THE EFFECT OF COMPOST MANURE AND NPK (20:10:10) ON PERFORMANCE GROWTH, YIELD AND NUTRIENT CONTENT OF *Amaranthus spp*. IN SOILS OF UMUDIKE, AN ULTISOL IN SOUTHEASTERN NIGERIA.

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ABSTRACT
Field and laboratory experiments were conducted to evaluate the effects of compost manure and NPK (20:10:10) fertilizer on the growth, yield and nutrient content of *Amaranthus cruentus* in an Ultisol in southeastern Nigeria. The treatments were: control (T1), 400kg/ha NPK (20:10:10) fertilizer (T2), 200 kg/ha NPK (20:10:10) fertilizer + 1 kg compost manure per bucket (10% compost) (T3), 200 kg/ha NPK (20:10:10) fertilizer + 2 kg compost manure per bucket (20% compost) (T4), compost manure 1kg per pot (10% compost) (T5) and compost manure 2kg per pot (20% compost). The treatments were laid out in a completely randomized design and replicated three times. The soil was strongly acidic, having a pH of 5.50 and low in total nitrogen (0.10%) organic carbon (1.10%), and the exchangeable bases. From the study, T3 gave the highest result on fresh *Amaranthus* yield, number of leaves and plant height. Stem girth increased steadily from the first week to the eighth week; 20% of compost gave the highest value of stem girth. T4 significantly ($p<0.05$) increased the nutrient content of *Amaranthus cruentus* than all other treatments. Treatments 3 and 4 were therefore recommended for profitable *Amaranthus cruentus* production in the study area.
Key words: Compost manure; NPK (20:10:10); *Amaranthus spp.*; ultisol soil; southeastern Nigeria.

INTRODUCTION

African leafy vegetables are increasingly recognized as possible contributors of both micronutrients and bioactive compounds to the diets of populations in Africa (Smith and Eyzaguirre, 2007). The continent is rich of vegetable species including *amaranth* which are among the most popular leafy vegetables in the continent (Maundu *et al*., 2009). *Amaranthusspp*. is an old cultivated crop originating from Latin America. *Amaranth* is a vegetable crop and belongs to the genus *Amaranthus.* It is broad-leafed non-grass plant that produces significant amounts of edible cereal-like grains. *Amaranth* (Family *Amaranthaceae*) is an underexploited plant with exceptional nutritive value (Downtown, 1973). *Amaranthus* is an important vegetable in human diet as a source of nutrients such as vitamin, minerals, sugar, protein and fiber needed for healthy body growth and sustenance (Bailey, 1992). The young leaves and stems are boiled as greens (NRC, 1984). It is grown as soup vegetable or for boiled salad greens (Adeyemi *etal*., 1988). The values of *Amaranthus* per 100% edible portion (leaves) are: water 85ml, calorie 48, protein 5g, fat 0.7g, carbohydrates 5g, fibre 1.5g, calcium 250mg, iron 4mg, B-carotene equivalent 1800mg, thiamine 0.1mg, riboflavin 0.3mg, niacin 1.5m and ascorbic acid 100mg (Ayalew, 2013).

Chemical fertilizer and compost were used to provide soil nutrients in order to maintain optimum soil fertility conditions and healthy growth of plants and quality yield. Chemical fertilizers help the growing crops to withstand stress conditions and in some cases these were used to correct plant nutrient deficiency.

FAO (1987) also attested that compost is used as an organic fertilizer that can be added to the soil. Fertilizing with compost means, apart from fertilizing the plants, also making use of the good properties of organic material as mentioned above. Compost manure is also known as natural fertilizer. Natural fertilizer comes from animal wastes and plants; for example, cow dung, sheep, goat or chicken droppings, urine, decomposed weeds and other plant or animal remains, e.g. waste from preparing food (Geshuny and Martin, 1992).

According to Leonard (1986), maximum net returns in crop production can adequately be sustained with adequate fertilizer program that will supply the amounts of plants nutrients needed. Djokoto and Stephen (1961) argued that Nitrogen is the most important element in the nutrition of compositing micro flora since it is required for the simulation of carbon substrate in organic waste. The next element after N that limits the crop production in the tropical regions and indeed most regions of the world is phosphorus (Holford, 1997). According to HUE, (1995) inadequate P supply will result in a decreased synthesis of RNA, the protein maker, leading to growth. Potassium is required in least amount but in soil it is required in large amount by many crops and it is important for maintaining the osmotic potential and rigidity of plant cells; hence it plays a vital role in water relations in the plant. Marschner (1995) observed that K is involved in water uptake from the soil, water retention in the plant tissue and long distance transport of water uptake in the xylem and photosynthesis in the phloem. With adequate K, cell walls are thicker, thereby improving plant resistance to lodging, pests and diseases (Bergmann, 1992).

It was based on the few highlighted qualities that these three elements are formulated into NPK fertilizer with different grade ratios. However, Nweke and Nsoanya (2015) attested that nutrient use

efficiency are been increased through the combination of organic manure and mineral fertilizer. It was against this backdrop that this work was conceptualized to evaluate the effect of compost manure and mineral fertilizer (20:10:10) on dry matter yield and nutrient content of *Amaranthus spp*.

OBJECTIVES OF THE STUDY

i. To compare the effects of compost manure and NPK (20:10:10) fertilizer on the vegetative growth and yield of *Amaranthusspp*.
ii. To compare the effects of compost manure and NPK (20:10:10) fertilizer on nutrient content of *Amaranthusspp*.

MATERIALS AND METHODS

DESCRIPTION OF THE EXPERIMENTAL SITE

Location of the study

The experiment was conducted at Michael Okpara University of Agriculture, Umudike which Umudike lies on within latitude 05°29'N and longitude 07°33'E at an elevation of 112m above the sea level. The area falls within the tropical rainforest zone, annual rainfall average is 2177mm and the monthly temperature ranges between 20°C and 36°C. Relative humidity ranges from 50-95% (National Root Crops Research Institute, Umudike, 2001).

SOIL SAMPLE COLLECTION AND PREPARATION

Representative soil sample was collected from the Eastern farm of the Michael Okpara University of Agriculture, Umudike. The samples were air dried and sieved through a 2mm mesh to remove roots and stones.

Physical and Chemical Properties of the Soil

General physical and chemical analysis of the soil was carried out using standard methods as follows:

Particle size Analysis

The particle size analysis was carried out using Bouyoucos hydrometer method (Jackson, 1964).

Soil reaction (pH)

Soil pH was determined using glass electrode pH meter in a soil to water ratio of 1:2.5 (Thomas, 1996).

Exchangeable Acidity

Soil exchangeable acidity was determined by the EDTA titration method (McLean, 1982).

Organic Carbon

Soil organic carbon was determined by Walkley and Black (1934) method.

Total Nitrogen

Soil total nitrogen was determined using the micro digestion and distillation method (Bremner, 2000).

Available Phosphorus

Available phosphorus was determined using Bray and Kurtz (1945) number two extractant.

The exchangeable Bases

The soil was leached with 1N NH_4OAc (Ammonium Acetate) at pH 7. Calcium and magnesium were determined using EDTA titration method while potassium and sodium were determined by flame photometry.

Effective Cation Exchange Capacity

Effective cation exchange capacity was calculated as the sum of exchangeable bases and exchangeable acidity.

Base Saturation

The percentage base saturation was calculated using the equation

$$\text{Base saturation} = \frac{\text{total exchangeable bases}}{\text{ECEC}} \times \frac{100}{1}$$

Treatments

The treatments used in the experiment are

T_1 (Control): No fertilizer/Manure.
T_2: 400kg/ha NPK (20:10:10) fertilizer
T_3: 200kg/ha NPK (20:10:10) fertilizer + 10% compost
T_4: 200kg/ha NPK (20:10:10) fertilizer + 20% compost
T_5: Compost manure 1kg/pot (10% compost)
T_6: Compost manure 2kg/pot (20% compost)

COMPOSTING OF ORGANIC MATERIAL

Poultry, pig and goat droppings were obtained from livestock farm of Michael Okpara University of Agriculture Umudike. The organic materials were mixed in the ratio of 1:1:1, the mixed organic materials was composted under shade for a period of three months, during which adequate moisture and aeration was ensured by the addition of water and turning with a stick at regular intervals. At the end of the composting period, the composted organic material (manure) was used for soil amendment.

GREENHOUSE EXPERIMENT

10kg of the soil sample was weighed into perforated 12 litre capacity plastic buckets and treatments were applied in three replicates. The buckets arranged in a completely randomized design (CRD) and the seeds of the *Amaranthuscruentus* were sown. The *Amaranthuscruentus* plant was grown in the green house for eight weeks. During the greenhouse experiment, the following growth parameters of the *Amaranthuscruentus* was measured plant height (cm), stem girth (cm), number of leaves area (cm) every week for eight weeks in the greenhouse. At 8 weeks after planting, the Amaranthus plant was harvested for analysis.

NUTRIENT CONTENT OF *Amaranthuscrutentus*

The dry shoot of *Amaranthuscruentus* was grinded and milled to pass through 1mm sieve. The grinded samples were subjected to Kjeldahl digestion at 360°C for 4 hours with concentrated H_2SO_4. Total Nitrogen was determined from the digest by steam distillation with excess NaOH. Phosphorus and potassium contents were determined by ashing 0.2g

plant sample in a muffle furnace at 600°C for 2 hours. The ash was cooled and dissolved in 1N HCl and from the solution, phosphorus was determined by the vanadomolybdate yellow calorimeter method using spectrophotometer. Potassium was determined using flame photometer.

STATISTICAL ANALYSIS

Data generated from green experiment and laboratory analysis were subjected to Analysis of Variance (ANOVA) and the treatment means were separated using Fischer's Least Significance Difference (FLSD) at 5% probability level.

RESULTS AND DISCUSSION

Physical and chemical properties of the soil used for the experiment

Table 1 shows the physical and chemical properties of the soil used for the experiment .The soil was sandy loam and low in pH (5.5 and 4.6 in water and salt respectively). This is an indication of strong acidity (Chude *et al*., 2004) for south east agroecological zone.

The nitrogen content was low (0.10%) according to Enwezor *et al*. (1990). The organic carbon value (1.10%) was also low . The exchangeable acidity value of 1.38 was expected because of the acidity nature of the soil due to heavy rains associated with the South east.

Available phosphorus value was moderate (20.00 mg/kg), the exchangeable bases (calcium, sodium, magnesuim and potassium) had the following values respectively: 3.80, 0.21, 2.20 and 0.24). The values were low; the ultisols of south eastern Nigeria were reportedly low in exchangeable bases (Nwite *et al*., 2009).

Table 1: Physical and chemical properties of the soil for the experiment

Parameter	Values
Soil pH (water)	5.50
Soil pH (salt)	4.60
Total Nitrogen (%)	0.10
Organic carbon (%)	1.10
Available Phosphorus (mg/kg)	20.0
Exchangeable Potassium (cmol/kg)	0.24
Exchangeable Sodium (cmol/kg)	0.21
Exchangeable Calcium (cmol/kg)	3.80
Exchangeable Magnesium (cmol/kg)	2.20
Exchangeable acidity (cmol/kg)	1.38
ECEC (cmol/kg)	7.83
Base saturation (%)	82.38
Sand (g/kg)	798.00
Silt (g/kg)	74.00
Clay (g/kg)	128.00
Textual class	Sandy Loam

Chemical properties of the compost used for the experiment.

Table 2 presents the properties of the compost used for the experiment. The pH was close to neutral (6.8), the organic matter content was high (13.81%), the calcium content, magnesium, potassium and sodium content were also high 0.78, 0.60, 2.40 and 0.55. This indicates a high potential for the compost to improve the soil chemical properties.

Table 2: Chemical properties of the compost used for the experiment

Parameters	Values
PH(water)	6.8
Total nitrogen (%)	1.23
Phosphorous (mg/kg)	0.88
Organic carbon(%)	13.81
Calcium(%)	0.78
Potassium(%)	2.40
Magnessium(%)	0.60
Sodium(%)	0.55

Effect of compost and NPK (20:10:10:10) on plant height of *Amaranthus spp*.

The effect of compost manure and NPK (20:10:10) fertilizer on plant height of *Amaranthus spp* is as shown in Table 3. The plant height increased steadily from week 1 to week 8 for all the treatments. However there were no significant (P>0.05) differences among the treatments from week 1 to week 4 except at weeks 6, 7 and 8 where we had significant differences; T3 (200kg /ha NPK (20:10:10) fertilizer + 10% compost) gave the highest significant value at week 6 (54.8 cm), week 7 (67.0 cm) and week 8 (77.5 cm). This could be as a result of the combination of compost which is an organic manure and NPK which is an mineral fertilizer, (Nweke and Nsoanya, 2015). Complementary use of organic and inorganic fertilizers has proved a sound soil fertility restorative strategy in many countries of the world (Unagwu *et al*., 2012).

Table 3: Effect of compost manure and NPK (20:10:10) on plant height of *Amarathus spp.*

Treatment	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
T_1	5.00	6.10	7.70	10.20	12.70	16.40	20.70	23.80
T_2	18.80	25.90	12.00	16.50	22.60	29.00	37.70	43.80
T_3	8.80	14.20	20.80	28.70	41.00	54.80	67.00	77.50
T_4	7.10	10.70	16.20	22.30	30.30	47.50	57.00	65.0
T_5	9.40	11.80	16.80	22.60	31.70	39.70	47.50	56.70
T_6	9.80	14.70	21.30	27.50	25.60	50.20	59.50	70.50
LSD	NS	NS	NS	NS	NS	24.41	26.48	30.04

WAP = Weeks after Planting

Effect of compost manure and NPK (20:10:10) on the stem girth of *Amarathus spp*

The effect of compost manure and NPK (20:10:10) on the stem girth of *Amarathus spp* is as shown on Table 4. Stem girth increased steadily from the first week to the eighth week after planting. T3, T6 and T4 (combination of NPK fertilizer with compost and 20% compost) gave the highest stem girth all through the experiment. Compost has been reported to increase soil fertility and cation exchange capacity, Ayalew (2013). It also increases the ability of the soil to hold and release essential nutrients.

Table 4: Effect of compost manure and NPK (20:10:10) on stem girth of *Amaranthus spp*.

Treatment	1 WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
T1	0.73	1.73	1.200	1.40	1.53	1.63	1.87	2.98
T2	0.63	1.10	1.500	1.77	2.00	2.57	2.77	5.09
T3	1.13	1.60	2.000	2.57	3.43	4.30	4.70	6.30
T4	0.87	1.33	1.733	2.33	2.83	3.37	4.03	11.45
T5	1.13	1.60	1.900	2.30	2.70	3.13	3.50	5.51
T6	1.17	1.70	2.133	2.63	2.97	3.57	4.13	8.02
LSD	0.26	NS	NS	NS	NS	1.44	1.27	0.95

WAP = Weeks after Planting

Effect of compost manure and NPK (20:10:10) on number of leaves of *Amarathus spp.* in greenhouse experiment

Table5 shows the effect of compost manure and NPK (20:10:10) on the number of leaves of *Amaranthus spp.* in the greenhouse experiment. T3 (200kg/ha NPK (20:10:10) fertilizer + 10% compost) gave the highest number of leaves. It could be as a result of the complementary effect of compost and NPK (20:10:10) fertilizer.

Table 5: Effect of compost manure and NPK (20:10:10) on the number of leaves of *Amarathus spp.* in the greenhouse

Treatment	1WAP	2WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
T_1	7.67	5.97	9.33	11.3	13.7	15.7	18.0	19.7
T_2	8.67	10.33	13.67	17.7	21.7	25.7	39.3	38.6
T_3	12.00	14.33	17.33	33.7	55.0	77.3	97.0	114.0
T_4	10.00	13.33	15.67	19.7	39.0	49.7	71.3	82.0
T_5	11.33	11.67	14.67	24.0	21.5	50.7	60.7	73.3
T_6	12.00	15.00	17.00	25.7	39.5	56.7	73.7	57.8
$LSD_{(0.05)}$	3.00	5.43	NS	NS	22.25	31.00	35.22	57.12

WAP = Weeks after Planting

Effect of compost manure and NPK (20:10:10) fertilizer on the nutrient content of *Amaranthus spp.*

Table 6 shows the nutrient content of *Amaranthus* at 8 weeks after planting in the green house. Nitrogen content was highest when T_4 (200kg/ha NPK fertilizer + 20% compost) was used. The value was significantly ($P< 0.05$) higher than all other treatments. This could be attributed to the high organic matter gotten from the compost (Table 5.2) and the nitrogen from the NPK (20:10:10) fertilizer. Phosphorus content was also highest in the vegetable treated with T_4 (200kg/ha NPK fertilizer + 20% compost). The same result was obtained for the potassium content of *Amaranthus spp.*

Table 6: The Effect of compost manure and NPK (20:10:10) fertilizer on the nutrient Content of *Amaranthus spp.*

Treatment	% N	% P	% K
T_1	1.43	0.99	2.98
T_2	2.63	2.83	5.09
T_3	2.74	3.18	6.30
T_4	3.44	7.98	11.45
T_5	2.23	2.91	5.51
T_6	2.74	3.87	8.02
$LSD_{(0.05)}$	0.30	0.23	0.95

Effect of compost manure and NPK 20:10:10 fertilizer on fresh weight (g) of *Amaranthus spp.* at harvest.

At harvest, the fresh weight (g) of *Amaranthus spp.* was in this order: T3>T4>T6>T5>T2>T1 (Table 7); there were significant differences ($P<0.05$) amount the treatment means. T3 gave the highest fresh weigh at harvest. This could be because of the effect of the combination of organic and mineral nutrient in the treatments, T3 which has been advocated to help in the integration of organic and synthethic sources of nutrient given rise to some positive interaction as well as supply of essential nutrients thereby increasing the efficiency of the two (Satyannarayana *et al.*, 2012).

Table 7: Effect of compost manure and NPK (20:10:10) fertilizer on fresh weight (g) of *Amaranthus spp.* at harvest

Treatment	Weight (g)
T_1	9.1
T_2	48.5
T_3	161.0
T_4	131.8
T_5	124.2
T_6	127.9
$LSD_{(0.05)}$	43.16

CONCLUSION

The result of this study showed that the soil of southeastern agro- ecological zone of Nigeria is acidic, which resulted to low organic carbon, low exchangeable bases such as calcium, sodium, magnesium and potassium. The incorporation of compost manure an organic fertilizer and NPK (20:10:10) which is a mineral fertilizer enhanced the growth and yield of *Amaranthus spp.* T3 (200kg/ha NPK (20:10:10) fertilizer + 10% compost) gave the highest yield of *Amaranthus* at harvest, while T4 (200kg/ha NPK (20:10:10) fertilizer + 20% compost)

gave highest nitrogen, phosphorus and potassium contents of *Amaranthus*. Combination of compost manure and NPK (20:10:10) is therefore recommended.

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