Morphological Characteristics of *Amaranthus Cruentus* L. as Influenced by Kola Pod Husk, Organomineral and NPK Fertilizers in Southwestern Nigeria

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ABSTRACT

Greenhouse experiment was conducted using two soil types: Orthic Luvisols at Ikorodu and Ojo (Dystric Fluvisol) respectively in southwestern Nigeria. The effects of organic, organomineral and NPK fertilizer treatments on height, number of leaves; plant girth and leaf area of *Amaranthus cruentus L.* were studied. Eight fertilizer treatments were compared. Residual effects of fertilizers were assessed in the second planting period. The soils were deficient in organic matter (OM), N and P. Compared with control, all the treatments significantly increased ($p<0.05$) plant height, number of leaves, plant and girth in the two locations. At Ikorodu, soil treated with KPH + NPK (50:50) mixture most significantly increased ($p < 0.05$) plant height, number of leaves, plant girth and leaf area while at LASU, PGB + NPK (50:50) had better residual effect on plant height, number of leaves, girth and leaf area of *cruentus* than single application of KPH, PGB and NPK fertilizer at the two sites. PGB:NPK (50:50) and KPH:NPK (50:50) had the highest yields. All combined treatments had higher growth and yield components of *Amaranthus.* PGB: NPK (50: 50) is recommended for optimum production of *amaranthus cruentus* and where it is not available, KPH: NPK (50:50) could be used. [New York Science Journal 2010; 3(5):130-134]. (ISSN 1554 – 0200).

Keywords: residual effect and soil types

1 INTRODUCTION

Amaranthus is one of the most important annual leaf vegetables in the tropics. *Amaranthus cruentus* has a short growing period of four to six weeks which serves as encouragement to farmers especially the rural and urban dwellers where it serves as a source of employment. *Amaranthus cruentus* thrives well on soils with high organic matter. Although the crop responds to organic manure, studies on effect of organic wastes, crop residues and integrated application of organic and inorganic fertilizers on performance of amaranthus are scarce.

Recently, research attention in humid tropical countries has shifted to utilization of agro industrial and organic wastes which can pose environmental hazard if not converted to agricultural and economic uses (Ayeni, 2010). These materials include kola pod husk and wastes derived from city refuse, animal wastes and other plant residues. Recently interest in organic and organomineral fertilizers arose from high cost and scarcity of inorganic fertilizers and huge amount of organic fertilizers required for crop production and handling problems. Study on response of amaranthus to organomineral fertilizers is scarce.

Organomineral fertilizer is a low input technology of improving nutrient status of tropical soils for sustainable crop production if fortified with inorganic fertilizer. Organomineral fertilizers combine the attributes of both organic and inorganic fertilizers (Ayeni, 2008). Studies by Adeoye *et al.*(2008), Fagbola and Ogungbe (2007) and Ojeniyi *et al*, (2009) recorded response of maize and pepper to organomineral fertilizers and the study by Ojeniyi *et al*. (2009) affirmed that pacesetter organomineral fertilizer increased soil and maize N, P and K content significantly. Therefore organomineral fertilizer was recommended for maize production.

This work studied the effect of ground kola (*cola nitida*) pod husk (CPH) grade B pacesetter organomineral fertilizer on growth parameters of amaranthus *cruentus* grown on two soils in southwestern Nigeria. The greenhouse work compared pacesetter organomineral fertilizer, cocoa pod husk, NPK fertilizer and combined use of their reduced rates on growth of amaranthus.

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 (6^0 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 Cocoa Research Institute of Nigeria (CRIN) and PGB fertilizer was obtained from the Pacesetter Organomineral Fertilizer Plant at Bodija, Ibadan, Nigeria. The KPH was oven dried at 70 ^oC to constant weight and milled to pass through 2 mm 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(i.e. for organic 75:25 NPK mixture) and at 1:1 organic (i.e. 50:50 mixture). The field experiment was set up at Ikorodu and Lagos State University (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 completely randomized design (CRD) with 4 replications at each site. The two organic materials were used solely as organic fertilizer and also mixed with NPK fertilizer to formulate OMF. The NPK (15:15:15) fertilizer was applied separately at the rate of 450 kg ha^{-1} obtained as optimum value for the crop. This treatment supplied 67.5 kg N ha^{-1} 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, labeled 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. Growth parameters were taken from 3rd to 5th week. After 5 weeks of growth, the *A. cruentus* plants were harvested by uprooting. The experiment was repeated without any fertilizer application at the second planting.

Data Collection

Data were collected on the plant height, number of leaves, plant girth and leaf area.

Chemical Analysis

Pre-cropping chemical analysis of the experimental soil was carried out before land preparation and repeated at the first and second 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 dichromate oxidation method. Available phosphorus was by the Bray 1 method, Exchangeable K, Ca and Mg were determined by extraction with 1M ammonium acetate at pH 7.0. K was determined by flame photometer, Ca and Mg by Atomic Absorption Spectrophotometer (AAS).

Data Analysis

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

3 RESULTS AND DISCUSSION

Pre copping soil analysis showed that the soils were low in OM, N and available P. the soil at LASU was acidic and less suitable for amaranthus for which pH 5.5 - 7.5 is recommended. LASU soil was also low in Ca and Mg hence its acidic nature. The soils require addition of fertilizers for optimum crop production. Compared with control, PGB and KPH alone or integrated with NPK fertilizer at reduced level increased plant height, number of leaves (Table 1), plant girth and leaf area (Table 2) at Ikorodu and LASU at 3, 4 and 5 weeks after sowing except PGB (100%), KPH (100%) and NPK (100%) which did not record higher plant height at 3rd week after sowing at Ikorodu. At both sites, growth and yield components of amaranthus increased as the day after sowing increased. On residual basis (Tables 3 and 4), single application of PGB, KPH and their integration with NPK fertilizer increased growth and yield components of amaranthus compared with control. Addition of NPK fertilizer to PGB and KPH performed better than when NPK fertilizer, PGB and

KPH were applied individually. This could be due to enhancement of decomposition of the organic materials and mineralization of nutrients especially N and P by addition of NPK fertilizer. Ayeni *et al*. (2008) observed similar increase in N and P when cocoa pod ash and poultry manure were respectively fortified with NPK fertilizer.

Table 1. Effects of different fertilizers on plant height (cm) and number of leaves of *A. cruentus* at 5 WAS at first cropping on Ikorodu and LASU soils in the greenhouse

Treatments	Plant height (cm) WAS						Number of leaves WAS					
	Ikorodu soil			LASU soil			Ikorodu soil			LASU soil		
	3	4	5	3	4	5	3	4	5	3	4	5
Control	11.20b	17.25abc	16.5d	3.70c	4.60c	4.00c	8.25ab	8.00c	7.25d	4.75c	5.25c	6.00b
PGB 100 %	10.68b	16.73bc	22.25cd	5.15bc	5.43b	10.50b	8.75ab	11.00a	12.50b	6.00abc	5.75bc	8.00ab
PGB+NPK (75:25)	11.90b	16.98bc	34.13a	7.60ab	10.95a	12.00b	6.75ab	10.00ab	15.75a	7.00a	9.00a	9.50a
PGB+NPK (50:50)	14.38a	22.70a	35.98a	7.98a	11.83a	17.50a	9.00ab	11.50a	13.00b	7.50a	9.25a	9.50a
KPH 100 %	11.00b	15.20c	31.03ab	6.15abc	8.30ab	11.75b	5.75b	10.00ab	13.75b	6.25abc	7.25abc	10.50a
KPH+NPK (75:25)	11.90b	21.20ab	35.85a	6.35abc	8.95ab	16.63a	9.00ab	12.00a	14.25ab	6.50ab	8.25ab	10.50a
KPH+NPK(50:50)	12.68ab	21.73ab	21.75cd	7.23ab	8.30ab	11.25b	9.50a	11.75a	13.00b	7.00a	7.5abc	8.50ab
NPK 100 %	10.15b	18.65abc	27.25bc	4.03c	4.95b	6.10c	8.50ab	9.00b	9.50c	5.00bc	5.75bc	5.75b
SE±	0.47	0.97	2.58	0.57	0.96	1.63	0.45	0.5	0.96	0.34	0.54	0.66

Means with the same letters are not significantly different according to Duncan Multiple Range Test
PGB = Pacessetter Grade B; KPH = Kola pod husk; NPK = NPK 15:15:15

Table 2. Effect of different fertilizers on plant girth (cm) and leaf area ($cm^{2)}$ of *A. cruentus* at 5 WAS first cropping on Ikorodu and LASU soils in the greenhouse

Treatments	Plant girth (cm) WAS						Leaf area WAS					
	Ikorodu Soil			LASU Soil			Ikorodu Soil			LASU Soil		
	3	4	5	3	4	5	3	4	5	3	4	5
Control	0.13c	0.28ab	0.3b	0.1b	0.1b	0.1b	57.63c	143.42b	208.87ab	3.29b	8.33c	6.71c
PGB 100 %	0.2a	0.25b	0.28b	0.1b	0.13ab	0.13ab	70.5b	141.1b	191.12b	11.78ab	12.92c	10.78c
PGB+NPK (75:25)	0.18b	0.28ab	0.33b	0.1b	0.18ab	0.18ab	76.45b	150.15ab	221.12ab	12.68ab	56.82ab	60.36a
PGB+NPK (50:50)	0.2a	0.30ab	0.38a	0.18a	0.20a	0.2a	72.68ab	213.33a	232.11ab	28.81a	69.19a	60.38a
KPH 100 %	0.2a	0.25b	0.3b	0.1b	0.15ab	0.15ab	70.76ab	135.58	215.21ab	13.95ab	23.96bc	19.26bc
KPH+NPK (75:25)	0.18b	0.28ab	0.3b	0.13b	0.13ab	0.18ab	67.85ab	229.45a	268.51ab	16.31ab	39.85abc	24.50bc
KPH+NPK(50:50)	0.23a	0.38a	0.4a	0.13b	0.13ab	0.13ab	98.92a	233.73a	341.82a	17.12ab	22.08bc	42.19ab
NPK 100 %	0.13b	0.28ab	0.33b	0.1b	0.10b	0.1b	60.42c	147.29ab	218.77ab	2.93b	11.11c	1.73c
SE±	0.01	0.01	0.01	0.01	0.01	0.01	4.45	15.22	16.88	2.91	7.98	8.26

Means having the same letter(s) in the same column are not significantly different at 5%.
PGB = Pacessetter Grade B; KPH = Kola pod husk; NPK = NPK 15:15:15

Growth and yield components of amaranthus tended to be higher when PGB or KPH was combined with NPK fertilizer at ratio 50:50 than when combined at ratio 75:25 (Tables 1, 2, 3 and 4) at both sites though. The better performance of PGB +NPK (50:50) than its corresponding PGB +NPK (75:25) might be as a result of higher NPK fertilizer content in PGB +NPK (50:50) which resulted in quicker release of plant nutrients such as N and P. This might have resulted in higher growth and yield components of amaranthus. Also, the lower performance of PGB (100%), and KPH (100%) compared with PGB or KPH combined with NPK fertilizer might be as result of immobilization of N and P by microbial activities.

Table 3. Residual effects of different fertilizers on plant height (cm) and number of leaves of *A. cruentus* at 5 WAS at second cropping in the greenhouse

Treatments	Plant height (cm) WAS						Number of Leaves WAS					
	Ikorodu Soil			LASU Soil			Ikorodu Soil			LASU Soil		
	3	4	5	3	4	5	3	4	5	3	4	5
Control	13.43b	18.53b	29.43b	5.13b	6.53b	6.9b	9.5b	10.75b.	13.25d	5.25b	6.50c	6.75b
PGB 100 %	15.05ab	22.75ab	32.45ab	6.88a	9.6a	10.43ab	11.00ab	13.11a	15.5abc	6.25ab	8.75ab	8.75ab

PGB+NPK (75:25)	15.3ab	22.33ab	34.83a	5.5a	9.75a	13.03a	11.00ab	12.75ab	17.75ab	6.12ab	9.5a	10.25ab
PGB+NPK (50:50)	13.93ab	21.33ab	31.38ab	6.93a	9.75a	13.08a	11.00ab	13.12a	14.5c	7.11a	8.75ab	10.5a
KPH 100 %	13.63ab	20.4ab	33.33ab	6.83a	8.45ab	9.58ab	10.00ab	12.75ab	14.75bc	6.05ab	8.00ab	8.75ab
KPH+NPK (75:25)	13.73ab	20.5ab	32.55ab	5.4a	7.05ab	7.8ab	10.25ab	13.25a	17.00abc	5.55ab	7.0b	6.75b
KPH+NPK 50:50	15.93a	23.2a	34.88a	5.28ab	6.7b	8.4ab	11.75a	13.5a	18.00a	6.04ab	7.25ab	8.25ab
NPK 100 %	14.55ab	22.75ab	33.58ab	5.3ab	6.25b	7.55b	10.50ab	11.75ab	14.50c	5.25b	6.75b	7.25ab
SE±	0.32	0.56	0.64	0.29	0.55	0.85	0.25	0.23	0.61	0.2	0.39	0.52

Means with the same letters are not significantly different according to Duncan Multiple Range Test
PGB = Pacessetter Grade B; KPH = Kola pod husk; NPK = NPK 15:15:15

The effects of fertilizers on A. *cruentus* performance on growth and yield components at second cropping showed that organic fertilizer materials were better than control and NPK at both locations. The substantial growth rate obtained by *A cruentus* at second and third cropping with NPK + KPH (50:50) compared to 100 % NPK confirmed the report of Ipinmoroti *et al.* (2002) that quick mineralization of inorganic component and the slow nutrient release of the organic constituents must have sustained the continuous better performance of *A cruentus* than their separate applications.

Table 4. Residual effects of different fertilizers on plant girth (cm) and Leaf Area (cm^2) of *A. cruentus* at 5 WAS at second cropping in the greenhouse

Treatment	Plant girth (cm) WAS						Leaf area (cm^2) WAS					
	Ikorodu Soil			LASU Soil			Ikorodu Soil			LASU Soil		
	3	4	5	3	4	5	3	4	5	3	4	5
Control	0.25a	0.35b	0.50b	0.1a	0.13ab	0.13b	77.83b	133.18c	155.13c	5.58c	9.35b	26.65c
PGB 100 %	0.27a	0.47ab	0.62ab	0.1a	0.15ab	0.18ab	103.85ab	212.23ab	204.13ab	17.15ab	33.95ab	43.68ab
PGB+NPK (75:25)	0.25a	0.45ab	0.63ab	0.1a	0.18ab	0.2ab	100.51ab	190.7ab	213.28ab	14.78b	40.13a	78.7a
PGB+NPK (50:50)	0.25a	0.47ab	0.63ab	0.1a	0.23a	0.23a	90.15ab	191.15ab	189.75ab	20.63a	51.73a	83.03a
KPH 100 %	0.23a	0.43ab	0.57ab	0.1a	0.15ab	0.20ab	78.78b	169.93bc	169.63	15.63b	34.73ab	46.85ab
KPH+NPK (75:25)	0.23a	0.45ab	0.61ab	0.1a	0.15ab	0.15ab	83.75b	171.75b	181.8ab	17.33ab	28.40ab	47.28ab
KPH+NPK (50:50)	0.28a	0.52a	0.65a	0.1a	0.13b	0.18ab	136.75a	233.88a	227.93a	10.98bc	20.88ab	37.58b
NPK 100 %	0.23a	0.36bb	0.63ab	0.1a	0.13b	0.13b	89.43ab	230.58a	174.3b	7.3c	14.10b	27.68bc
SE±	0.01	0.01	0.02	0	0.01	0.01	6.8	11.96	8.58	1.85	4.95	7.51

Means with the same letters are not significantly different according to Duncan Multiple Range Test
PGB = Pacessetter Grade B; KPH = Kola pod husk; NPK = NPK 15:15:15

Furthermore, increase in growth and yield of *A. cruentus* at second and third cropping over NPK fertilizer application conformed with finding of Adebayo and Akanni (2002) that household or domestic wastes and FYM sustained growth of *A. cruentus*. In addition, the better growth rate recorded on *A. cruentus* when KPH and PGB as organomineral fertilizers were applied is in line with the work of Kang and Balasubramaniam (1990) supported by Babatola *et al*. (2002) on leaf vegetable that high and sustained yield could be obtained with judicious and balanced NPK fertilizer combined with organic sources of plant nutrients.

4 CONCLUSION

Growth parameters showed that plant height, girth, number of leaves and leaf area 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 organomineral fertilizer (OMF) enhanced better growth. The combined use of the organic material with NPK at (50:50) mixtures was adequate for kola pod husk and Grade B at Ikorodu and LASU respectively at first and second cropping of *A. cruentus.*

Application of KPH + NPK (50:50) and (75:75) and PGB + NPK (50:50) and (75:25) mixture gave better growth effects across the growth parameters considered at the two locations in the first two growing periods in the greenhouse at the two locations.

5 REFERENCES

1 **Ayeni, L.S.2010**. Effect of combined cocoa pod ash and NPK fertilizer on Soil Properties, nutrient uptake and yield of Maize. Journal of American Science, 6 (3): 79 - 84

2 Ayeni L.S. 2008. Integration of cocoa pod ash, poultry manure and NPK 20:10:10 fertilizer for soil fertility management - Incubation study. Continental Journal of Agronomy, Nigeria 2: 25 - 30.

3 **Adeoye, G.O., M.K.C. Sridhar, O.O., Adeoluwa., M Oyekunle E.A. Makinde andOlowoake A.A. (2008).** Comparative evaluationof organomineral fertilizer and mineral fertilizer on yield and quality of maize. Nigerian journal of Soil Science 18: 132 -- 137.

4 **Fagbola,O and P.N Ogungbe. 2007.** Growth and yield response of some maize cultivars to organomineral fertilizer application in simulated degraded soil under greenhouse condition. Nigerian Journal of soil Science. 7:87 - 93.

5 **Ojeniyi, S.O., Owolabi O., Akinola O.M., Odedina S.A. 2009** Field study of effect of organomineral fertilizer on maize growth, yield, soil and plant nutrient composition in Ilesha south west Nigeria Nigerian Journal of Soil Science 19: 11 - 15

6 **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.

7 **Ayeni L.S, Adetunji,M.T and Ojeniyi, S.O 2008.** Comparative nutrient release from cocoa pod ash, poultry manure, NPK 20:10:10 and their combinations - Incubation study. Nigerian Soil Science, 18: 23 - 26.

8 **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.

9 **Kang and Balasubramaniam. .V. 1990.** Long term fertilizer trial on Alfisols in West Africa. In: *Transactions of XIV International Soil Science Society (ISSS) Congress*, Kyoto Japan. 350. pp.

9 **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

10 **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.

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