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# Influence of Compost on Growth, Nutrient Uptake and Dry Matter Partitioning of Grain Amaranths (*Amaranthus hypochondriacus* L.)

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**Abstract:** A field trial was conducted during the late seasons of 2007 and 2008 at the Teaching and Research Farm of Olabisi Onabanjo University, College of Agricultural Sciences, Ayetoro to determine the type of compost and estimate the quantity in t $ha^{-1}$ that will give optimum yield and quality grains by grain amaranths (Amaranthus hypochondriacus.). Data collected were analyzed using ANOVA with differences in means separated by DMRT ($P \leq 0.05$). Results showed that shoot and grain yield were significantly ($P \leq 0.05$ )influenced by compost. Application of 4 t $ha^{-1}$ of compost enhanced optimum grain yield and quality of grain amaranths on Oxic paleustalf in derived savannah agro-ecology. Cattle dung compost displayed superior influence over poultry manure compost in improving growth, yield and nutritional performance of grain amaranths. Nutritional composition increased in the order of grain > leaves > stem. However, there was no significant difference in the nutritional composition of stems and grains of grain amaranths among the compost rates and types applied.

**Key words:** Grain amaranth • Compost • Growth • Yield • Grain quality

## INTRODUCTION

Amaranths are vegetable crops and belong to the genus *Amaranthus* which includes approximately 60 species [1]. The genus *amaranths* which produce large seed heads of edible, light-coloured seeds are developed for seed production [2] Grain amaranths is a good source of protein, fibre, carbohydrate, fat and minerals like Ca and Fe in considerable amount. The leaves of the plant are edible to humans and domesticated animals as well as the seeds which can be prepared into varying food types such as gruel called '*sattoo'* or milled into flour to make chapattis [3]. The grains also contain 6-10 percent oil, which is predominantly unsaturated fatty acids and is high in linoleic acid, which is necessary in human nutrition [4]. The oil is found to have seven percent squalene, which is much higher than the amount found in other common vegetable oils [5] Amaranth seed is high in protein (15-18%) and contains respectable amounts of lysine and methionine, two essential amino acids that are not frequently found in grains. It is high in fiber and contains calcium, iron, potassium, phosphorus, and vitamins A and C [6].

Peasant amaranths farmers in Nigeria operate at < 20% below productive efficiency when compared with 2-4.5 MT potential yield achievable through adoption of improved varieties, optimum spacing, crop protection measures and good soil fertility management strategy [7-10]. This is premised from the fact that most of the growers rely solely on native soil fertility from nutrient and organic build up in a fallow and nutrient recycling processes. However, this soil fertility management practice are not adequate to satisfy the nutritional requirements for high yielding grain amaranths. Thus, leading to declining soil fertility with attendant reduction in crop productivity.

Although excess nitrogen application has been reported to have positive effect on the yield of the plant however, this practice predisposes grain *amaranths* to lodging [1]. According to Olaleye *et al.*, [11] nitrogen is the most mobile and easily exhaustible nutrient in the soil and is subjected to substantial leaching and losses resulting in ground water nitrate pollution if nitrogenous fertilizers are applied in excess. In addition to the environmental problem consequent upon excess application in most farming communities in many parts of the developing world including Nigeria, commercial

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fertilizers are often beyond the reach of these poor resource farmers in terms of availability and affordability. Consequently, alternative soil fertility maintenance techniques need to be evoloved in order to meet up with food need of the teeming populace. One of such technique is the use of both animal and crop residue compost [1, 12, 13].

Composting is a biological process of aerobic decomposition, which degrades labile organic matter to carbon dioxide, water vapour, ammonia, inorganic nutrients and a stable organic material containing humic like substances [14]. In spite of the numerous benefits of compost in crop growth as evidenced from literature, [15-17], information on the optimum compost required for growing amaranths on degraded soils are scanty in literature. Over and above this, nutrient availability, uptake efficiency and quality of grains produced by crop varies according to efficiency of the applied materials to released the bound nutrient as reported by Agboola and Sobulo [18] and Akanbi *et al.*, [13]. The work reported here sought to evaluate the growth, yield and quality of nutritional composition of grain amaranths as influenced by varying rates and types of compost applied to Oxic paleustalf in derived savannah agro-ecology.

## MATERIALS And METHODS

The study was carried out at the Teaching and Research Farm of College of Agricultural Sciences, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State, Nigeria. Ayetoro lies on latitude 7°15'N and longitude 3° 3'E in a deciduous-derived savannah zone of Ogun State. The climate is sub-humid tropical with a long time average annual rainfall of 1, 909.30m. The soil is a lateritic and described as Oxicpaleustalf. Compost prepared from three organic waste materials of both plant and animal origin: cattle dung, poultry manure and Maize Stover. Compost was prepared using concrete surface heap method as described by Lara, [19] and Akanbi *et al.*, [17]. The field used was formerly under late season vegetable production and left to fallow for almost one cropping season.

**Nutrient Analysis of Soil and Compost:** Samples of the matured compost were taken for physical and chemical analysis in the laboratory using stand ard methods [20]. Prior to land preparation, pre-planting soil samples was rand omly collected per replicate within the depth of 0-15cm. The soil sample was air-dried and crushed to pass a 2mm and 0.5mm sieve and taken to the laboratory for physical and chemical analysis to determine their nutrient level prior to application of compost. Representative samples was analyzed for pH, using 1:2 (soil: water) suspension, particle size [21], total nitrogen using the micro-kjeldahl method [22], and exchangeable cations (K, Ca, Mg and Na) after extraction with 1N $NH_4OAC$ (pH 7). K in the filtered extract was determined with a flame photometer, whereas Ca, Na, and Mg were determined with an atomic absorption spectrophotometer (AAS model, Buck 200). Available phosphorus (Bray-1-P) was determined by colorimeter using the method of Bray and Kurtz [23] and organic carbon. Seed of grain amaranths cultivated was obtained from National Horticultural Research Institute (NIHORT) Ibadan.

**Experimental Design and Treatments:** The experimental design was a Split-plot design with three replicates. The main plot effect was the compost type (Cattle dung + Maize stover and Poultry manure + Maize stover) while the sub plot effect was the levels of compost applied (0, 4, 8, 12t/ha ) and 45kg of NPK (15-15-15). Ten treatments derived from a factorial combination of five ammendement levels and two types of compost were used for this study.

**Land Preparation and Crop Management:** The land was cleared using slash method, the debris were packed and beds constructed to a height of about 30cm (to ensure that the profile stay in position), reduce compaction and increase water infiltration. Prior to planting, each compost level treatment was applied to each plot and worked into the soil properly to facilitate even distribution of the applied materials. Each block had an area of $24x5m^2$. Each block was further sub-divided into two main plots of $24x2m^2$ dimension each with five sub-plots each measuring $4x2m^2$. Seeds of amaranths were planted directly on the field using drilling methods. At 10 Days After Sowing (DAS) each plot was thinned to obtain an equivalent of 320, 000 plants $ha^{-1}$. 1m space was created between each replicate and plot to reduce interplant competition for resources among the replicates. 0.16m/l of karate (Lambdacylothrin EC 25%) was sprayed bi-weekly to control insect pest infestation on the leaves and grains. The field was manually rouged as required to prevent weed competition. Watering was done everyday for the first three weeks and continued every other day till harvest.

**Data Collection**

**Growth Parameters:** Data collection on growth and yield of grain amaranths started at 21 DAS at 3-weekly intervals from two tagged plants from the middle row per plot. Plant height was determined using a meter rule from the base to the tip of the main shoots. Number of leaves was recorded by counting.

**Dry Matter Partitioning:** At 63 DAS, when the vegetative development of grain amaranths had reached the maximum and at flower initiation, destructive harvesting of four plants per treatments was done to determine the fresh and dry matter yields of the shoots and roots which were measured separately using an electric weighing balance. The plant shoots and roots were oven dried at 80°C for 48 hours after which the samples were weighed to obtain the dry matter yield. The inflorescence were harvested when the heads have matured from twenty sampled plants in each treatment at 84 DAS and processed manually to recover the grains. Grain yield was recorded by weighing the seeds using an electric weighing balance.

**Plant Tissues Nutrient Content and Uptake:** After determination of fresh shoot, root and grain weight. They were dried in an oven 70°C for 48 hours. Dried samples were milled and ground for tissue analysis. Total P were determined by the Vanadomolybdate method, K by flame photometry and total N was analyzed using micro-kjheldahl procedure and crude protein was evaluated by multiplying the total N by a factor of 6.25. Crude fibre, Ether extract, Ash, CHO and moisture content were also analyzed using methods of AOAC [24].

**Data Analysis:** Data collected were subjected to analysis of variance (ANOVA) using Statistical Analysis System [25]. The differences in means were separated by Duncan multiple range test (DMRT) at 5% probability level.

## RESULTS AND DISCUSSION

Application of varying levels and types of compost had significant ($p < 0.05$) influence on growth, shoot and grain yield, dry matter components, nutrient uptake and nutritional composition of grain amaranths (*Amaranthus spp.)* grown on Oxic Paleulstalf (Sand y clay Alfisol) in derived savannah agro-ecology.

**Growth and Development:** The results showed that application of varying rates of compost had no significant influence on the growth parameters of grain amaranths at the initial (0 to 21 days after sowing) growth stages. However, as the crop grew further, compost application had significant influence on the performance of the crop (Figure 1). This observation suggests that the native soil nutrient could only support amaranth growth for the first three weeks beyond which; the plant might be predisposed to nutrient deficiencies.

Application of 12t ha$^{-1}$ compost resulted in the highest production (61.61) of number of leaves (Fig. 1a) but, there was no significant difference among the three rates of compost applied in terms of other growth parameters measured. Thus, it appears that application of superfluous compost would enhance leaf production in grain amaranth. Plots where 4 t ha$^{-1}$ of compost was applied had the tallest plants and wider leaf area although, there was no significant difference among the three levels of compost (Fig. 1b and d). The lowest growth parameters were observed in plots where no compost was applied (Fig. 1a-d).

The results revealed that application of 4 t ha$^{-1}$ being the lowest compost rate had influence on the growth parameters of amaranths which is comparable to other rates of compost and mineral fertilizer application. Thus, sub-optimal level of compost application appeared to be adequate for normal growth and development of grain amaranth as any further increase in the rate of compost application would only produce marginal yield. Similar report have being pointed out by Odeleye, *et al.*, [12] and Olaleye *et al*., [11] where they reported that application of excessive amendment to soil would merely encourage biological growth at the expense of economic yield. Thus, application of 4 t ha$^{-1}$ of seemed sufficient for optimum amaranth growth and development.

It is evidenced from this study that, the applied materials contain sufficient N that promoted vegetative growth in grain amaranth (Table 1). Therefore, amaranth growers interested in leaf production could apply 4 to 12 t ha$^{-1}$of compost to boost leaf production necessary to supply adequate nitrogen which is an essential component of chlorophyll, protoplasm, protein and nucleic acid and its absence at appropriate levels could cause yellowing of leaves and stunting of plant growth [26].

Application of different types of compost had significant influence on growth and development of grain amaranth. Grain amaranth had significantly most number of leaves produced, stem diameter and the tallest plants in plots where Cattle dung-Maize stover Compost (CMC) was applied (Fig. 1e-g). This observation implies that CMC seemed superior to Poultry manure-Maize stover

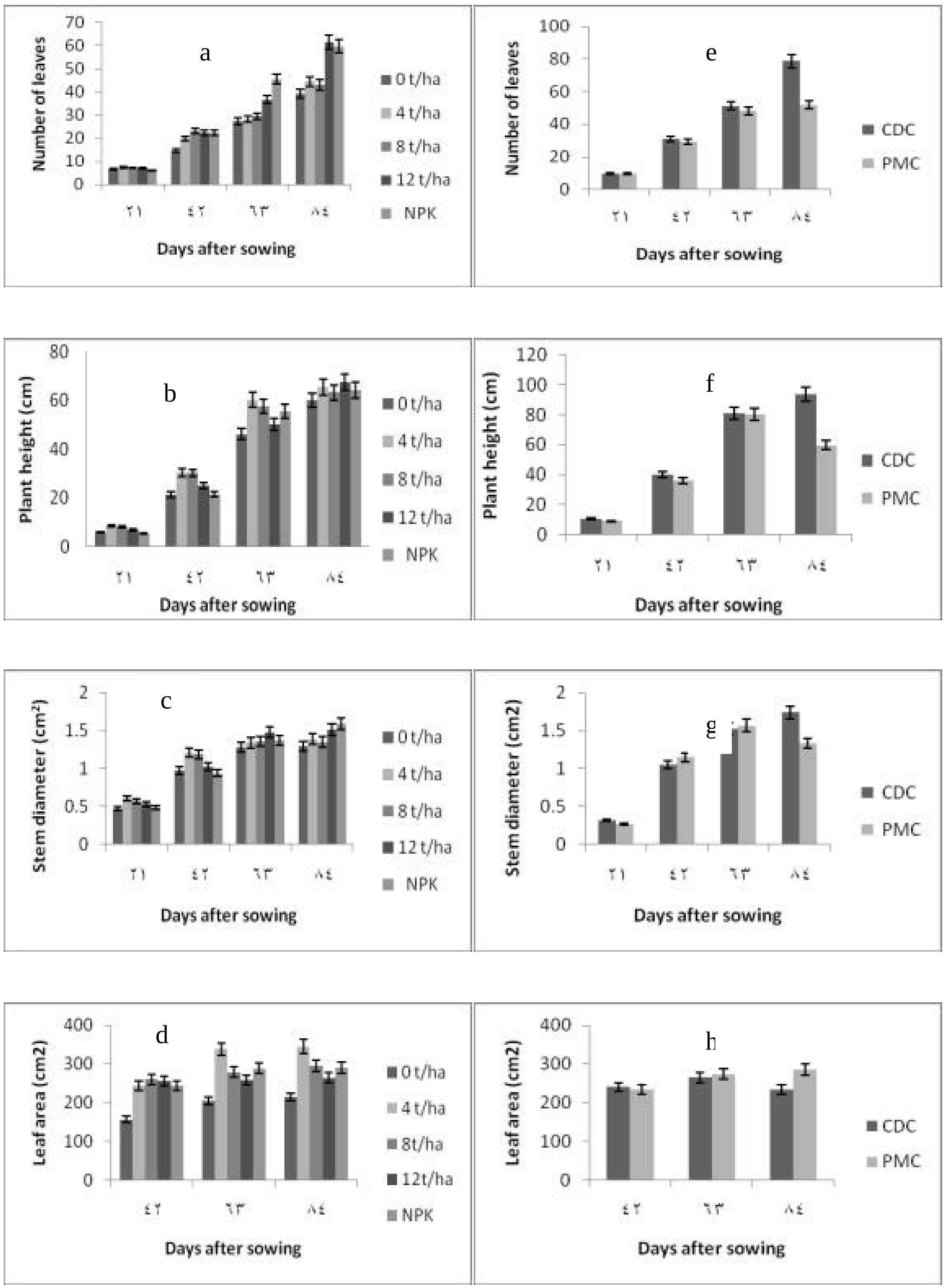


Fig. 1: Influence of compost on growth parameters of grain amaranths
*CDC=Cattle dung+Maize stover compost, PMC= Poultry manure+Maize stover compost*

Table 1: Physical and chemical characteristics of soil and compost used for the study

| Parameters | Soil | CMC * | PMC |
|---|---|---|---|
| pH ($H_20$) | 7.05 | 5.24 | 5.78 |
| Total Nitrogen | 0.30 | 2.12 | 2.67 |
| P(mg / kg) | 42.53 | 6.05 | 7.48 |
| K cmol/kg | 0.28 | 2.96 | 3.05 |
| Na cmol/kg | 0.53 | 0.89 | 1.11 |
| Ca cmol/kg | 0.93 | 2.86 | 2.14 |
| Mg cmol/kg | 0.75 | 1.23 | 1.88 |
| OC (%) | 2.62 | 19.72 | 22.73 |
| OM (%) | 4.50 | 33.91 | 34.67 |
| Zn mg/kg | 3.46 | 1.12 | 1.11 |
| Sand (%) | 56.60 | na | na |
| Silt (%) | 22.38 | na | na |
| Clay (%) | 21.02 | na | na |

*CMC = Cattle dung-Maize stover Compost, PMC = Poultry manure-Maize stover Compost na = Not available*
**Dry weight basis*

Compost (CMC) in supplying the necessary plant nutrients required for growth of grain amaranth in the study area.

*Amaranths* performed significantly better in plots where CMC were applied up till maturity than those where PMC was applied. Though, the performance of the two compost types on growth of grain amaranth was comparable up to a particular growth stage but differed significantly at maturity where CMC displayed better performance. Thus, CMC which appeared to supply the required nutrients up till maturity in all the growth parameters except the leaf area (Fig.1h) would be a good alternatives for inorganic fertilizers in grain amaranth production. This is expedient considering the fact that *A hypochondriacaus* is grown mainly for its grain yield. Therefore, a soil amendment that would supply adequate nutrients for its growth up till grain maturity would be a better option than that which would supply abundant nutrients only at the early (vegetative) growth stage but marginal at the latter (grain maturity) growth stage.

**Grain and Dry Matter Yield Components:** Figures 2 and 3 showed that application of varying rates and types of compost had significant ($p<0.05$) effect on grain and dry matter yield. Among the three compost rates, application of 4 t haG$^{1}$ of compost had significantly the highest amount of grain yield (1.55 t haG$^{1}$) and was comparable to mineral fertilizer (Fig 2d). Although, there was no significant difference among the other rates of compost and inorganic fertilizer applied however, plots that received 4 t haG$^{1}$ had the tallest inflorescence (22.31cm) (Fig. 2a) as well as most inflorescence (38.78g), (Fig. 2b) dry matter (6.79 t haG$^{1}$) (Fig. 3a) and harvest index (48.04) (Fig. 3b). This infers that application of 4 t haG$^{1}$ of compost would boost yield and yield components of grain amaranth in derived savannah agro-ecology. Despite the fact that, weight of fresh shoot harvested was the highest (156.09t haG$^{1}$) ((Fig. 2c)) in plots where 12t haG$^{1}$ of compost was applied there was no significant difference among the compost rate and inorganic fertilizer applied. This implies that superfluous compost application would be promote canopy and shoot production. This observation is similar to the findings of Myers [27]and Sumar *et al*. [28].

Application of CMC had significant influence on yield and yield component of grain amaranth when compare to PMC. Plots where CMC was applied had the tallest and most inflorescence, the highest grain yield and dry matter components (Figure 2e, f and h). However, grain amaranths had the most fresh shoot yield and harvest index in plots where PMC was applied (Fig.2g and 3d). This implies that CMC seems to perform better than PMC in terms of inflorescence production, grain yield and dry matter partitioning. Nonetheless, PMC is superior to CMC as it relates to shoot production. Thus suggesting that PMC would be the best option for shoot production while CMC would be adequate for grain production in the production of this crop. Hence both compost type could be used as a split application whereby shoot supporting compost is applied at the vegetative growth stage while grain promoting compost is applied at the flowering initiation (reproductive) stage.

**Nutrient Uptake:** Grain amaranth showed significant differences in its response to nutrient uptake among the varying rates of compost applied. N (1.37mgkgG$^{1}$), P (0.39 mgkgG$^{1}$) and K (1.31 mgkgG$^{1}$) uptake was significantly higher in plots where mineral fertilizer was applied. The rate of nutrient uptake was directly proportional to the quantity of the applied compost. N uptake was significantly the highest in plots where 12 t haG$^{1}$ was applied but not significantly different from plots that received 8 t haG$^{1}$(Table 2). Generally, there was no significant difference between P and K uptake among

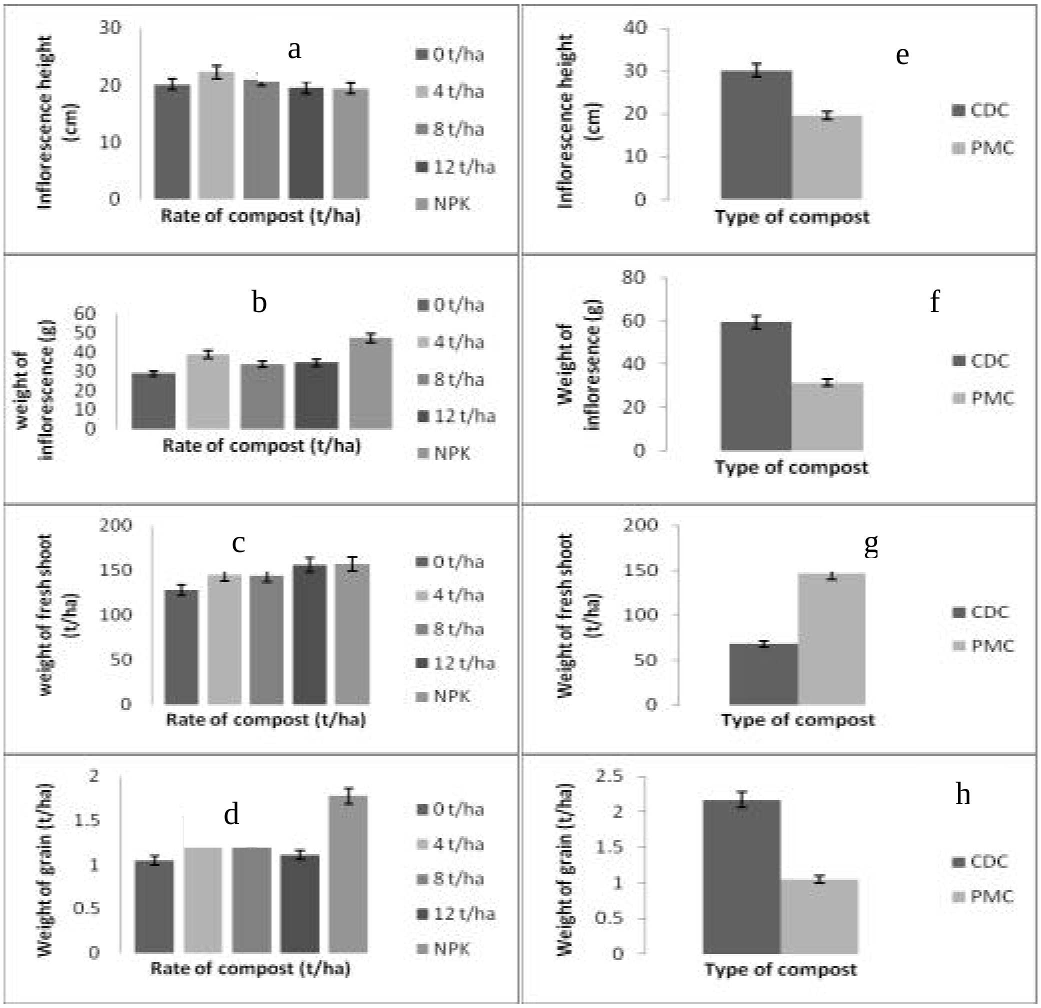


Fig. 2: Influence of compost on yield components and dry matter partitioning of grain amaranths. CDC=Cattle dung+Maize stover compost, PMC= Poultry manure+Maize stover compost

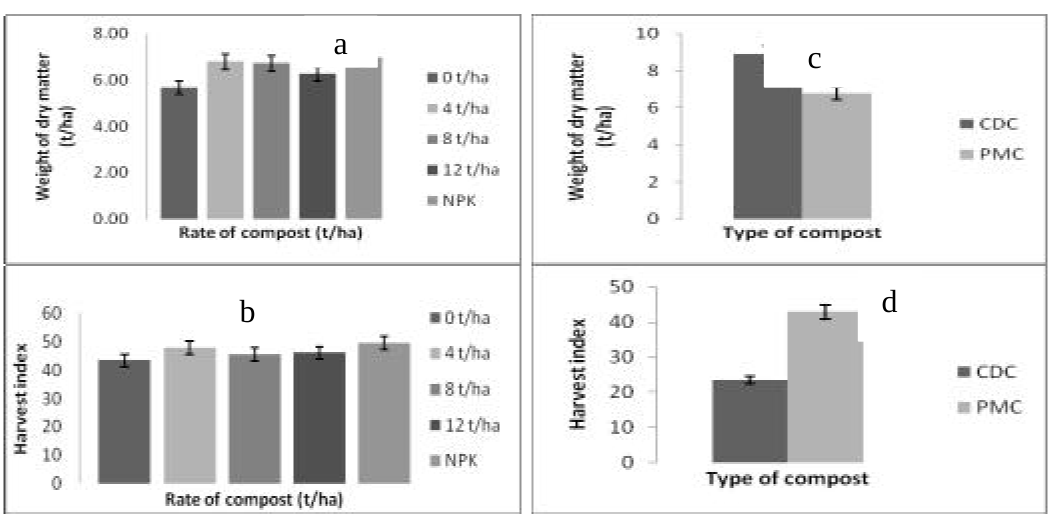


Fig. 3: Influence of compost on dry matter yield and harvest index of grain amaranths. CDC=Cattle dung-Maize stover compost, PMC= Poultry manure-Maize stover compost

Table 2: Nutrient uptake of grain amaranths plants

| | COMPOST | N | P | K |
|---|---|---|---|---|
| COMPOST RATE (t/ha) | 0 | $1.02^{d}$ | $0.29^{c}$ | $1.09^{d}$ |
| | 4 | $1.22^{c}$ | $0.31^{c}$ | $1.15^{cd}$ |
| | 8 | $1.31^{b}$ | $0.32^{bc}$ | $1.22^{bc}$ |
| | 12 | $1.33^{b}$ | $0.36^{ab}$ | $1.26^{ab}$ |
| | NPK | $1.37^{a}$ | $0.39^{a}$ | $1.31^{a}$ |
| COMPOST TYPE | CDC | $1.22^{b}$ | $0.31^{b}$ | $1.19^{a}$ |
| | PMC | $1.28^{a}$ | $0.35^{a}$ | $1.22^{a}$ |
| COMPOST TYPE x RATE | * | * | ns | |

*Means with similar alphabets along the column within same treatment are not significantly different (P#0.05) using DMRT. PMC= Poultry manure + Maize stover Compost, CMC= Cattle dung + Maize stover Compost. * = Significant, ns = Not Significant*

Table 3: Influence of varying compost rates and types on the nutritional composition of leaves of grains amaranth.

| Compost (tha$^{-1}$) | Protein (%) | Fat (%) | Fibre (%) | ASH (%) | Dry Matter (%) | Moisture Content (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| 0 | $8.50^{d}$ | 1.15a | 1.55a | 5.00a | 88.50a | 9.50a | 70.69a |
| 4 | $8.95^{c}$ | 1.25a | 1.73a | 5.80a | 89.50a | 10.50a | 71.78a |
| 8 | $9.15^{bc}$ | 1.25a | 1.70a | 5.50a | 90.50a | 11.50a | 72.85a |
| 12 | $9.20^{b}$ | 1.25a | 1.70a | 6.00a | 89.00a | 11.00a | 72.20a |
| NPK | $9.55^{a}$ | 1.35a | 1.77a | 6.15a | 89.50a | 10.50a | 71.00a |
| CDC | $8.70^{b}$ | 1.26a | 1.83a | 5.90a | 8.40a | 10.60a | 71.71a |
| PMC | $9.40^{a}$ | 1.24a | 1.55b | 5.50a | 89.40a | 10.60a | 71.69a |
| Compost type x Rate | * | ns | * | ns | ns | ns | ns |

*Means with similar alphabets along the column within same treatment are not significantly different (P#0.05) using DMRT. PMC= Poultry manure + Maize stover Compost, CMC= Cattle dung + Maize stover Compost. * = Significant, ns = Not Significant*

Table 4: Influence of varying compost rates and types on the nutritional composition of grains amaranth stem

| Compost (tha$^{-1}$) | Crude Protein (%) | Ether Extract (%) | Crude Fibre (%) | ASH (%) | Dry Matter (%) | Moisture Content (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| 0 | 3.60a | 0.60a | 1.10a | 4.00a | 43.10a | 6.90a | 33.80a |
| 4 | 7.60a | 0.95a | 2.60a | 9.50a | 86.30a | *13.70a* | *65.65a* |
| 8 | 7.70a | *1.05a* | 3.00a | 8.75a | *86.45a* | 13.55a | *65.95a* |
| 12 | *7.90a* | 0.99a | 3.20a | *9.40a* | 86.40a | 13.60a | 64.91a |
| NPK | 8.05a | 1.10a | 3.30a | 8.50a | 86.95a | 13.05a | 66.00a |
| CDC | 7.56a | 1.04a | 2.68a | 8.66a | 86.18a | 13.82a | 66.24a |
| PMC | 6.38a | 0.84a | 2.60a | 7.40a | 69.50a | 10.50a | 52.28a |
| Compost type x Rate | ns | ns | ns | ns | ns | ns | ns |

*Means with similar alphabets along the column within same treatment are not significantly different (P#0.05) using DMRT. PMC= Poultry manure + Maize stover Compost, CMC= Cattle dung + Maize stover Compost. * = Significant, ns = Not Significant*

Table 5: Influence of varying compost rates and types on the nutritional composition of grain amaranth grains

| Compost (tha$^{-1}$) | Crude Protein (%) | Ether Extract (%) | Crude Fibre (%) | ASH (%) | Dry Matter (%) | Moisture Content (%) | Carbohydrate (%) |
|---|---|---|---|---|---|---|---|
| 0 | $5.25^{a}$ | $0.80^{a}$ | $0.65^{a}$ | $2.75^{a}$ | $46.00^{a}$ | $4.00^{a}$ | $36.55^{a}$ |
| 4 | $10.10^{a}$ | $1.74^{a}$ | $1.60^{a}$ | $4.80^{a}$ | $91.65^{a}$ | $8.35^{a}$ | $73.14^{a}$ |
| 8 | $9.75^{a}$ | $1.55^{a}$ | $1.65^{a}$ | $4.55^{a}$ | $91.05^{a}$ | $8.95^{a}$ | $73.55^{a}$ |
| 12 | $10.50^{a}$ | $1.75^{a}$ | $1.55^{a}$ | $4.80^{a}$ | $91.10^{a}$ | $8.90^{a}$ | $72.50^{a}$ |
| NPK | $10.60^{a}$ | $1.88^{a}$ | $1.63^{a}$ | $5.00^{a}$ | $91.70^{a}$ | $8.30^{a}$ | $72.60^{a}$ |
| CDC | $7.96^{a}$ | $1.51^{a}$ | $1.35^{a}$ | $3.70^{a}$ | $72.20^{a}$ | $7.80^{a}$ | $57.68^{a}$ |
| PMC | $10.52^{a}$ | $1.58^{a}$ | $1.48^{a}$ | $5.06^{a}$ | $92.40^{a}$ | $7.60^{a}$ | $73.65^{a}$ |
| Compost type x Rate | ns | ns | ns | ns | ns | ns | ns |

*Means with similar alphabets along the column within same treatment are not significantly different (P#0.05) using DMRT. PMC= Poultry manure + Maize stover Compost, CMC= Cattle dung + Maize stover Compost. * = Significant, ns = Not Significant* the three levels of compost applied but the least uptake was observed in unfertilized plots. While the highest P and K uptake was observed in plots that received recommended rates of mineral fertilizer but not significantly different from any of the applied compost rates.

Application of PMC significantly enhanced N and P uptake in grain amaranths. Amaranths significantly uptake highest nutrient in plots where PMC was applied. This is possibly because the nutrients contained in the material were easily released for crop utilization.

**Nutritional Composition:** Application of compost had influence on nutritional composition of shoots and grain of *amaranths*. Results revealed that nutritional composition of amaranths was directly proportional to the rate of compost applied. More nutrients were partitioned into grain that any other parts of the crop. This is in consonance with the reports of Betschart *et al.* [4], Kauffman and Weber [6], O' Brien and Price [8] and Cole [29] but contrary to the results of Olaniyi *et al.* [1]. Accumulation of protein in leaves of grain amaranth was significantly the highest (9.55%) in plants that received inorganic fertilizer (Table 2). Similarly, among the various compost rate, application of 12 t ha$G^1$ compost enhanced the highest protein and ash accumulation in leaves of *A. hypochondriacaus* while, highest dry matter (90.50%), moisture content (11.50%) and carbohydrate (72.85%) was accumulated in leaves harvested vegetable from plots where 8 t ha$G^1$ was applied and this was comparable to the effect of NPK fertilizer (Table 3). Application of compost had no significant influence on nutritional composition in stem of grain amaranth. Nutritional composition in the parts of the crop showed that accumulation of protein, fat and carbohydrate was the highest in grain, and the least in stem. However, fibre content in the stem was the highest and the least in the grain. Similarly, types of compost had no significant influence on the stem of grain amaranth however, better results was observed in stem of amaranth where cattle dung compost was applied (Table 4).

Whereas, no significant difference was observed in nutritional composition of the stem and grains obtained from this vegetable nonetheless, application of compost enhance nutritional composition of grains harvested. PMC tends to enhance accumulation of the nutrients than better CMC (Table 5).

The study showed that compost had significant influence on growth, grain yield and nutritional composition of grain amaranths. This agrees with the findings of Walters *et al.* [30] and Webber *et al.* [31]. Application of 4 t ha$G^1$ of compost enhanced optimum performance of grain amaranths on oxic paleustalf in derived savannah agro-ecology. Cattle dung compost displayed superior influence over poultry manure compost in improving growth, yield and nutritional performance of grain amaranths although, both compost could be used in split application. Related observation have been pointed out by Preetha *et al.* [32]. Application of compost derived from aerobic decomposition combination of either cattle dung or poultry manure and maize stover can be used as an alternative cheap and sustainable source of fertilizer for maintaining soil fertility and improving crop yield on continuous basis.

## REFERENCES

1. Olaniyi, J.O. K.A. Adelasoye and C.O. Jegede, 2008. Influence of nitrogen fertilizer on the growth, yield and quality of grain amaranth varieties. World J. Agric. Sci., 4(4): 506-513.
2. Endres, C., 1986. Influence of production practices on yield and morphology of *Amaranthus cruentus* and *Amaranthus hypochondriacus.* M.Sc Thesis, Univ. Arkansas, Fayetteville.
3. Singhal, R.S. and P.R. Kulkami, 1988. Review: amaranths-an underutilized resource. Int. J. Food Sci. Tech., 23: 125-139.
4. Betschart, A.A., D.W. Irving, A.D. Shepherd and R.M. Saunder, 1981. *Amaranthus cruentus*: milling characteristics, distribution of nutrients within seed components and the effects of temperature on nutritional quality, J. Food Sci., 46: 1181-1187.
5. Lyon, C.K. and R. Becker, 1987. Extraction and refining of oil from amaranth seed. J. American Oil Chemistry Sociol., 64: 233-236.
6. Kauffman, C.S. and L.E. Weber, 1990. Grain Amaranth. www.hort.purdue.edu/new crop/ proceedings., pp: 1-127.
7. Olayide, S.O., 1982. Food and nutrition crises in Nigeria. Ibadan University Press, pp: 123.
8. O' Brien, G.K. and M.L. Price, 1998. Amaranth: grain and vegetable types. *Echo Technical Note.* http://www.echotech.org/technical/technotes/amar anth.PDF.
9. Van der Vossen, H.A.M., O.A. Denton and I.M. El Tahir, 2004. *Citrullus lanatus* (Thunb.) Matsun and Nakai. In: Grubben, G.J.H. and Denton, O.A. (eds.) Plants resources of tropical Africa. 2. Vegetables. PROTA foundation Wageningen, The Netherland s, pp: 185-191.

10. Olaniyi, J.O., 2007. Evaluation of yield and quality performance of grain amaranth varieties in the Southwestern Nigeria. Res. J. Agron., 1(2): 42-45.
11. Olaleye, A.O., U.M. Ndubuaku and O.A. Dada, 2008. Comparative study of the performance of jute plant (*Corchorus olitorius*) on home garden soil, farmland and cocoa plantation soils as influenced by varying levels of N-fertilizer. J. Tropical Agric., Food, Environ. Extension, 7(1): 78-84
12. Odeleye, F.O., O.M.O. Odeleye, O.A. Dada and A.O. Olaleye, 2005. The response of okra (*Abelmoschus esculentus* (L.) Moench) to varying levels of poultry manure and plant population density under sole cropping. J. Food, Agric. Environ., 3(3 and 4): 68-74.
13. Akanbi, W.B., C.O. Adebooye, A.O. Togun, J.O. Ogunrinde and A.S. Adeyeye, 2007. Growth, herbage and seed yield quality of *Telferia occidentalis* as influenced by cassava peel compost and mineral fertilizer. World J. Agric. Sci., 3(4): 508-516.
14. Senesi, N., 1989. Composted materials as organic fertilizers. Sci. Environ., 81/82: 521-542.
15. Smith, S.J., J.E. Hall and P. Hadley, 1992. Composting sewage sludge in relation to their suitability for use as fertilizer materials for vegetable crop production. Acta Hort., 302: 203-245.
16. Adediran, J.A., N. De Baets, P.N.S. Mnkeni, L. Kiekens, N.Y.O. Muyiwa and A. Thys, 2003. Organic waste materials for soil fertility improvement in the border regions of the Eastern Cape, South Africa. Biol. Agric. Hortic., 20: 283-300.
17. Akanbi, W.B., A.O. Togun and J.A. Adediran, 2006. Growth and yield of maize (*Zea mays* L.) as influenced by compost and nitrogen fertilizer. J. food, Agric. Environ., vol. 4(2):
18. Agboola, A.A. and R.A. Sobulo, 1981. A review of soil fertility in southwestern zone, Nigeria. FDALR. Kaduna, Report, 6: 1-15.
19. Lara, A., 2006. Compost-What is it? *California Integrated Waste Management Board.* 1-3 Article (916) 341-6595. Retrieved Oct. 15, 2006 from http:// www.ciwmb.ca.gov/Organics/html.
20. IITA., 1982. Selected methods for plant and soil analysis. Manual series No. 7. International Institute of Tropical Agriculture. (IITA), Ibadan, Nigeria.
21. Bouyoucos, J., 1962. Hydrometer method improved for making particle size analysis. Agro. J., 54: 39-45.
22. Bremner, J.M. and D.R. Keeney, 1966. Determination of isotope ratio analysis of different forms of nitrogen in soils: 3: Exchangeable ammonium nitrate and nitrate by extraction methods. Soil Sci. Amer. Proc., 30: 577-582.
23. Bray, R.H. and L.T. Kurtz, 1945. Determination of total organic and available forms of phosphorus in soils. Soil Sci., 59: 39-45.
24. AOAC., 1990. Association of Official Analytical Chemists, 16th ed. Arlington, Va, USA: AOAC.
25. SAS Institute, 1996. Statistical Analysis System /STAT user’s guide. Version 8. 6th ed. SAS Inst. Cary. NC.
26. Bergman, W., 1992. Nutritional Disorders of plant. Gustav Fischer Verlag Jena. New York, pp: 386.
27. Myers, R.L., 1998. Nitrogen fertilizer effect on Grain. Agron. J., 90: 597-602.
28. Sumar, L., J. Pacheco, A.I.R. Concha, G. Castelo, R. Aedo, Y.C. Choquevilca and E. Valdeiglesias, 1992. Grain amaranth research in Peru. Food Rev. Int., 8: 87-124.
29. Cole, J.N., 1979. Amaranth: from the Past, for the Future. Rodale Press, Emmaus, PA
30. Walters, R.D., D.L. Coffey and C.E. Sams, 1988. Fiber, nitrate and protein content of *Amaranthus* accessions as effected by soil N application and harvest date. Hortscience, 23: 338-341.
31. Weber, L., E. Hubbard, D. Putnam, L. Nelson and J. Lehmann, 1988. Amaranth grain production guide. Rodale Press, Inc., Emmaus, PA and American Amaranth Institute, Bricelyn, MN.
32. Preetha, D., P.K. Sushama and K.C. Marykutty, 2005. Vermicompost+inorganic fertilizers promote yield and nutrient uptake of amaranth *(Amaranthus tricolor* L.). J. Tropical Agric., 43(1-2): 87-89.