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Evaluating the Effect of Vermicompost and Humus Soil on Green Vegetable (*Amaranthus retroflexus*) Production.

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Abstract

The increasing waste generation rate, high collection cost and dwindling financial resources are the major problems faced by most developing countries for efficient solid waste management. In some cities, organic waste (market and household) are dumped indiscriminately or littered on the streets causing environmental deterioration. Biological processes such as composting and vermicomposting to convert vegetable (as valuable nutrient source) for agricultural use would be of great benefit. The first step was to provide habitat that housed the earthworms, making it seem like they are in their natural environment, minimise their escape and foster the process of vermicomposting. A worm bin was constructed with white wood, aired and netted with mosquito net to minimise worm escape. Bedding materials was introduced into it containing some biodegradables; careful considerations were taken in the choice of earthworms used for the process as some are better vermicomposters. The worm bin was kept in an environment having an ambient temperature range of 22 to 25.2 degree Celsius and kept moist at all times and at the same time; biodegradables were deposited for continued vermicomposting. At the end of the process which has no time frame depending on the quantity of vermicompost that is needed to be realized from the process, the worms are carefully separated from the worm bin and the proceed was ready for use after having no trace of any biodegradable found. Humus soil was sourced from a nearby poultry farm. The three samples viz; the vermicompost, the humus soil and the control were taken to the laboratory to analyse their nutritional value and were later used to plant green vegetable (*Amarantus retroflexus*). Each sample was put in a poly pot having three replicate. The plant height, stem girth, number of leaves and the leaf area index of each plant in each poly pot were determined and the results obtained were subjected to the Analysis of Variance (ANOVA). From the ANOVA result, it was concluded that vermicompost gave high statistical difference at P=0.05 in all parameters assessed. However, results obtained showed that vermicompost seeded with *Amaranthus retroflexus* performed greatly over the control and in some cases slight difference statically over humus soil.

Keywords: Decompose, earthworm, Bio degradable, Vermicompost.

1. Introduction

The quest for improved and better crop yield with little or no cost is a function of the potentials of the soil and the extra soil enhancer added to the soil by the farmer; be it in form of humus soil or in compost like form. Repeated application of agrochemicals such as fertilizers, fungicides and pesticides on soils has resulted in high concentration of extractable heavy metals and subsequent uptake of these heavy metals by the grown plants (Arthur *et al*, 2005). The addition of these fertilizers however can also inhibit the uptake of some major metal contaminants such as lead (PBC) due to metal precipitation of pyromorphite and chloropyromorphite (Chaney *et al*., 2000). Natural chelating actions of plant and microbial origin seem more promising than synthetic chemical chelating agents. Since chemical chelating agents have additional toxicity to the plant, they may increase the uptake of metals but decreases plant growth thus proving to be of limited benefit (Malik) *et al*., 2000a).

Yard and Food waste make up a major component of solid waste in most municipalities throughout the world (Dickerson, 2001). Biological processes such as composting followed by vermicomposting can be used to convert vegetable waste into agriculturally useful humus soil. Food waste such as tender twigs, dry leaves, fruits and tuber crops peels can be converted to manure in the form of compost or vermicompost. This can be produced in commercial quantity for large scale farming hence managing waste emanating from left-over food, reducing environmental nuisance, in the process generate income and employment and reducing dependence on chemical fertilizers.

Vermicompost is a bio-chemical process of composting; utilizing various species of worms usually: red wigglers, white worm and earthworm to create a heterogeneous mixture of decomposing vegetable or food waste (excluding meat, fats, diary and oil) under a controlled environment. It is similar to plain compost, except that earthworms are used in addition to microbes and bacteria to turn organic waste into a nutrient rich fertilizer (Liam Heneghan *et al*, 2000). Vermicompost does not contain only worm castings but also bedding material such as grinded egg shell, compost manure, sawdust and different types of organic waste (Sangwa *et al*, 2008). Vermicompost is the excreta of worm which is rich in humus and nutrients and can be used for any crop.

Humus soils have been used as a way of sustaining soil productivity. However, the extent to which farmers can depend on this input is constrained by unavailability of the right humus soil at the right time, high cost, lack of technical know-how and lack of access to credit facility. This has diverted the attention of scientists towards making use of organic materials (both organic manure and organic waste) for improving the physical properties of soils that allow profitable crop production.

1.1 Objectives of the study

The objective of this research is to evaluate the effect of the use of vermicompost and humus soil on vegetable (*Amaranthus retroflexus*) crop production.

2. Material and Methods

2.1 Equipment and tools used

Sample collection equipment: ATC digital PH meter, a hand digital thermometer, a weighing scale, digital venire calliper, hand gloves and poly pots.

Materials for vermicomposting: worm bin, bedding materials (Grinded egg shell, shredded paper, sawdust, grass), water, worms and non-fatty organic waste (vegetable, garbage, plantain, banana peels etc.)

2.3 Construction of the earthworm bin

The worm bin was constructed with white wood. The wood was carefully selected based on careful design consideration as white wood have little or no chemical related substance that can pose as a threat to the life of the earthworms hence, stalling the production process (vermicomposting) as well as its characteristics and properties.

The size of the bin was 1.2m for the length, 0.9m for the width and 0.6m is for the depth. In the construction of the worm bin eighteen holes of a specified diameter were drilled at the four sides of the bin (3 by 6) for good aeration and same was done beneath the bin for proper draining of excess water.

2.4 Bedding preparations

The materials used for bedding includes: grinded egg shell, shredded newspaper, saw dust and some grasses. These materials were soaked in water for three days to enable the materials absorb water and later squeezed out from the bedding materials. The bedding was mixed thoroughly and placed inside the worm bin. About ½ kg of exotic varieties of red earthworms (*Eisenafoetias*) ranging between 200 and 300 in number were spread across the bedding material. For the first week 1kg of food waste (vegetables, plantain, pawpaw, banana and fruit peels were added to the worm bin as source of food and subsequently the amount of food added was increased to 1.5-2kg depending on the rate of composition.

2.5 Analytical methods of Vermicomposting

The bedding materials were thoroughly mixed and moist to ensure that the earthworms feel comfortable as though they were in their natural habitat. The temperature of the bedding material was read to be 25.2 degree Celsius and 1kg of food containing cassava meal (Eba in Nigeria), banana/plantain peels, vegetable strews and garbage was added to the bin and partially mixed with the bedding materials. Wetting of the vermicompost was done every two days with 1-1.5 liters of water gotten from their natural habitat ie from the stream. The temperature of the vermicompost before and after wetting was taken.

During the composting periods, one of the most important parameter was the temperature inside the worm bin which determines the rate of decomposition of the organic waste being fed to the earthworm. It was observed that the bedding materials for the worms were a little alkalinic having a P^h value of 7.2 but later declined to neutral point of 6.9 and was constant till the end of composting. At exactly two months, the organic waste added to the vermicompost have turned into a soil-like substance, light brown in color and contains little or no form of solid organic matter/waste. The earthworms were carefully handpicked not leaving behind the eggs/cocoons in the vermicompost.

2.6 Parameter assessed

The following parameters were assessed for a period of five weeks after germination of *Amaranthus retroflexus*.

i. Number of leaves
ii. Stem girth (cm) of plants
iii. Height of plant
iv. Leaf area index of plant

3. Method of data analysis

The data collected were subjected to analysis of variance (ANOVA) and the means separated using significant difference at P = 0.05. The result after completion was subjected to an ANOVA test at 95% significant level

Where; VS is vermicompost soil

HS is humus soil

CS is the control soil

The plant height was measured with the aid of a meter rule in (cm) while the stem diameter was measured with the aid of a venire calliper. The leaf area index was gotten with the aid of a tracing paper placed above the plant and traced with a pencil.

4. Results and Discussions

Observation revealed that from table on 1, 3 and 5 below potted Amaranthus with Vermicompost made good progress from the very beginning of seed germination up to maturity. They were green leaves and broader shoots which are thick and longer with an average greater number of branches per stand. Significantly, they were much better (nearly two-fold in growth and bored over 50% in all parameters) over those grown on the Humus soil and Control soil.

Table 1: Mean Table for the number of leaves for five weeks

TREATMENT	Week 1	Week 2	Week 3	Week 4	Week 5	Average
VS	2	9	17	24	24	15.2
HS	2	8	15	19	20	12.8
CS	2	5	12	17	19	11

Values for each week are averages of seven days for all three pots of same treatment

Table 2: Two way test of number of leaves between subjects of effect.

Source	Type III sum of squares	Df	Mean square	F	Sig.
Model	3386.06(a)	7	483.724	228.531	0
Treatment	44.4	2	22.2	10.488	0.006
Block	806.667	4	201.667	95.276	0
Error	16.933	8	2.117		
Total	3403	14			

R squared=0.995(Adjusted R squared=0.991)

The result after completion was subjected to an ANOVA test at 95% significant level

Also table 3 shows that VS has the highest performance with a mean value of 8.68 mm while the control soil has the lowest performance with the mean of 6.20mm.

Table3: Mean Table for the Stem Girth for Five Weeks

TREATMENT	Week 1	Week 2	Week 3	Week 4	Week 5	Average
VS	0.69	4.2	6.63	8.54	8.68	28.74
HS	0.54	3.67	6	7.38	8.1	5.14
CS	0.54	3	5.23	5.89	6.2	20.93

Values for each week are averages of seven days for all three pots of same treatment

Table 4: Two way test for the Stem Girth between subjects of effect

Source	Type III sum of squares	Df	Mean square	F	Sig.
Model	488.334(a)	7	69.762	243.408	0.000
Treatment	6.337	2	3.169	11.056	0.005
Block	103.187	4	25.797	90.008	0.000
Error	2.293	8	286		
Total	490.627	14			

R squared=0.995(Adjusted R squared=0.991)

Table 5: Mean Table for the Height for five weeks

TREATMENT	Week 1	Week 2	Week 3	Week 4	Week 5	Average
VS	5.1	11.6	24.0	40.3	58.7	27.94
HS	3.6	9.3	20.6	32.6	46.7	22.54
CS	2.8	6.0	16.4	31.0	40.8	19.4

Values for each week are averages of seven days for all three pots of same treatment

The result after completion was subjected to an ANOVA test at 95% significant level

The laboratory test result presented in table 7 below include major components such as total nitrogen, total carbon, phosphorus and potassium and minor components such as calcium, magnesium, manganese etc. It can be seen that vermicompost soil, control soil and the humus soil had a P^H value of 6.9 which is adequate for normal plant growth but on the contrary the P^H of the control soil was 6.1 which is below the minimum plant requirement for normal plant growth. However, after the integration of vermicompost into the control soil the P^H was boosted up to the normal minimum P^H requirement for plant growth. This means that vermicompost serve as a booster.

Table 6: Two way test Height between subjects of effect.

Source	Type III sum of squares	Df	Mean square	F	Sig.
Model	12435.273(a)	7	1776.468	184.622	0.000
Treatment	44.400	2	93.218	9.688	0.007
Block	806.667	4	1026.372	106.667	0.000
Error	16.933	8	9.622		
Total	3403.000	14			

R squared=0.994(Adjusted R squared=0.988)

Table 7: Chemical and nutrient status of vermicompost, vermicompost plus control soil, Humus soil and the control

Parameters	Vermicompost	Vermicompost plus control	Humus soil	Control
P^H (H2O)	6.9	6.9	6.9	6.1
Elec. Conductivity Ms/Cm	950.0	750.0	50.0	100.0
Total Carbon G/Kg	36.8	15.7	37.8	25.5
Nitrogen Mg/Kg	113.0	328.5	222.5	95.5
Available P Mg/Kg	0.0046	0.0044	13.94	8.79
Potassium Mg/Kg	341.5	970.0	950.5	675.0
Magnesium Mg/Kg	383.5	2347.5	1525.0	692.5
Copper Mg/Kg	15.2	8.2	9.55	9.15
Iron Mg/Kg	35700.0	8900.0	12125.0	15775.0
Manganese Mg/kg	264.5	112.5	346.5	431.0
Zinc Mg/Kg	80.5	54.1	50.2	68.2
CalciumMg/Kg	466.0	154750.0	59750.0	540.0

The electrical conductivity of the control soil was also low but when it was mixed with vermicompost it automatically increased to an appreciable value. From literatures, 0.002 percent of phosphorus is needed for normal growth of the plant. The laboratory analysis also revealed that available phosphorus in the humus soil and the control soil was above the required phosphorus needed for normal plant growth. The introduction of raw vermicompost into the soil reduced the value from 8.79 to 0.0044 which is within the acceptable range. Again, it was keenly observed that the PH value for all samples were 6.9 except for the control which was 6.1 but, when amended with vermicompost, it value rose to 6.9 which was same for almost all parameters.

Table 8 shows that vermicompost soil is excellent in leaf area and possesses more weight and hence higher resistant to wind. The leave of Amaranthus is one of the most important part of the plant because it determines the market value at which it can be sold as a larger leave index will attract buyers and sells at a good price, holds more nutrient and well enjoyed in meals.

Table 8: The mean leaf area index (cm) for five weeks

TREATMENT	Week 1	Week 2	Week 3	Week 4	Week 5	Average
VS	4.15	4.70	5.79	6.04	7.90	5.72
HS	4.00	4.03	4.70	5.12	5.88	4.80
CS	2.90	3.02	3.80	4.06	4.09	3.57

Values for each week are average of seven days for all three pots of same treatment.

Table 9 below tells about the rate of seed germination, the average growth rate, the greenness of the leaves and the number of counted leaves. For the germination rate, vermicompost soil and the humus soil had the same rate of germination which was on the third day after sowing but for the control soil, it germinated on fifth day which imply that some elements necessary for plant growth is either inadequate or incomplete. Looking at the average growth per week which is in cm, for the whole life spam of the plant, VS and HS have always done better than that of CS but the important aspect of the plant which is the leaves, VS produced more leaves in total of 26 in number, HS 20 and CS 19 and like I stated above, the leaves are the core value of the plant as it is the basis for which it can be marketed or bought at the market place. And VS has proved superior in that wise as it produced more of the leaves than others.

Table 9: Agronomic impacts of Vermicompost, humus soil and the Control soil on the growth and development of potted *Amaranthus* seed (average growth in cm).

Parameter	VS	HS	CS
Seed sowing	24th May	24th May	24th May
Seed germination	3rd day	3rd day	5th day
Avg. growth in 1st week (cm)	5.1	3.6	2.8
Avg. growth in 2nd week (cm)	11.6	9.3	6.0
Avg. growth in 3rd week (cm)	24.0	20.6	16.4
Avg. growth in 4th week (cm)	58.7	46.7	40.0
Colour & texture of leaves	Green & Thick	Green & Thick	Light green & thin
Avg. number of leaves	26	20	19

With the eye observation on the greenness of the leaves, the VS and HS has a deep green colour while CS is lighter in green colouration compared to its counterpart.

This conclusively proves that vermicompost store and retains more nutrients, have more beneficial microbes and other growth promoting factors than the humus soil and the control over a period of time to stabilizes any element into it right proportion needed for plant growth either by increasing it when it value is low for plant growth or decreases it when it value is too high which may be injurious to plant and better still, make it be at equilibrium to suit the plant as the case may be.

5. CONCLUSION

The study on vermicompost carried out established the fact that vermicompost works as an excellent plant enhancer and is nutritionally much superior and much more powerful growth promoter than the organic/humus type of fertilizer and can compete with any chemical fertilizers as it is nutritive, protective, cheaper and sustainable alternative to the destructive chemical fertilizers and other forms of composts for safe crop production. Vermicompost provide more bio-available nutrients to crops over time and also have some critical growth promoting biochemical factors not found in humus soil and other conventional fertilizer and cannot be made available by chemical fertilizers. It also has a better water holding capacity. Use of vermicompost also induces crops to attain maturity faster and bear flowers, seeds etc.

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