Available online @ www.actasatech.com

acta SATECH **3**(1): 1 - 6 (2009)

Effects of different Organic Nutrient Sources on the Growth and Dry Matter Yield of Amaranthus *(Amaranthus Cruentus)*

Daramola D. S., A. S. Adeyeye & D. Lawal

Department Of Agriculture And Industrial Technology, Babcock University, Ilisan Remo, Ogun State

*Correspondingauthor <ddaramola@babcockuni.edu.ng>

ABSTRACT

The effect of organic N fertilizers on the growth and shoot dry matter yield of Amaranthus cruentus (tete, Yoruba or green, common name) generally refers to as purple Amaranthus was studied in a field experiment at the Teaching and Research Farm of Babcock University Ilisan Remo, Ogun State, Nigeria. The seedlings were transplanted at the age of three weeks. There were six treatments in the study: the control (NO-N), 50kgN/ha as: Urea (UR), Farm Yard Manure (FYM), Poultry Manure (PM), Composted Sawdust CSD and Composted Maize Husk (CMH) respectively were replicated four times in a Randomized Complete Block Design (RCB). Growth variables of Amaranthus studied included plant height; leaf and branch numbers as well as dry matter yield. Application of the organic nutrient sources produced taller plants, more profuse leaves and branches and higher shoot dry matter yield compared to either the inorganic N source (UR) or the NO-N (control) treatment. Also, among the organic nutrient sources, application of N as PM, CMH and CSD separately in that order appeared superior to FYM in terms of promoting the economic yields namely: higher leaf/branch production and dry matter yield of the amaranthus.

INTRODUCTION

Amaranthus cruentus is a leaf vegetable crop that has gained recognition in Nigeria especially in the south-western states where it is cultivated widely in home-gardens, urban and peri-urban areas (Adebayo and Akoun 1999). *Amaranthus* species are regarded as one of the most popular tropical greens (NIHORT, 1989). One of the reasons for the increased interest in *Amaranthus* is because of its nutritional qualities. For example, its grain has a range of 12-17% protein and high lysine, which is an essential amino acid, found to be low in cereal and tuber dietary items of Nigerians (Putman *et al.,* 1989). *Amaranthus* thus has high potentials for reducing malnutrition, which is rampant in Nigeria. Apparently emphasizing the nutritional attributes of Amaranthus, Olufolaji and Tayo (1980) and Ninzawa (1997) noted that the vegetable is rich in vitamins (A and B) and in minerals like iron and calcium.

It is generally known that manuring and choice of variety are amongst the most practical ways of enhancing yield of vegetables. In this regard, organic manure has been identified as a potential source of nutrients in vegetable production (Ehigiator, 1998). The effect of organic manure has been studied on other crops namely: maize (Mukurumbira, 1992 and Nandwa, 1992). Organic manures either in form of incorporated haulm, straw, or livestock resides have significant effects on soil biological activities (Mader *et al.,* 1996, Solomon and Ogeh, 1995), nutrient retention in degraded or sandy soil (Ayuso *et al.,* Onweremadu *et al.,* 2003; Olufolaji and Tayo 1980) and on microbial biodiversity as well as the activities of faunal/floral populations (Havlin *et al.,* 2005).

The use of wastes to amend degraded soils has been found to bring about physical and biological rejuvenation.(Havlin *et al.,* 2005) and did not produce environmental harm (Akanbi *et al.,* 2003). In an acid soil, application of organic manures has been found to raise pH and chelates micronutrients (Ezeaku *et al.,* 2003) and to exert ameliorating effect on acidity (Hautin *et al.,* 1995).

Recent studies have even shown that the use of commercial fertilizers in Nigeria for crop production is limited by their scarcity and high cost (Akanbi *et al.,* 2001). Based on high cost of mineral fertilizers, Havlin *et al.,* (2005) stressed that it is move profitable to use livestock manures. Adedoyin (1995) emphasized that mineral fertilizers are never adequately and timely available to farmers. The use of mineral fertilizer alone even when available and affordable had yielded limited success in rehabilitating degraded soils (Noma *et al.,* 2003).

It is generally known that N in soluble mineral fertilizers is released rather fastly and that a part of it may be lost through leaching especially if the rate of release transcends plant uptake. However, the organic N, P and S, which have biogenic origin (Havlin *et al.,* 2005) has the virtue of being released slowly and steadily (Janik, 1986, Hartz *et al.,* 1996, Smith *et al.,* 1992) to meet the N demand of crops at all stages of growth.

In their work, Hartz *et al.,* (1996) and Smith *et al.,* (1992) also noted that composts made from organic wastes when applied increase soil organic matter and supply plant nutrients in a slowly available pattern. The slow release pattern of organic nutrients prevents luxury consumption (Lampkim, 2003). Also, in a study involving evaluation of corn-cob compost on plants in acid red soil, Praset *et al.,* (1985) reported the suitability of the compost in overcoming harvest loss due to acidity. In the light of the benefits of organic manures, it has become relevant to carry out more researches in order to come up with which of the organic nutrient sources would be comparable or even superior to the expensive mineral fertilizer formulations in crop production. Therefore, the study reported here investigated the relative effects of four different organic nutrient sources on the growth and shoot dry matter yield of Amaranthus.

MATERIALS AND METHODS

Experimental Site

The study was carried out at the Teaching and Research Farm of Babcock University, Ilisan-Remo, Ogun State (6° 54N and 3° 42E) in the rain forest of Southwestern Nigeria between November 2004, and February 2005. The area has a mean rainfall of 2400mm and the soil texture is loamy clay of Histisol series (Muck Histisol).

Organic materials used as composts

The sawdust (SD) used for the compost was collected from the carpentry workshop of Babcock University, while the maize husk (MH) was obtained from the Teaching and Research farm maize plot following the dehusking of the maize cobs. The MH was chopped into pieces (approximately 5cm) ready for composting separately along with the SD. The two wastes were primed with 2% top soil (collected from a forest) and moistened to speed up composting. The composting of the SD and MH was done in six pits dug for each waste material. The turning of the composting materials was affected by moving them from one pit to another weekly. The composting lasted for six weeks after which the composts were shade-dried and the composted maize husk (CMH) was crushed to simulate the particle size of composted sawdust (CSD). The two materials were each covered with a polythene sheet to minimize nutrient loss through volatilization.

The poultry manure (PM) was collected from Ibukun-Olu Farm in Osun State while the Farm Yard Manure (FYM) was collected from the cattle pens at the Babcock University Livestock farm. The two manures: PM and FYM were crushed into particle sizes similar to that of CSD. Samples of the four organic manures: CSD, CMH, PM, and FYM and soil were analyzed for chemical properties in the analytical laboratory of Babcock University, Ilisan Remo (Table 1) before the experiment using the standard methods described by IITA (1982).

Amaranthus seeds and seedlings

The seed of *Amaranthus* used for the study were obtained from the seed store of the National Horticultural Research Institute (NIHORT), Ibadan. Seedlings of the vegetable were raised in a nursery (trays) for three weeks before transplanting into the experimental plots.

Seedbed preparation and the treatments

The farm site for the experiment was ploughed, harrowed and beds (1.45m × 0.75m), which represented plots, were constructed. There were six plots per block each spaced 30cm (0.3m) apart. The treatments consisted of the: (i) Control (NO-N), (ii) 50kgN/ha as 0.11 ton Urea (UR 45%N) per hectare (iii) 50kgN/ha as 6.0tons Farm Yard manure (FYM) per hectare (iv) 50kgN/ha as 4.0 tons Poultry Manure (PM) per hectare (v) 50kgN/ha as 6.0 tons Composted sawdust (CSD) per hectare and (vi) 50kgN/ha as 7.4tons composted Maize Husk (CMH) per hectare. The treatments (6) were replicated four times (24 plots) and laid out using a randomized completed block design (RCB). Each of the five nutrient sources was worked into the soil two weeks before transplanting of the seedlings. The seedlings were lifted with a ball-of earth using a hand trowel and transplanted at a spacing of 25cm by 20cm at a stand density of two seedlings per hill (64plant/plot). There were 4rows/plot. The minerals fertilizer treatment Urea (UR) was worked into the soil (side-dressing) three days after transplanting.

Data collection and analysis

Data collections were done at 4 and 6 weeks after transplanting (WAT). Plant height, stem girth, number of branches and leaves were taken on a set of four plants from the middle-row of each plot.

During each sampling period, the four plants were cut 2cm above the ground level (shoot), chopped and weighed fresh on a mettler top-loading balance (Excell model). The chopped materials were enveloped and oven dried at $80^{\circ C}$ for 48 hours. The data colleted were subjected to analysis of variance (ANOVA) and the means separated using the least significant difference (LSD) at 5% level.

RESULTS

Analysis of the soil and Manures

The result of the soil and manure analyses before the experiment presented in Table 1 show that nitrogen concentrations of the organic manures were low generally but highest in poultry manure (PM). The C/N ratio of CSD was highest followed by that of CMH indicating the carbonaceous nature of the wastes. Available P was highest in PM: about 50% higher than the P content of CSD suggesting that the mash fed to the birds which produced the PM was probably high in phosphorous. The soil used for the experiment was somewhat acid (pH 5.93) which may explain its low available P and N concentrations respectively (Table 1). Availability in most soils is at maximum near pH 6.5 (Havlin *et. al,* 2005). The organic matter content of the soil was found to be low, and correspondingly so, was total N (Table 1). The fact that 95% of total soil N is organic N (Havlin *et al.,* 2005) might largely explain the observed relationship between the two soil characteristics.

Table 1: Chemical properties of Soil and Organic manures before experiment

Properties	Soil	Farmyard Manure	Poultry Manure	Composted Saw dust	Composted Maize Husk
pH (1:2 soil/$Cacl_2$	5.93	7.76	6.0	6.55	6.55
Nitrogen (%)	0.48	0.84	1.42	0.9	0.68
Carbon (%)	0.92	1.80	1.20	2.80	1.60
C/N ratio	1.92	2.14	0.85	3.10	2.35
Available (%)P	4.38	0.29	0.34	0.16	0.23

Plant height, stem girth and leaf production

The plant height, stem girth and leaf number variables are presented in Table 2. At 4WAT, plants were found to be significantly taller with N application irrespective of source compared to the control (NO-N) at 5% level. Significantly shorter plants were observed with application of N as CMH compared to when N was applied through any of the other sources; a probable reflection of the comparatively lower N concentration in the compost (Table 2). Plants were taller respectively with application of PM and CSD relative to when N was applied as UR. However, plant heights were similar in plots to which UR and FYM were separately applied at 4WAT. As regards stem girth, though not significantly, application of N as any of the organic manures gave bigger stem size when N was supplied as either UR or relative to NO-N treated plants. Plants produced significantly more leaves with the application of any of the organic nutrients sources than with NO-N treatment ($P \leq 0.05$), which has similar leaf production with UR-treated plants. Leaf production was similar in plants treated with UR and FYM (Table 2). At 6WAT, there were increases in plant height, stem girth and leaf production relative to 4WAT under each of the treatments. Nitrogen application irrespective of source, gave taller plants, larger stem girth, and higher leaf number compared to NO-N treatment. Each of the organic nutrient source application resulted in taller plants compared to the UR application; but only the plants treated separately with CSM and CMH. Means (column) followed by the same letters are not significantly different (LSD 5%) were significantly taller at 5% level (Table 2). Bigger plants were produced through application of each of the organic nutrient sources compared to application of UR (inorganic fertilizer). Amongst the organic nutrient sources, stem girth was biggest in CMH- followed by PM-treated plants. Plant leaf number production was significantly higher with application of any of the organic nutrient sources relative to the control treatment. Plant treated with any of the organic nutrient sources produced significantly more leaves than the UR-treated plants. Amongst the organic nutrient sources, only PM application resulted in significantly greater number of leaves compared to the FYM application. The UR-treated and FYM-treated plants produced similar number of leaves (Table 2).

Branch production and shoot weight

Results of branch production and shoot weights (wet and dry) are presented in Table 3. For each of the treatments evaluated, there was (on the average) not less than 50% increases in branch production and shoot weights (wet and dry) respectively as the plant aged. Branch production at 4WAT was greater in plants that received N, irrespective of source compared to the control treatment; but the differences were only significant ($P \leq 0.05$) when the N was applied as either PM or CMH (Table 3). Amongst the N sources, only CMH-treated plants produced significantly higher branch number than UR-treated plants at 4WAT; But, at 6WAT, PM-treated plants had significantly higher number of branches compared to the UR-treated plants which had similar branch number per plant with the control.

Except for UR, (the inorganic N source in this study), application of N as any of the organic nutrient sources resulted in significantly higher fresh shoot weight at 4WAT compared to the control. Fresh shoot weight of CSD-treated plants and FYM-treated plants were similar; but each of the fresh weights was significantly higher (5% level) compared to when either PM or CMH was applied.

However, at 6 WAT, application of N irrespective of source produced significantly higher fresh shoot weight compared to the NO-N treatment. Application of any of the organic nutrient sources resulted in significantly higher fresh shoot weight than application of UR at 5% level (Table 3). Amongst the organic nutrient sources, application of CSD only gave significantly higher fresh shoot weight than the application of FYM. Separate applications of the other two organic nutrient sources resulted in fresh shoot weights similar to when the FYM was applied. As for the shoot dry matter weight, N application except as UR, gave significantly higher shoot dry matter yield ($P \leq 0.05$) compared to the control (4WAT). Amongst the organic nutrient sources, FYM application resulted in significantly higher shoot dry matter yield than application of any of the other three sources (Table 3). But at 6WAT, except for application of FYM as a organic nutrient source, application of any of the remaining organic nutrient sources resulted in significantly higher shoot dry matter yields ($P \leq 0.05$) than the control. In terms of the variable, the use of UR as N source proved least effective amongst other N sources. Shoot dry matter yields under FYM, UR and the control treatments were however similar (Table 3). The shoot dry matter yield of CSD – treated plants was highest followed by those of PM-treated plants.

DISCUSSION

During the study, the variables assessed on the *amaranthus* increased with age (between 4 and 6 WAT) for all fertilizer treatments especially the organic manures, this is an evidence of the slow but steady nutrient release property of organic manures (Hartz *et al,* 1996). Also, in the study, application of N irrespective of source (organic or inorganic) promoted plant growth (initial and subsequent) in terms of height, stem girth, leaf and branch production and shoot dry matter yield over the non-fertilizer treatment showing the importance of N nutrition for above ground vegetative-development – a vital yield index of *amaranthus.* An adequate supply of N to plants is associated with vigorous seedling emergence, vegetative growth and yield (Havlin *et al.,* 2005). From the response to N observed it is also evident that the soil sued was low in N- content (Table 1). It is remarkable that the application of the organic N sources namely PM, CSD and CMH showed superior positive

Table 2: Effects of different Organic Nutrient sources on height, stem girth and leaf number of Amaranthus at 4 and 6 WAT

	← 4 WAT →			← 6 WAT →		
Treatments	**Height/plant (cm)**	**Stem girth (cm/plant)**	**Leaf No Per plant**	**Height/plant (cm)**	**Stem girth (cm/plant)**	**Leaf No Per plant**
NO-N	20.5d	2.1a	22c	26.5b	2.7a	26d
50kg/ha (UR)	24.7b	2.1a	23bc	28.2b	2.9a	35cd
50kgN/ha (FYM)	26.1ab	2.5a	35ab	30.1a	3.0a	44bc
50kgN/ha (PM)	27.2a	2.4a	38a	29.5ab	3.5a	57a
50kgN/ha (CSD)	27.7a	2.7a	41a	33.1a	3.4a	49ab
50kgN/ha (CMH)	22.7c	2.4a	40a	33.0a	3.8a	47ab

Table 3: Effect of different organic nutrients sources on branch number; shoot (fresh and dry) weights of *Amaranthus* at 4 and 6WAT.

	← 4WAT →			← 6WAT →		
Treatment	**Branch No/plant**	**Fresh shoot wt. g/plant**	**Dry shoot wt. g/plant**	**Branch No/plant**	**Fresh shoot wt. g/plant**	**Dry shoot wt. g/plant**
NO-N	2.0c	16.8d	6.3c	4.0c	33.6d	18.2b
50kgN/ha (UR)	3.6bc	21.4d	7.0c	6.0bc	51.2c	25.0ab
50kgN/ha (FYM)	4.0abc	48.0a	17.2a	9.0ab	85.7b	28.2ab
50kgN/ha (PM)	6.8ab	37.7b	12.8b	11.5a	96.7ab	30.2a
50kgN/ha (CSD)	5.0abc	48.5a	13.5b	8.8ab	109.7a	30.8a
50kgN/ha (CMH)	7.3a	30.6c	11.6b	10.0ab	100.3ab	29.2a

Means (column) followed by same letters are not significantly different (LSD 5%)

effects on dry matter yield of *amaranthus* and in terms of the branch, leaf number, stem girth and dry matter yield compared to the inorganic source.

However, application of Composted Saw Dust (CSD) produced highest top yields (fresh and dry) at 6WAT amongst the other organic nutrient sources probably because nutrients release from CSD occurred more slowly over a longer period than was the case with any other composts. In addition, greater initial microbial nutrient immobilization might have occurred in CSD-treated plots prompting subsequently higher nutrients re-cycling via mineralizing for plants development. In contrast to the other organic nutrient sources applied, CSD had higher %C (Table 1), hence the apparent highest microbial mobilization. Earlier workers like Ehigiator (1998) identified manures as possible alternative sources of nutrients to inorganic fertilizer in crop production especially vegetables.

This is apparently because organic manure, are a storehouse of not only primary, but secondary and trace elements (Janik, 1986; Plaster, 1992). The nutrients such as N in organic manures are released in synchrony with crop needs throughout the growth season (Havlin *et al.,* 2005) in contrast to block release pattern commoner with soluble mineral fertilizers. The above attributes of organic manures in addition to their capability to improve soil structure, retain nutrients and water for plant use (Olufolaji and Tayo, 1980; Lai, 1987; Anyanwu *et al.,* 2001) could partly explain the superiority of the organic manures as N sources in vegetable production over inorganic urea N fertilizer used in this study. The results obtained seem to indicate that any of the organic nutrient sources has potentials as fertilizers for the *amarathus* production. In selecting any of them however, it is pertinent to consider the relative rates of decomposition and mineralization and the comparative persistence in nutrient supply ability of the organic manures (Havlin *et al.,* 2005) during the different growth phase of the crop. Apparently, the relative inferior effects shown on variables assessed by FYM (an organic manure) and UR (an inorganic N source) respectively compared to the other organic nutrient sources used could be attributed to low %N in FYM (Table 1) and loss of N through volatilization in both (Havlin *et al.,* 2005).

Conclusion

The positive responses of *amaranthus cruentus* in terms of increased plant growth in height, stem girth, leaf and branch production and fresh/dry matter yields to apply N in this study compared to NO-N treatment stressed the essentiality of the nutrient for optimum Amaranthus productivity especially when the N was supplied from organic manure sources. The superior benefits through separate applications of PM, followed by CMH and CSD respectively on leaf/branch production, stem girth and shoot dry matter yield showed the organic manures as potential alternative organic nutrient sources to UR in the production of the vegetable. However, it is important to base the choice of any of the organic nutrient sources on which of them is most easily mineralized; least prone to losses through volatilization and hence, the most capable of persistent supply of nutrients to current and of exerting residual effect on subsequent crops.

REFERENCES

Adebayo, O. and Akoun J, (1999) Effect of Organic Manure and spacing on the yield and yield components of *Amaranthus cruentus.* Federal Ministry of Forestry, Ibadan.

Adedoyin, S.F. (1995) An Assessment of the linkage in the delivery of technologies on rehabilitation and management of soil in Ogun State, Nigeria. A paper presented at the 3rd All African Soil Science Conference, University of Ibadan, Ibadan. 19-26 Aug 1995.

Akanbi, W.B, Togun, A.O, and Baiyewu, R.A (2001). Suitability of plant residue compost as nursery growing medium for some tropical fruit tree seedlings. *Moor Journal of Agricultural Research* 2: 41-45.

Akanbi, W.B., Adediran, J.A., Togun, A.O. and Sobulo R.A.(2003). Effect of Organic base fertilizer on the growth, yield and storage life of tomato *Lycopersicon esculentum,* Mills. *Bioscience Research Communication* 12(4): 14-18.

Anyanwu A.C, Anyanwu B.O and Anyanwu V.A (2001). A textbook of Agriculture Science and Colleges African Fep Publishers Ltd. Onitsha, Nig 43lp

Ayuso, M.J.A., Pascual, C.G. and Hernandez, T. (1996). Evaluation of Urban wastes for agricultural use. *Soil Science and Plants Nutrition* 42(1): 105-111

Ehigiator, J.O., (1998). Farm yard manure; need for adoption as an alternative to chemical fertilizer uses in Nigeria. *Nigeria Journal of Hort. Science,* 3:19-26

Ezeaku, P.l. Olimati, J.A and Ahmakhian, S.O. (2003) Significance of Soil Characteristics to Urban waste disposal on Agricultural Lands in

Anyigba North Central Nigeria. Proceedings of the Annual Conference of the Soil Science Society of Nigeria. 220-227.

Hautin, J.A. Karem, L.E. Adeoye A. (1995) Effect of moss-shrub waste compost on the growth of barley on loamy sandy soil. *Commun Soil Sci Plant Anal* 126 (19 and 20): 3275 – 3289.

Havlin, J.L. Beaton, J.D. Tisadale, S.L. and Nelson, W.L. (2005) Soil Fertility and Fertilizer – An Introduction to Nutrient management 7th Edition. Pearson Prentice Hall, New Jersey. 515p

Hartz, T.K., Costa, F.J. and Schrader, W.L (1996). Suitability of composted green waste for horticultural uses. *Hortscience* 31(6): 961-964

International Institute of Tropical Agriculture (IITA) (1982). Selected methods for soil and plant analysis. Manual series No 6, IITA, Ibadan 33p.

Janik J. (1986) Horticultural Science 4th edition, W.H. Freeman and Company N4 746p

Lai, R (1987) Managing the soil of sub-Saharan *African Science*, 236; 1069-1074

Lampkin, N (2003) Organic Farming. The Agricultural note book 20th Edition (ed R.S Soffer) Blackwell Publishing 288-303

Mader, P; Pfiffner, L, Lutzow, M.V., Pliessbach, A. and Munch, J.C, (1996). Soil ecology impact of organic and conventional agriculture on soil biota and its significance for soil fertility. Fundamentals of organic Agricultural. (T. Oestergaard ed) Conference Proceedings, pp 24-46. International Federation of Organic Agriculture Movement, Tholey-Theley.

Minzawa, N.A. (1997) Comparing nutritional value of exotic and indigenous vegetables. Proceedings of a workshop on Africa indigenous vegetables. Limbe, Cameroun 70-75

Mukurumbira L. (1992). Re-cycling of crop residue to supplement N requirement of maize in Zambia. Report of the Tropical Soil Biology and Fertility Program (Paul, S.S and Paul L.W. eds) 48p.

Nandwa, S.M (1992) The effects of stover placement on soil properties and Processes and productivity of maize in tea agro-ecosystem in Kenya. In Report of Tropical Soil Biology and Fertility Programmed. (Paul D. S and Paul L.W eds) 48p

National Horticultural Research Institute. (1985) Guide to the production of Amaranthus (tete), Telferia and Cochorus Olitorus NIHORT production Guide, NIHORT, Ibadan 80p.

Noma, S.S. Anka, L.A. Ibrahim, S.A. and Yakubu, M. (2003) Rehabilitation of a Degraded ustipsamment in Sokoto, Nigeria using different combinations of soil amendment. Proceedings of the 28th Annual Conference of Soil Science Society of Nigeria. 235 – 239.

Olufolaji, A.O. and Tayo, T.O. (1980) Growth, development and mineral contents of three cultuvars of *Amaranthus, Scientica. Hort*. 13 (2); 181- 189,

Onwerenmadu, E.U., Oti N.N. Ibeawuchi, I.I. and Obilo, O.P. (2003) Effect of Dehydrated pig manure (DPM) on maize yields in degraded soil of Owerri, South-eastern Nigeria. Proceedings of the 28th Annual Conference of Soil Science Society of Nigeria. 81 – 86.

Putman, D.H, Oplinger, E.S, Doll, J.D and Schutte F.M. (1989). Nutritional value; Alternative Field crop manual. 39p

Plaster E.J. (1992) Soil Science and Management. 22nd Edition. Delmor Publisher Inc, NY. 514p.

Smith, S.R., Hell, J.E. and Hadley P. (1992) Comparing Sewage sludge waste in relation to their suitability for use as fertilizer materials for vegetable crop production. *Acta Hort*. 302: 202- 215

Solomon, M.G. and Ogeh, J.S. (1995) Use of leguminous plants and rice husk as fertilizer materials. In proceeding of the 3rd African Soil Science Society Conference 1995. University of Ibadan, Ibadan 84- 89. Aug 19-26, 1995