

## Effects of Organic, Organomineral and NPK Fertilizer Treatments on the Quality of *Amaranthus Cruentus* (L) On Two Soil Types In Lagos, Nigeria

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### ABSTRACT

Under tropical soils, the precise requirement of inorganic fertilizer and its possible substitute is yet to be validated for the production of *Amaranthus cruentus* L. The nutrient requirement of *A. cruentus* under two soil types and yield quality under field conditions. Field experiment was conducted at two locations in Lagos State: Ikorodu (Orthic Luvisol) and Lagos State (LASU) Ojo Campus (Dystric Fluvisol) to investigate the effects of organic and organomineral and NPK fertilizer treatments on the quality of *Amaranthus cruentus* L. Eight fertilizer treatments. (1) Control (no fertilizer), (2) Pacesetter's Grade B (PGB) 100 %, (3) PGB + NPK (75:25), (4) PGB + NPK (50:50), (5) Kola Pod Husk (KPH) 100 %, (6) KPH + NPK (75:25), (7) KPH + NPK (50:50) and (8) NPK (100 %) were tested at first planting. Residual effects of the fertilizers were assessed in the second and third planting periods. The experiment was arranged in a randomized complete block design in four Replications. Parameters assessed include proximate analysis. Data were analysed using ANOVA. The KPH + NPK (75:25) resulted in significant ( $p < 0.05$ ) higher crude protein content (19.8 and 14.9 %), ether extract (8.5 and 8.2 %) while crude fibre (9.5 and 10.8 %) was lower than control at Ikorodu and LASU respectively. The KPH and PGB had high potential in *A. cruentus* production. At Ikorodu, KPH + NPK (75:25) was the best while at LASU, PGB + NPK (75:25) was optimum. KPH + NPK (75:25) gave highest crude protein content, ether extract and lowest crude fibre in *A. cruentus*. [Nature and Science 2010;8(3):56-62]. (ISSN: 1545-0740).

**Keywords:** *Amaranthus cruentus*, organomineral fertilizer, quality and soil type

### 1.Introduction

Edible species of the genus *Amaranthus* namely: *A. cruentus*, *A. dubius*, *A. caudatus* and *A. hypochondriacus* are common in Nigeria. *Amaranthus cruentus* is a Mexican and Guatemalan species which is useful both as a grain or leaf vegetable type. The grain types have white seeds. The vegetable types have dark seeds. It is probably the most adaptable of all amaranth species, and it flowers under a wider range of day length better than the others. *A. cruentus* was most likely introduced to Africa by Europeans. *Amaranthus cruentus* and *A. hypochondriacus* are characteristically very vigorous with broad leaves and protein rich edible seeds. The *A. cruentus* crop is variously known with broad leaves and protein rich edible seeds. The *A. cruentus* crop is variously known locally as 'tete' (Yoruba), 'green,' (Igbo) or 'aleho' (Hausa), it is a tender herbaceous plant with edible leaves and

tender stem. Its importance lies basically in its ease of cultivation and the quality of the leaves and tender stem. With other ingredients such as pepper, "egusi", melon, it is used to make soup. *Amaranthus cruentus* leaves contain 3.5% protein and 1.5 % carbohydrate as well as 0.75 % minerals and 6.7 % vitamins (Saunders and Becker, 1983). *Amaranthus cruentus* is cultivated and consumed all over the country and it can be rated among the top five of the most important national vegetables. The average consumption of *A. cruentus* leaves in the tropics is estimated at about 20 – 25g per head per day which is below the recommended rate of 100 g per head per day (Olufolaji, 1996). Protein from *A. cruentus* leaves provides as much as 25 % of the daily protein intake during the harvest season. It is grown all the year round (Denton and Olufolaji, 2000).

The seeds of *A. cruentus* contain about 16-18% protein while maize 9-10 % protein (NCR1984). *Amaranthus cruentus* leaves are similarly rich in protein content. Higher amino acid lysine content of the seeds makes the seeds even more important nutritionally. The protein has much lysine mixture as found in milk (Tayo, 1996).

On the other hand, the carbohydrate content of the *A. cruentus* leaves and seeds is 30-60 % with the seed having higher protein-calorie content needed for growth and energy (Tayo, 1996). The nutritional quality of *A. cruentus* is similar to that of leaf vegetables. However, because the dry-matter

content is often high, an equivalent amount of fresh *A. cruentus* often provides 2 to 3 times the amount of nutrients found in other vegetables (Saunders and Backer, 1983).

Kola pod husk and PGB fertilizers are among wastes generated in the kolanuts plantation and in the processed municipal wastes, respectively. Farmers are aware of the availability of these wastes but no farmer has put these into use in vegetable production. Most times, these wastes are dumped at dumpsites and incinerated.

Titiloye *et al.* (1985) reported 45 different waste materials rich in the following nutrient elements: N, P, Ca, Mg, Zn, Cu, Fe and Mn. Farm wastes represent a potential source of nutrients that could be harnessed to boost agricultural production (Solomon and Ogeh, 1995). Organic materials such as FYM, poultry manure, green manure, crop residues, water weeds, city wastes etc. have been reported as suitable substitute for inorganic fertilizers to maintain sustainable crop production and environmental quality (Pawar, *et al.*, 2003). Reports on the positive responses of crops to the various organic fertilizers cut across all the classes of agricultural crops including leaf vegetables (Schippers, 2000; Adebayo and Akanni 2002).

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

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, nutrient uptake and yield quality of *A. cruentus* in two ecological areas of Lagos State. The organic materials were chosen because they are locally available.

## **2. 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). Ikorodu is located in the rain forest area of south west, Nigeria (6° 37'N; 3° 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°27'N; 3°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°C 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<sup>-1</sup>) for *Amaranthus cruentus* was

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 Layout**

The experiment was laid out in a randomized complete block design (RCBD) with four replications, per location. Land area for the experiment was 27 x 16 per location. *Amaranthus cruentus* seedlings were raised and transplanted to seedbeds at a spacing of 10 cm by 20 cm, using one seedling per hole. Harvesting was done at 6 weeks after transplanting. The experiment was repeated without any fertilizer application at the second and third planting periods.

### **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.

### **Proximate Analysis of Plant**

**The plant materials were analysed for crude protein, ether extract, crude fibre, moisture content and ash**

### **Data Collection**

Data were collected on the, proximate analysis.

### **Data Analysis**

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

### **3 Results**

#### **Pre-cropping chemical analysis**

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. 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. 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 proximate analysis of leaves *A. cruentus* at first field cropping at Ikorodu and LASU**

The 100 % NPK produced significantly ( $P < 0.05$ ) more crude protein contents (18.8 %) than all other treatments at Ikorodu while at LASU, 15.9 % was obtained at KPH + NPK (75:25) mixture (Table 1). At Ikorodu, 100 % KPH enhanced significantly ( $P < 0.05$ ) more crude fibre value (15.7 %) than all other treatments while at LASU, 10.9 % was obtained at PGB + NPK (50:50) mixture. The KPH + NPK (50:50) mixture produced significantly ( $P < 0.05$ ) more ether extract than all other treatments at both locations. Control produced significantly ( $P < 0.05$ ) more ash content (17.5 and 22.5 %) than all other treatments at Ikorodu and LASU respectively (Table 1).

**Table 1. Effects of different fertilizers on Proximate analysis of leaves of *A. cruentus* at 6 WAS at first field cropping at Ikorodu and LASU**

Treatments	Ikorodu					LASU				
	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %
1 Control	10.63f	13.90e	2.59g	12.75a	11.95h	12.75g	10.30b	5.09e	14.77a	15.15e
2 PGB (100%)	13.13c	14.30c	2.27h	12.18c	15.91d	15.75f	10.87a	5.15d	11.2f	18.88d
3 PGB+NPK (75:25)	12.56d	12.15g	5.52b	10.52g	15.79e	15.88d	10.93a	2.82h	9.88h	19.14c
4 PGB+NPK (50:50)	14.13d	15.32g	5.08d	11.40e	14.41f	15.81e	10.93a	3.04g	10.70g	18.94d
5 KPH (100%)	12.13b	15.71a	3.09f	11.09f	17.53a	17.56b	8.42d	5.42b	12.25d	22.54b
6 KPH+NPK (75:25)	13.19c	14.09d	4.53e	12.45b	16.62b	17.69a	9.83c	3.82f	12.89c	23.18a
7 KPH+NPK (50:50)	13.56b	12.99f	5.69a	11.81d	16.06c	17.38c	10.83a	9.51a	11.99e	19.21c
8 KPH (100%)	18.81a	11.58h	5.10c	12.18c	11.9g	12.63g	10.49b	5.12c	13.51b	14.62f

PGB = Pacesetter 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%. Duncan multiple rang test (DMRT).

#### **Residual effects of different fertilizers on proximate analysis *A. cruentus* at second field cropping at Ikorodu and LASU**

Soil that previously treated with KPH + NPK (50:50) and PGB + NPK (75:25) mixture significantly ( $P < 0.05$ ) produced more crude protein (19.8 and 14.9 %) than other treatments at Ikorodu and LASU respectively, at both locations (Table 2). 100 % NPK significantly ( $P < 0.05$ ) enhanced percent crude fibre (CF) value (13.4 and 14.9 %). The lowest CF was recorded at PGB + NPK (75:25) mixture (9.5 %) at Ikorodu, while at LASU 10.8 % was obtained at where PGB + NPK (50:50) mixture was previously applied (Table 2). Soil previously treated with PGB + NPK (50:50) and (75:25) mixture significantly ( $P < 0.05$ ) enhanced ether extract (8.5 % and 8.2 %) respectively than other treatments at Ikorodu and LASU. Soil previously treated with PGB + NPK (50:50) mixture significantly ( $P < 0.05$ ) produced more moisture content (11.9 %) than other treatments at Ikorodu, while at LASU 13.5 % was obtained where KPH + NPK (50:50) mixture was previously applied. At both locations 100 % KPH

significantly ( $P < 0.05$ ) produced more ash content (18.7 and 19.85 %) than other treatments (Table 7).

#### **Residual effects of different fertilizers on proximate analysis of *A. cruentus* at third field cropping at Ikorodu and LASU**

At the third cropping, soil previous treated with 100 % KPH and KPH + NPK (50:50) moisture significantly ( $P < 0.05$ ) enhanced more crude protein value (10.3 and 2.5 %) than other treatments at Ikorodu and LASU respectively (Table 3).

Crude fibre (10.7 and 15.5 %) was significantly ( $P < 0.05$ ) enhanced at control in Ikorodu and LASU respectively. Soil previously treated with 100 % KPH significantly ( $P < 0.05$ ) increased ether extract value (5.9 and 9.9 %) than other treatments at Ikorodu and LASU respectively. Significantly ( $P < 0.05$ ), more moisture content (11.2 and 15.2 %) was at 100 % NPK and control in Ikorodu and LASU respectively. Soil previously treated with KPH + NPK (50:50) and KPH + NPK (75:25) mixture significantly ( $P < 0.05$ ) enhanced more ash content (32.1 and 23.4 %) than other treatment at Ikorodu and LASU, respectively (Table 3).

**Table 2. Residual effects of different fertilizers on proximate analysis of leaves of *A. cruentus* at 6 WAS at second field cropping at Ikorodu and LASU**

Treatments	Ikorodu					LASU				
	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %
1 Control	7.00h	12.70b	2.48g	10.77f	14.09f	1.25h	13.15c	1.89h	11.80c	14.91f
2 PGB (100%)	9.38f	12.63c	2.88e	11.69c	13.95g	14.68b	10.83h	7.65b	10.45h	17.37c
3 PGB+NPK (75:25)	10.00e	9.48h	6.63b	10.99e	14.89e	14.88a	10.96g	8.23c	10.86f	15.85e
4 PGB+NPK (50:50)	13.13d	10.56g	8.48a	11.91a	15.96b	14.44c	11.57e	7.08c	11.99b	11.52h
5 KPH (100%)	13.35c	12.52d	3.46f	10.69b	16.71a	6.25d	11.25f	3.29f	11.46e	19.65b
6 KPH+NPK (75:25)	19.50b	12.15e	5.34c	11.85b	15.05c	3.31e	12.92d	3.37e	11.70d	16.74a
7 KPH+NPK (50:50)	19.75a	13.38a	5.26c	10.60h	14.91d	2.88f	13.79d	3.95d	13.45a	16.40d
8 KPH (100%)	7.25g	11.17f	2.16d	11.55d	12.63h	2.19g	14.94a	2.10g	10.51g	13.84g

PGB = Pacesetter 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%

**Table 3. Residual effects of different fertilizers on proximate analysis of leaves of *A. cruentus* at 6 WAS at third field cropping at Ikorodu and LASU**

Treatments	Ikorodu					LASU				
	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %	Crude Protein	Crude Fibre	Ether Extract	Moisture Content	Ash %
1 Control	2.81g	10.71b	2.24f	7.35h	28.53c	1.44f	15.50a	2.12h	15.17a	11.18h
2 PGB (100%)	5.38e	7.70h	3.14f	8.84e	31.80b	1.88d	12.16d	7.83e	10.37h	20.50d
3 PGB+NPK (75:25)	4.88f	8.58e	5.55c	9.48c	22.77f	1.88d	11.60e	7.77f	10.47g	17.64f
4 PGB+NPK (50:50)	5.50d	11.80a	5.46d	8.67f	23.38e	1.94c	12.46c	9.85b	10.82f	20.09f
5 KPH (100%)	10.25a	9.98d	5.69a	11.24a	20.38g	2.06b	7.23h	9.93a	10.89e	22.38b
6 KPH+NPK (75:25)	7.31c	8.50f	4.54e	10.49b	17.57h	1.88d	12.63b	7.86c	12.77b	17.02g
7 KPH+NPK (50:50)	9.88b	8.45g	5.61b	8.11g	32.12a	2.50a	9.49f	7.83d	11.63c	20.52c
8 KPH (100%)	1.4h	10.05c	2.55g	9.08d	23.78d	1.49e	7.46g	11.14d	11.14d	23.41a

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

#### 4 Discussion

The fertilizer treatments at first cropping produced significantly ( $P < 0.05$ ) higher percent crude protein (CP), ether extract and ash than control at both locations. This was in agreement with the report of Manga *et al.* (2004) that protein content can be increased with any of the N fertilizer application. The percent crude fibre (CF) and moisture content (MC) were higher at NPK and control treatment at both locations. This was showing poor quality of *A. cruentus* produced and that good source of fertilizers were needed to improve its yield quality. At the second and third field cropping, the residual effects of fertilizer treatments on *A. cruentus* on percent CP were higher at Ikorodu compared to LASU. The KPH

and PGB as organic and organomineral fertilizer enhanced significantly ( $P < 0.05$ ) higher percent CP and ether extracts. This was above the critical level obtained (13-17 % and 0.3 100g-1) for CP and ether extracts at 100 % NPK at both locations as reported by Oyenuga and Fetuga (1975); Rubatzky and Yamaguchi (1997). The increase in CP might be because N is an important element in protein synthesis. This observation was in agreement with earlier reports of Abidin and Yasdar (1986). Since P uptake was increased, it was not surprising that CP increment was due to its role in protein synthesis. Brady (1974) reported that P functions in the production of albumen which is a form of protein.

The availability of P in the soil at the end of first and second cropping where KPH + NPK and PGB + NPK (50:50) and (75:25) mixture were previously applied might result to other elements being made available for growth and yield of *A. cruentus*. This observation confirmed the earlier work of Ojo and Olufolaji (1997) that the presence of P in soil increase quality of yield of *A. cruentus*. Recent findings by Alabi and Odubena (2001) indicated that leaf chlorophyll, K:Na and C:N ratio of organic fertilizer treated crops were found to be higher than NPK treated crops. These contents might have been responsible for better plant growth

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