU, PGB + NPK (75:25) mixture significantly (P<0.05) enhanced more shoot fresh weight (8.64 t $ha^{-1}$) than other treatments except PGB + NPK (50:50) mixture and sole used PGB (8.09 and 8.60 t $ha^{-1}$) respectively (Table 2).

**Shoot dry weight**

Significantly (P<0.05), more dry matter yield (4.21 t $ha^{-1}$) was observed where KPH + NPK (50:50) mixture was previously applied than 100 % NPK and control (1.90 and 1.56 t $ha^{-1}$) at Ikorodu. At LASU, soil previously treated with PGB + NPK (50:50) mixture had 1.88 + $ha^{-1}$ while at the control the value was 0.05 t $ha^{-1}$ (Table 2).

**Effects of different fertilizers on shoot fresh and dry matter yield of *A. cruentus* at 6 WAS at third field cropping at Ikorodu and LASU**
**Shoot fresh and dry weight**

Soil previously treated with KPH+NPK (50:50) mixture produced more shoot fresh weight (34.66 t $ha^{-1}$) than other treatments at Ikorodu. At LASU value (7.24 t $ha^{-1}$) was obtained where PGB + NPK (75:25) was applied (Table 3). Significantly (P<0.05), more dry matter yield (4.00 t $ha^{-1}$) was observed where KPH + NPK (50:50) were previously applied than 100 % NPK and control (1.54 and 1.49 t $ha^{-1}$). At LASU, value (1.68 and 0. 04 t $ha^{-1}$) were obtained where PGB + NPK (75:25) mixture and control were previously applied (Table 3).

Table 2. Residual effects of different fertilizers on yield, by *A. curentus* at 6 WAS at second cropping at Ikorodu and LASU

| | Ikorodu | | LASU | |
|---|---|---|---|---|
| Treatments | Yield (t $h^{-1}$) | | Yield (t $ha^{-1}$) | |
| | SFW | DMY | SFW | DMY |
| Control | 10.36b | 1.56b | 0.16c | 0.05c |
| PGB (100%) | 29.20ab | 3.4ab | 8.60a | 1.78a |
| PGB+NPK (75:25) | 32.68a | 3.85a | 8.64a | 1.88a |
| PGB+NPK (50:50) | 30.88ab | 3.45ab | 8.09a | 1.66a |
| KPH (100%) | 35.09a | 3.96a | 1.39bc | 0.33bc |
| KPH+NPK (75:25) | 33.67a | 3.94a | 2.08b | 0.38b |
| KPH+NPK (50:50) | 41.27a | 4.21a | 1.66bc | 0.37b |
| KPH (100%) | 13.52b | 1.90b | 0.866c | 0.21bc |

KPH = Grade B: KPH = Kola pod husk; NPK = NPK 15:15:15

Means having the same letter(s) in the same column are not significantly different at 5%.

**4 Discussion**

Shoot fresh weight and shoot DMY enhancement where fertilizers were applied at first cropping with significant (P<0.05) increase in shoot production was probably due to fertilizer sources. The NPK + KPH (50:50) mixture expressed a positive overall influence at Ikorodu while PGB + NPK (50:50) did the same at LASU could be due to differences in the type of fertilizers as earlier reported by Swift and

Anderson (1992) confirmed by Adeoye *et al.* (2005) that manure types and environmental pattern affect nutrient release pattern of organic materials used on the soil.

The residual effects of fertilizers on *A. cruentus* performance at second and third croppings on the field showed that organic fertilizer materials were better than the control and NPK at both locations.

The high yield obtained by *A. cruentus* at second and third croppings with NPK + KPH (50:50) and (75:25) mixture compared to 100 % NPK confirmed the report of Ipinmoroti *et al* (2002) that quick mineralization of inorganic components and the slow nutrient release of the organic constituents must have sustained the continuous better performance of *A. cruentus* than their separate applications.

Furthermore, increase in yield of *A. cruentus* at second and third cropping over NPK fertilizer application conformed with the findings of Quatmane *et al.* (1999) and Adebayo and Akanni (2002) that household or domestic wastes and FYM sustained yield of *A. cruentus.* In addition, the high yield recorded on *A. curentus* when KPH and PGB as organomineral fertilizers were applied confirmed the report of the Kang and Balasubramaniam (1990) supported by Akanbi *et al.* (2000) and Babatola *et al* (2002) on leaf vegetable that high and sustained yield could be obtained with the judicious and balanced NPK fertilizer combine with organic sources of plant nutrients.

**5 Conclusion**

Shoot fresh weight and shoot dry matter yield of *A. cruentus* were increased by the application of PGB and KPH fertilizer treatments. The use of the organic materials in combination with NPK as orgnomineral fertilizer (OMF) enhanced more yield. This could be due to faster rate of nutrient release through the mixture compare to their complimentary synergistic effect of organic and inorganic fertilizer sole usage. The combined use of the organic material with NPK at (50:50) mixtures for N was adequate for kola pod husk and Grade B at Ikorodu and LASU respectively at first, second and third cropping of *A. cruentus.* The application of KPH + NPK (50:50) and (75:25) and PGB + NPK (50:50) and (75:25) mixture produced more yield at the two locations in the first two growing periods on the fields, except at the third growing period when (75:25) mixture proved better at the two locations.

**Author for correspondence**

Dr. (Mrs) .Makinde, Esther .A

Lagos State University, Ojoo, Lagos, Nigeria

Department of Botany

**References**

1 Campbell, T. A. and J. A. Abott. 1982. Field evaluation of vegetable Amaranths (*Amaranthus species*). 7 (2): 407-409.

2 National Research Council (NRC). 1984. Amaranth. In: Modern prospects for an ancient crops. National Academic Press, Washinton, D.C. pp 1 - 48

3 Olagunju, O. B. 1991. In fertilizer trials on performance of grain amaranth (*Amaranthus cruentus*).Unpublished B.Sc., Project, Agronomy Department, University of Ibadan.

4 Denton, L. and A.O. Olufolaji, 2000. Nigeria's most important vegetable crops. In:M.O. Akoroda (ed) Agronomy in Nigeria, University of Ibadan, September 2000. pp. 85-93.

5 Tollesa, D. 1999. Effect of organic and inorganic fertilizers on maize grain yield in western Ethiopia. *African Crop Science Conference Proceedings*, 4: 229-232.

6 Titiloye, E.O., A.A., Agboola and E.O. Lucas. 1985. Evaluation of fertilizer values of organic waste materials in southwestern Nigeria. *Biological Agriculture and Horticulture* 3:25-37.

7 Adeoye, G.O., M.K.C. Sridhar, O.O., Adeoluwa and N.A. Akinsoji, 2005.

Evaluation of naturally decomposed solid wastes from municipal dumpsites for their manorial value in southwest Nigeria. *Journal of Sustainable Agriculture.* 26.4:143-152.

8 Obatolu C.R. 1991. Growth and nutrient uptake of coffee (*coffee spp)* seedlings grown on different organic materials. PhD. Thesis. Dept. of Agronomy. University of Ibadan.xiv + 289pp

9 Adeoye, G. O., M.K.C. Sridhar and R. R Ipinmoroti. 2001. Potassium recovery from farm wastes for crop growth. *Communications in Soils and Plant Analysis*, 32.15 &16: 47- 58.

10 Ipinmoroti, R .R., M. A. Daniel, A. M. Akinlade and E. A. Makinde. 2006. Effects of spent cocoa pods on soil properties and plant growth, *Nigerian Journal of Soil Science*, 6: pp.78-84.

11 Sridhar, M. K. C., S. A. Sulu and G.O. Fasina. 1995. Rural urban waste management and processing as source of organic fertilizer. *Bulletin Federal Ministry of Agriculture and Natural Resources*, Abuja, Pp. 110-120.

12 Food and Agricultural Organization (FAO) 1992. Conversion and rehabilitation of African Land. FAO. A document presented at FAO Regional

13 Makinde, E.A. (2007): Evaluation of organomineral fertilizer on growth, yield and quality of *Amaranthus cruentus* on two soil types in Lagos state, Nigeria a Ph.D thesis in Department of Agronomy University of Ibadan. Pp 1-154.

14 Jackson, M.L. 1958. Soil chemical analysis, Constable and Co. Ltd, London Conference A1C/90/410/57001, Rome.

15 Bray, R.A. and L.T. Kurtz. 1945. Determination of total organic and available forms of phosphorus in soils. *Soil Science.* 59:39- 45

16 IITA 1979. International Institute of Tropical Agriculture Annual Report for 1992. Ibadan, Nigeria Series No 1 In. Soil Science and Plant Analysis. 15:461-475.

17 Ipinmoroti, R.R. and G.C. Adeoye. 2002. Effect of organic and NPK fertilizers on tea (Camellia sinesis) performance on a humid lowland ecological area of South Western Nigeria. *Proceedings of Horticultural Society of Nigeria Conference.* Ibadan, Nigeria. Pp. 69-74.

18 Quatmane, A.M.R., M. Provenzano, M. Hafidf and N. Senes. 1999. Composted materials from different sources analysed by differential scanning. *African Crop Science Conference Proceedings*, 4:311-316.

19 Adebayo, O. and Akanni 2002. Effects of organic manure and spacing on the yield and yield components of *Amaranrhus cruentus. Proceeding of Horticultural Society of Nigeria Conference* 14th – 18th April 2002, Ibadan. Nigeria pp. 85-90.

20 Babatola, L.A., O.B. Adebayo and O.I. Lawal, 2002. Effects of different rates of poultry manure and NPK on performance of *Celosia argentia. Proceeding of Horticultural Society of Nigeria.* Ibadan, 14-19 May 2002. pp. 54-56.

21 Akanbi, W.B., M.O. Akande, R.A. Baiyewu and J.O. Akinfasoye, 2000. Effect of maize stover compost and Nitrogen fertilizer on growth, yield and Nutrient uptake of Amaranthus. *Moor Journal of Agricultural Research.* 1.1:6-5.

Date of submission 12th November, 2009