



Effect of Vermicompost and Mineral Fertilizer on Growth of *Amaranthus Cruentus*

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ABSTRACT

A pot experiment was conducted at the Teaching and Research farms of the Department of Vocational and Technical Education located within Ahmadu Bello University farms in 2016 and 2017 growing seasons. Degraded surface soils (0-20cm) from the research farm were used to study the effect of Vermicompost on the physical and chemical properties of the soil and growth of green Amaranth. Four treatments (0, 5, 7 and 10T/ha) of vermicompost were replicated 3 times in a complete randomized design. Data were collected on growth parameters: number of leaves, fresh weight, and dry matter weight and plant height. Collected data were analyzed using ANOVA. The results indicated that the growth parameters of Amaranth were significantly influenced by rate of applied vermicompost to the soil. The performance of soil amended with vermicompost was significantly higher compared with control. Also, nutrient content (available P, Ca, Mg, total N, CEC, and base saturation) of soil amended with vermicompost was significantly higher and increased with increase in rate of applied vermicompost. The overall results suggest that there is a great potential in amending agricultural soil with vermicompost for economic recovery and national development in the study area.

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INTRODUCTION

Operation feed the nation (OFN) and other agricultural programmes promoted the increase use of chemical fertilizers and pesticides to increase crop yield, in due cause, such tropical soils turned unproductive due to the indiscriminate use of chemical fertilizers and lack of proper amendments of organic matter. One of the best way to reverse this environmental degrading is to make proper use of the available unutilized organic biodegradable wastes converting them into vermicompost.

Vermicomposting is the process of transformation of recent organic matter into stabilized organic matter through the action of earthworms (Nogales et al., 2005). Vermicomposting (worm composting) is defined as a process in which earthworms play a major role with microbes in the conversion of organic solid waste into more stabilized dark, earth-smelling soil conditioner and nutrients such in macro and micronutrients (Abdul-Soud et al, 2015). According to Khan and Ishaq (2011) Vermicomposting is a biotechnological process of composting in which certain



species of earthworms are used to enhance waste conversion by process of fragmentation of organic wastes by earthworms and produce a better product called vermicompost. The vermicompost which are produced have a fine structure and contain nutrients in forms that are readily available for plant uptake (Atiyeh et al., 2000). Thus vegetable wastes and non-edible portions that are usually discarded during harvesting, marketing and processing can be used as very good composting materials.

Tropical lands including savanna lands are low in soil organic carbon (SOC). The low SOC is attributed to reduced natural vegetation and lack of below and above the ground crop growth (Ayorinde, 2013). These coupled with relatively high temperatures all year round promote rapid turnover rates of organic materials. Thus, the degraded and depleted tropical soils are low in soil quality causing poor crop yield (Binyam, 2014). Soil restorative farm practices are therefore needed to mitigate soil degradation trends.

Amaranthus is one of the most important annual leaf vegetables in the tropics. *Amaranthus Cruentus* has a short growing period of 4-6 weeks. The short growing period serves as an encouragement to farmers, especially urban dwellers. *Amaranthus cruentus* requires a soil with high organic matter. Although, *Amaranth* crop responds to organic manure, studies on effect of vermicompost on performance of *Amaranthus Cruentus* are rare. The objective of this study was to evaluate the efficacy of vermicompost with and without inorganic fertilizer on growth and yield of *Amaranth*s.

MATERIALS AND METHODS

The study was conducted within the Teaching and Research farms of Vocational and Technical Education located within Ahmadu Bello University farms in 2016 and

2017 growing seasons. The experiment site is located within Latitude 11° and 7° and Longitude 8° 5'.

Materials for vermicompost include poultry manures, vegetable chippings, fruit wastes and other food residues collected from the local market located in Samaru. The materials were chopped into small pieces 1-2cm and thoroughly mixed. The mixed organic materials were allowed to partly decompose for 14 days and then earthworms were introduced. The vermicompost was incubated for sixty days.

Plastic pots (2.5l) was filled with surface soil (0-20cm) obtained from the experimental site. Based on the area, each pot was amended with the appropriate rate of vermicompost. The pot experiment consists of five treatments namely: control (no application of vermicompost), 3, 5, 7 and 10 T/ha vermicompost. Each treatment was replicated three times. The experimental layout was complete randomized design. The vermicompost was broadcasted and worked lightly into the surface of the soil using a small trowel. Each pot was watered to field capacity and allowed to further incubate for five days.

Experimental Design

The experiment was laid out in a completely randomized design (CRD) with four replications. Vermicompost and mineral fertilizer (NPK15-15-15) were used as amendments for the experiment. The optimum N requirement (67.5kg N ha⁻¹) for *Amaranthus Cruentus* (Makinde, 2007) was used to amend the vermicompost ratio of 3:1 (vermicompost:NPK), 1:1 and 1:3. The test crop was *Amaranthus Cruentus* early maturing type (ED82/1019).

Plastic pots were filled with surface soil (0-20cm), labeled and the seeds of *Amaranthus Cruentus* were sown. Three planting holes were drilled and two seed per hole were sown in each pot. Two weeks after



sowing *Amaranthus Cruentus* seedlings were thinned to one plant per hole to give a total of three plants per pot. Growth parameters were taken 3rd, 4th and 5th week. The experiment was terminated at 5th week after sowing by harvesting. *Amaranthus Cruentus* was harvested by uprooting. A second planting was done without further addition of amendments to obtain data on residual effects of the amendments on growth of Amaranth.

Soil Analysis

Chemical analysis of the experimental soil was carried out before land preparation and after harvesting. The soil samples were air dried, crushed and passed through 2mm sieve. The sieved soil samples were analyzed for N, P and exchangeable bases. Total N was determined using dichromate oxidation. Available P was determined by the Bray 1 method. Exchangeable K, Ca, and Mg were determined by extraction with 1m ammonium acetate at pH7. Potassium was determined by flame photometer, while Ca and Mg were determined by atomic absorption spectroscopy (AAS).

Data Analysis

Data were collected on growth parameters: plant heights, number of leaves,

stem girth and leaf area. Collection of data on residual effects followed the same procedure as first data. The data obtained were analyzed using analysis of variance (Anova). Significant means ($p < 0.05$) were separated using Fischer least significance difference (LSD).

RESULTS AND DISCUSSION

Pre Cropping Soil Analysis

Pre cropping soil analysis (Table 1) showed that the soil is strongly acidic pH 5.2 and low in organic carbon. Acidic pH in soil is indicative of low content of calcium (Ca) and magnesium (Mg). Such soil is less suitable for growth of amaranth for which pH 5.5-7.5 is recommended (Oworu et al., 2010). The values of total nitrogen, available phosphorus, and potassium of the experimental soil were below the critical values of the soils of Savanna (Aduloju, 2004), this may be due to low soil organic matter. The low soil contents for the major nutrients signify need for crop improvement. The high C: N in pre cropping soil is an indication that the nitrogen is tied up causing N deficiency in the soil (Olaniyi and Ojetayo, 2012). The soil therefore requires addition of fertilizers for optimum crop production.

Table 1: Selected Physico-chemical properties of the soil and Vermicompost

Parameters	Pre-cropping	Post-cropping	Vermicompost
pH (water)	5.7	6.8	8.4
Organic Carbon (%)	1.4	2.7	30.4
N(%)	0.02	0.6	1.77
P (mg/kg)	34	46	1186
Ca(cmol/kg)	0.06	0.12	340
Mg(cmol/kg)	16	37	304
K(cmol/kg)	13	105	650

Growth Parameters

In comparison with the control addition of amendments vermicompost,

NPK alone or the combination of the two in any ratio resulted in increased growth parameters of amaranth as evident in Table



2. Generally plant height of amaranth was higher in crops treated with amendments than amaranth from control (no amendments). For example, plant height in control pots was only 9.64cm and 13.77cm at 3 and 5 WAS respectively. Addition of vermicompost alone (100%VC) resulted in

plant height of 11.32cm and 23.77cm respectively an increase of over 100%. In the same manner, addition of NPK alone ((100%NPK)) produced plant height ranging from 10.73cm at 3rd week after sowing (WAS) to over 25cm at 5WAS.

Table 2. Growth Parameters of Amaranth as influenced by Vermicompost.

Treatment	2WAT	4WAT	6WAT
	Plant Height (cm)		
Control	9.64	11.73	13.77
100%VC	11.32	16.88	23.77
100%NPK	10.73	15.76	25.08
75%VC+25%NPK	11.41	17.14	28.33
50%VC+50%NPK	14.31	19.22	31.76
25%VC+75%NPK	13.77	15.33	22.34
LSD	1.77	1.49	2.03
	Stem Girth (cm)		
Control	0.12	0.14	0.15
100%VC	0.21	0.23	0.24
100%NPK	0.14	0.17	0.19
75%VC+25%NPK	0.22	0.25	0.25
50%VC+50%NPK	0.23	0.25	0.27
25%VC+75%NPK	0.05	0.03	0.03
LSD	0.02	0.02	0.03

Table 3: Growth Parameters of Amaranth as influenced by Vermicompost.

Treatment	2WAT	4WAT	6WAT
	Leaf Area (cm²)		
Control	58.64	107.68	113.42
100%VC	84.76	142.88	208.44
100%NPK	77.36	178.22	212.33
75%VC+25%NPK	80.62	169.13	219.66
50%VC+50%NPK	88.14	184.44	228.32
25%VC+75%NPK	74.33	122.84	187.44
LSD	3.44	4.77	4.95
	Number of leaves		
Control	8.22	8.00	13.14
100%VC	9.77	11.00	10.78
100%NPK	10.2	10.00	13.00
75%VC+25%NPK	10.7	12.22	13.72
50%VC+50%NPK	12.0	14.40	14.01
25%VC+75%NPK	9.3	11.00	10.2
LSD	1.61	2.18	2.9



Similarly, addition of combination of VC+NPK also resulted in growth parameters significantly higher than found in control. The highest growth of plant height (31.76cm) is found in the combination of VC and NPK at ratio 1.1 (50%VC+50%NPK). The better performance of combined application of VC and NPK is probably due to quick release of nutrient for immediate plant uptake by NPK and quick mineralization of vermicompost. Ayeni et al (1008) observed similar result when poultry manure is mortified with NPK fertilizers. Growth components such as stem growth, leaf area and number of leaves of *Amaranthus Cruentus* were higher when vermicompost was combined with NPK 10:10:10 at equal ratio (tables 2, 3 & 4) than at any other ratio. The better performance of 50%VC+50%NPK than other combinations 75%VC+25%NPK is probably as a result of higher content of NPK fertilizers which resulted in quicker release of N and P. The dip in plant height and leaf area of *Amaranthus Cruentus* at higher rate of NPK (25%Vermicompost/75%NPK) suggests the fact that concentration of nutrients at this level tends to become toxic to the crop. The control plants produced the

shortest plant height and other growth parameters as they had to rely on the native soil fertility which from the result of chemical analysis was deficient in nutrients. Thus, the increase in number of leaves under amended and unamended (control) pots reconfirmed the role of organic materials like vermicompost either alone or in combination with fertilizers in promoting vegetative growth in leafy vegetables (Tijani-Eniola, 2000).

Residual Effects of Vermicompost

The effects of vermicompost and NPK amendments on the performance *Amaranthus Cruentus* on growth and yield components at second and third cropping (residual effects) showed that vermicompost materials were better than NPK and control (Tables 4 and 5). The significant growth difference of 50%VC+50%NPK over 100% NPK is indicative of slow nutrient release of organic material compared with inorganic (NPK) fertilizer. This is in consonance with the report of Adebayo and Akanni (2002) that an organic material from domestic wastes sustains the growth of *Amaranthus Cruentus*.

Table 4: Residual Effect of Vermicompost on Growth of *Amaranthus*.

Treatment	2 WAP	4 WAP	6WAP
Plant Height (cm²)			
Control	7.8	8.7	10.4
100%VC	12.3	15.7	26.3
100%NPK	10.4	12.7	22.3
75%VC + 25%NPK	13.6	17.5	25.6
50%VC + 50NPK	13.2	15.7	28.9
25%VC + 75%NPK	10.8	13.2	17.4
LSD	1.7	2.1	2.4
Stem Girth (cm²)			
Control	0.1	0.12	0.11
100%VC	0.22	0.22	0.21
100%NPK	0.11	0.13	0.13
75%VC + 25%NPK	0.15	0.13	0.14
50%VC + 50NPK	0.16	0.11	0.17
25%VC + 75%NPK	0.11	0.17	0.16

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Table 5: Residual Effect of Vermicompost on Growth of Amaranth.

Treatment	2 WAP Leaf Area (cm ²)	4 WAP	6WAP
Control	46.7	44.9	48.2
100%VC	87.6	138.8	220.6
100%NPK	67.4	108.8	116.5
75%VC + 25%NPK	66.6	102.7	119.2
50%VC + 50NPK	72.6	98.4	122.6
25%VC + 75%NPK	65.4	86.4	166.6
LSD	12.6	11.2	12.1

	Number of Leaves		
Control	6.44	6.22	9.66
100%VC	11.68	13.46	14.44
100%NPK	10.22	9.45	9.66
75%VC + 25%NPK	9.66	9.02	9.44
50%VC + 50NPK	9.22	8.68	8.80
25%VC + 75%NPK	7.84	9.12	10.04

CONCLUSION

The growth parameters (plant height, leaf area, stem growth) of *Amaranthus Cruentus* were significantly increased with application of vermicompost and NPK when applied individually or collectively. Joint application of 50%VC+50%NPK at ratio 1:1 gave best growth effect across the growth parameters in the first growing period thereby enhancing productivity of the crop. At second and third growing period 100% VC performed better thereby showing better residual effect. Managing the crop at this level of amendments could be strategic for increased productivity of *Amaranthus Cruentus*.

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