EFFECT OF NEEM-BASED COMPOST RATE ON SOIL PHYSICOCHEMICAL PROPERTIES AND GROWTH RESPONSES OF AMARANTHUS VIRIDIS IN AWKA

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ABSTRACT

A field experiment was conducted at the students' research farm Faculty of Agriculture, Nnamdi Azikiwe University Awka to determine the effect of Neem-based compost rate on soil physicochemical properties and growth responses of Amaranthus viridis in Awka. Three treatments were used and a control was set out to monitor the effects of the applied treatments. The design was laid out in a Randomized Complete Block Design (RCBD), with 4 replication each. Where beds with 0 t/ha received 0kg of the compost, 3.5 t/ha received 2.1 kg/m² of the compost, 7 t/ha received 4.2 kg/m² of the compost and 10.5 t/ha received 6.3 kg/m² of the compost. The experiment lasted for 6 months and plant data was collected before harvesting. The treatments were applied in an experimental plot of 2m by 2m. The result obtained was subjected to a statistical analysis of variance using GENstat and least significant difference (LSD) to compare the mean. The mean were separated at 5% level of significance. Generally the applied treatments improved soil fertility as there was a significant increase in Moisture content (MC), Field capacity (FC), Plant Available water (PAW), Permanent wilting point (PWP), Bulk density (BD), and Total porosity (TP) of the soil. Also, potential hydrogen ion (pH), Available phosphorus (Av. P), Nitrogen (T.N), Organic carbon (OC), Calcium (Ca), Magnesium (Mg), Potassium (K), Sodium (Na), Exchangeable Acidity (EA), Effective Cation Exchange Capacity (ECEC), Base Saturation (BS) and exchangeable aluminum (Al3+) were all significantly differed. On the effects of the treatments on growth parameters, T3 (7 t/ha) gave the highest plant height and number of leaves with mean value of 25.8", and 30.9" respectively. The control gave the highest mean leaf width 3.43".

Keywords: Neem-based Compost, Amaranthus viridis.

1. INTRODUCTION

Soil fertility is the ability of soil to sustain agricultural plant growth. Soil depletion occurs when the components which contribute to fertility are removed and not replaced, and the conditions which support soils fertility are not maintained. However, soil nutrient depletion and fertility degeneration are becoming topical issues among the major causes of decline in crop yield and per-capita food production (Henao and Baanante, 2006). Poor cultivation practices such as continuous cropping could result in low soil fertility through reduction in soil organic matter (SOM), and increase in soil acidity (Aihou *et al.*, 2008). In recent times, due to the high cost of inorganic fertilizers, nature of our soils and inherent low nutrient conversion efficiency (AGRA, 2007), attention has moved to organic manures as a superior option.

Organic material contributes directly to the building block of SOM, which performs diverse functions in improving the soil physical, chemical and biological properties. The maintenance and management of SOM in a cropped field are central to sustaining soil fertility (Woomer and Swift, 2004).

Compost use is one of the most important factors, which contribute to increased productivity and sustainable agriculture. In addition, compost can solve the problem faced on farmers with decreasing fertility of their soil. Due to soil fertility problems, crops return often decrease and the crops are more susceptible to pest and disease because they are in bad condition (Madeleine *et al.*, 2005).

Composted organics has other beneficial effects, including diverting landfills wastes to alternative uses, removal of pathogen inocula or weed seeds and decomposition of petroleum, herbicide or pesticide residues, erosion control and as a nutrient source for sustainable re-vegetation of degraded soils. Using compost can improve the capacity to produce safe clean green horticultural produce and importantly increase the potential for large-scale organic food production (Paulin and Peter, 2008).

The presence of organic matter in the soil is fundamental in maintaining the soil fertility and decreasing nutrient losses. Application of organic matter (compost, manure) to this soil would have multifaceted benefit; such as in soil aggregate stabilization through binding the soil particle; reduce the impact of erosion preventing further depletion of soil nutrients (Eyasu, 2002). Thus, compost is a good organic fertilizer because it contains nutrients as well as organic matter. Organic matter has number of important roles to play in soils, both in their physical structure and as a medium for biological activity. In addition, organic matter makes its greatest contribution to soil productivity. Organic matter is needed to retain the water and nutrient. Hence, the farmers need to take care of the organic matter content of the soil. An integrated approach, combing application of compost with an application of artificial fertilizer is a good strategy for sustainable crop production (Gete *et al.*, 2010).

Hence, to sustain the balance of soil fertility and reduce soil erosion, and to ensure agricultural productivity adoption of composting technology and application of amenable compost is quite essential. Therefore, the main aim of this study was to determine the effect of Neem-based compost rate on soil physicochemical properties and growth responses of *Amaranthus viridis* in Awka.

The specific objective of this research includes, the determination of the effect of Neem-based compost rate on:

1.Soil physicochemical properties of the research area.

2. Growth responses of *Amaranthus viridis*.

Justification of the Study

The information and discussion highlighted here indicate the potential uses of compost which can be developed and harnessed with benefit in agricultural pursuit. The soil, one of the key factors of agricultural production is essentially a living system by virtue of its teeming consortium of organisms. The soil therefore needs to be nurtured, bio-remediated and sustained biologically with compost. The global emphasis is now on organic eco-farming which uses compost in order to promote human and environmental health and realize sustainable food security. For health reasons, and in order to be globally relevant as a food producing and exporting nation, Nigeria needs to go into eco-farming. It is gratifying that Nigeria ecosystem is endowed with favourable climatic features, available and healthy water supply. Valuable species of plants, trees, crop, soil organisms, flora and fauna are also around, even though depleted, through wrong management measures. These resources will need to be increased, multiplied, reactivated and harnessed by appropriate cultural resources. These bio-resources can then contribute to produce effective compost and uplift the Nation Nigeria socioeconomically.

2.MATERIALS AND METHODS

Study Area

The study was conducted during the cropping season of 2019 at the Nnamdi Azikiwe Students Research farms Awka. Awka which is in Anambra is located in the South Eastern Nigeria. The experimental site lies within latitude 6°14'52''N and longitude 7°7'8''E. The Research farm has annually been used by 400 Level students in the faculty of Agriculture for their practical activities. The land has been in use for over six (6) years for the production of cucumber (*Cucumis sativa*), maize (*Zea mays*), Rice (*Oryza sativa*), and Cassava (*Manihot esculenta*). Some of the weeds found in this area includes mimosa, elephant grass, and African never die.

Awka has an altitude of 4417cm above sea level. Latitude 6°16' N and Longitude 7°71'E, an average annual rainfall 600-1650mm with minimum temperature of 270C and maximum temperature of 300C and Relative Humidity 75-80%. Rain fall over Nigeria is of two regimes: A bi-maximum south of 100N and a single maximum north of this latitude. This distribution is partly s a result of the seasonal oscillations of the inner-tropical discontinuity. July- August is consider to be anomaly in rainfall climatology of Nigeria when rainfall is reduced over southern Nigeria Despite the great depth and humidity of tropical maritime (mT) air near the coast. It is a period of reduce rainfall separating two main rain season and can last up to six weeks. Rainfall pattern which is control by the movement of inter tropical discontinuity air mass, is character by a dry season. November-March with dry continental North East winds dominating during this period and long wet season which occur normally from April to October.

2.2 Neem-based compost preparation

Neem leaves were gathered around the multi-purpose hall area in Nnamdi Azikiwe University, Awka and Poultry manure was sourced from farmers. The neem leaves weighing 20kg + Poultry manure 20kg were later mixed and bagged.

After 3 weeks of composting it was opened for aeration and applied on the experimental site on the 22nd of March 2021, at different rates. The experiment was carried out during 2021 farming season, inside UNIZIK

Compost rate include:

a. T1 = 0 t/ha

b. T2 = 3.5 t/ha

c. T3 = 7 t/ha

d. T4 = 10.5 t/ha

Experimental Design

The design was laid out in a Randomized Complete Block Design (RCBD), with 3 replication each. Where beds with 0 t/ha received 0kg of the compost, 3.5 t/ha received 2.1 kg/m² of the compost, 7 t/ha received 4.2 kg/m² of the compost and 10.5 t/ha received 6.3 kg/m² of the compost.

Nursery Preparation

The nursery was carried out done in a shade using sawdust and poultry droppings as the nursery media. Seeds were sourced from local farmers and it was broadcasted over the nursery tray on the 17th of March, 2021. On the 21st of March, 2021 the seeds germinated.

Soil Sample Collection

Soil sample was collected with auger for undisturbed soil. The soil sample were prepared for soil analysis by air drying for 5 days, crushed, sieved with 2 mm stainless steel sieve, bagged and properly labeled.

Data Collection

Data were collected randomly from the field in order to have representative soil sample. Composite samples were taken to laboratory for analysis to determine the physico-chemical properties of the soil in the study area

Laboratory Analysis

The following Soil physical and chemical analysis were carried out

- **Particle size Distribution**: The hydrometer method as described by Gee and Or (2002) was used to determine the particle size distribution of the samples, while the soil textures were determined using the USDA Textural triangle

Undisturbed soil sample was collected with core of a known volume and weight.

Soil sample was weighed fresh, and then allowed to drain on air for 14days.

The sample was weighed after 2 days, and then weighed again at 14days before oven drying the sample.

- **Moisture Content:** This was calculated using

$$Mc = \frac{\text{fresh weight - oven dry weight}}{\text{oven dry weight}} \times 100$$

- **Permanent wilting point:** This was determined using saturated solution of calcium sulphate ($CaSO_4$). Here, the soil sample was weighed and oven dried at 110°C, after which the hygroscopic coefficient was multiplied by a pf factor of 1.75 according to Grewal *et al*. (1990)
- **Field Capacity:** Field capacity was determined using undisturbed core samples from the field. The soil core sample was soaked in water for 24 hours at pf of zero by Grewal *et al.* (1990).

- **Available Water Content:** This was determined by the difference between field capacity and permanent wilting point of plant by Obi (2000).
  AWC = FC - PWP
- **Soil Total Porosity**: This was calculated from the bulk density as shown in this equation:
  Total porosity (%) $= \frac{1-Bd}{pd} \times 100$
  Where Bd = Bulk density
  Pd = particle density (2.65g/cm^3)
  As described by Anderson and Ingram (1993).
- **Soil pH**: The soil pH in water was estimated using pH Meter in 1:2.5 ratio of soil to water according to Thomas (1996).
- **Saturated Hydraulic Conductivity (K-sat)** was determined by the constant head permeameter method; Darcy's equation as explained by Youngs (2001).
- **Bulk Density (BD**) was determined using the core method as described by Anderson and Ingram (1993).
- **Gravimetric Moisture Content:** Moisture content of the soil was determined by oven drying at a temperature of 105^{0}C and percentage of moisture in soil calculated mathematically as follows:
  $$GMC = \frac{W2-W3}{W3-W1} \times \frac{100}{1}$$
  Where W_1=Weight of the can
  W_2=Weight of wet sample + can
  W_3=Weight of oven dried sample + can
  using the core method as described by Anderson and Ingram (1993).

- **Soil organic carbon (SOC)**: The wet digestion method (Nelson and Sommers, 1996) was used to determine the organic carbon content of the soil samples.
  $$\text{Organic carbon in soil} = \frac{\text{Me } K_2Cr_20_7 - \text{MeFS}0_4 \times 0.003 \times 100\ (F)}{\text{Mass of air-dried soil to be used}}$$
  Where F = correction factor
  Me = Normality of solution x volume to be used.
  While organic matter was calculated by multiplying organic carbon with Van Bemmelen factor (1.724).
- **Total Nitrogen (TN):** Total nitrogen in the soil sample was determined by the Macro-Kjeldahl method (Brookes *et al.*, 1985). Nitrogen in 1g of soil sample was converted to $(NH_4^+)_2SO_4$ by digestion with concentrated sulphuric acid (H_2SO_4). The $NH4^+$ liberated by distillation of the digest with an alkaline solution (NaOH), and the NH_4^+ was liberated by distillation, was determined by titrating with a standard HCl.
- **Exchangeable Basic cations (calcium, magnesium, potassium and sodium):** Exchangeable bases (K, Ca, Na, and Mg) were extracted with 1N NH_4OAC buffered at pH 7.0 Thomas, 1982). 2.5g of air dried and sieved soil was weighed into a 50ml extraction vessel and 50ml of extraction reagent (1N NH_4OAC) was added and shaken

for two hours on a mechanical shaker. It was immediately filtered and the filtrate was collected for element determination by Jones, (2001). The amount of Ca and Mg was determined using Ethylene Diamine Tetra-Acetic (EDTA) titration method while potassium and sodium was determined by flame photometer (Rhoades, 1982)

- **Exchangeable acidic cations:** Exchangeable acidity, aluminium and hydrogen were determined by the titrimetric method according to the routine methodology adapted from Mclean, (1980). Primarily, the exchangeable acidity was determined by titration of 50ml extract with 0.05N Na0H, using 1% phenolphthalein as an indicator. The concentration of Al^{3+} was obtained by back-titration of the same extract, previously used, after the acidification with a drop of 0.5N HCL and addition of 10ml of NaF, with 0.5N HCL.
- **Available phosphorus:** This was determined using Bray 2 method of Bray and Kurtz (1945) One gram (1g) of air dried and sieved soil was weighed into a 15ml centrifuge tube and 10ml of the extracting solution (1N NH_4F) was added. This was shaken for one minute on a mechanical shaker and decanted. 5ml of the supernatant was taken with a pipette and put into 20ml test tube then 5ml of distilled water and 2ml of molybdate solution was added and mixed properly. 10ml of stannous chloride ($SnCl_2H_2O$) was added and mixed again. Available phosphorus was measured using a spectrophotometer.
- **Effective Cation Exchange Capacity (ECEC):** This was calculated by summation of exchangeable cation and the exchangeable acidity. (Exchangeable Ca + Mg + Na + K) + Exchangeable acidity.
  ECEC = TEB + EA
- **% Base saturation**
  It was calculated using %BS = $\frac{TEB}{ECEC} \times \frac{100}{1}$
  Where TEB = total exchangeable bases
  ECEC = effective cation exchange capacity
- Plant data
- Plant Height: The height of the sampled plant were taken using thread which was placed on the soil surface of the plant to the apex of the plant. Data collected after each measurement were recorded before harvesting.
- Number of Leaves: The total number of the leaves on each sampled plant were counted and recorded before harvesting.

Data Analysis

Data collected after the soil physico-chemical analysis was subjected to analysis of variance (ANOVA) and treatment means separation using least significant difference (LSD) at 5% probability level with a GENSAT statistical package (Buyse et al., 2015).

Plate 1: neem leaves + poultry manure

Plate 2: bagged compost materials

Plate 3: Transplanted Amaranthus viridis

Plate 4: Compost prior to application on the plots

3. RESULTS AND DISCUSSION

Pre-Soil Physicochemical Analysis

The physicochemical properties of the soil used for the experiment before treatment application is shown in Table 1.0 below. The soil texture was sandy clay loam with pH in water value of 6.8

and pH in KCl value of 5.5 indicating near neutral and strongly acid reaction respectively based on the ratings given by Adaikwu et al. 2013. The soil was low in organic carbon content (1.09 %), organic matter (1.88 %), exchangeable bases (Ca (4.8 %), Mg (1.00 %), K (0.321 %), and Na (0.277 %) and effective cation exchange capacity (ECEC) (8.18 cmol/kg) but moderate in available phosphorus (18.10 mg/kg) and high in base saturation (78.23 %) based on the ratings given by Adaikwu et al. 2013. The low levels of nutrients obtained in the experimental soils indicate low fertility status and may be attributed to high temperature, high rainfall and leaching losses which characterize the tropical areas (Parnes R. 1990 and Osodeke V.E. 1996). The low fertility status could also be attributed to continuous cropping which necessitates the need for an additional supply of nutrients.

Table 1.0: Pre-soil physicochemical properties

SOIL PARAMETERS	VALUES
SAND (%)	58.40
SILT (%)	20.20
CLAY (%)	21.40
Textural Class	Sandy Clay Loam
MC (%)	25.85
BD (g/cm^3)	1.53
TP (%)	42.26
HC (Cm^3/hr)	8.80
pH	5.48
Av.P (mg/Kg)	18.10
N (%)	0.104
OC (%)	1.09
OM (%)	1.88
Ca (Cmol/Kg)	4.80
Mg (Cmol/Kg)	1.00
K (Cmol/Kg)	0.321
Na (Cmol/Kg)	0.277
EA (Cmol/Kg)	1.78
ECEC(Cmol/Kg)	8.18
BS (%)	78.23
Al^{3+}	0.68

COMPOST (**NEEM LEAVES** + **POULTRY MANURE**)

The chemical analysis of the neem-based compost as presented in Table 2.0 showed that the compost had a slightly alkaline pH (9.3) when measured in water. The compost had 31.61 % organic carbon, 54.49 % organic matter, 0.98 % total nitrogen, 2.3 % total P, 1.12 % total K, 6.1 % Ca, 2.8 % Mg and 0.73 % Na; the C:N being 30.99.

Table 2.0: Chemical properties of compost

Parameters	Values
pH	9.3
N (%)	0.98
P (%)	2.3
K (%)	1.12
Ca (%)	6.1
Mg (%)	2.8
Na (%)	0.73
OC (%)	31.61
OM (%)	54.49
C/N ratio	30.99

NOTE: N= Nitrogen, P= Phosphorus, K= Potassium, Ca= Calcium, Mg= Magnesium, Na= Sodium, OC= Organic Carbon, OM= Organic Matter , C/N= Carbon Nitrogen ratio

EFFECT OF NEEM-BASED COMPOST RATE ON SOIL PHYSICAL PROPERTIES

The effects of 0 t/ha (T1), 3.5 t/ha (T2), 7 t/ha (T3), 10.5 t/ha (T4) on soil physical properties are shown in Table 3.0. From the results of the ANOVA, soil physical properties that were significantly different have their corresponding L.S.D values shown in the table.

Particle Size Distribution (PSD): The relative distribution of sand, clay and silt sizes was shown in Table 3.0. The compost rate showed no significant difference on sand particle while the rate and interaction between poultry manure and rate did not show any significant difference.

In silt and clay the organic manure type, rate and interaction between the two did not show any significant difference, although there were variations among the particle size distribution, following the addition of different rates of compost, the changes were not statistically significant. The lack of changes in the particle size distribution confirm Hulugalle (1994) who asserted that changes in Soil texture do not occur easily and may take many years to occur irrespective of the management practice applied.

Moisture content (MC): From Table 3.0, the highest mean value of moisture content (mc) was observed in T4 (32.30 %) and the lowest mean value of the moisture content was observed in T1 (27.27 %). Statistically there was a high significant difference ($p < 0.05$) in the moisture content among the compost rates and this could be because of the high-water holding capacity of the compost. The moisture content increased with increasing rate of compost application and this improvement was not surprising rather it was consistent with previous studies that application of organic manure such as poultry manure improved soil physical properties to some extent, as reported by Udom and Lale, 2017.

Field Capacity (FC): The effect of compost rate on field capacity are shown in Table 3.0, with the highest mean value recorded in T4 (25.63 %) and the lowest mean recorded in T1 (19.15 %). The ANOVA table shows that there was a significant difference ($p < 0.05$) among the different rates of compost application. The field capacity mean values increased with increasing rate of application.

Plant Available Water (PAW): From the ANOVA table, there was a significant difference ($p < 0.05$) highly among the different rates of compost, with the plant available water increasing with increasing rate of compost application. The highest mean was recorded in T4 (16.60 %) whereas the lowest mean was recorded in T1 (13.50 %) as shown in Table 3.0. This finding is in line with Black et al. (1999) who conducted a study with the Florida Department of Transportation to determine the effects of compost on PAW and turf establishment on Florida roadsides. The study included mixed compost at several application rates and incorporated to 20 cm. The PAW of compost amended plots was greater (12 % increase) than controlled plots.

Permanent Wilting Point (PWP): The permanent wilting point of the soil was very low in the control (T1), but increased significantly ($p < 0.05$) with application of the different compost rates. Statistically there was significant difference among the rate of compost application, with the highest value recorded in T4 (9.03 %) and the least value observed in T1 (5.65 %).

Bulk Density: From Table 3.0 the treatment (rates of compost) applied significantly ($p < 0.05$) reduced Bulk Density. The highest mean value recorded in T1 (1.60 g/cm³) and the lowest mean value recorded in T4 (1.51 g/cm³), this could be due to the addition of low-density organic matter into the mineral soil fraction. This result is in support with Brown and Cotton (2011) who observed that soil bulk density followed a predictable pattern with decreased bulk density at increasing rate of compost.

Total Porosity: Table 3.0 shows that the treatment (rates of compost) applied significantly ($p < 0.05$) increased Total Porosity. The highest mean value recorded in T4 (43.01 %) and the lowest mean value recorded in T1 (39.62 %). This result corroborates with Amlinger *et al*, 2007 who observed that there is a positive effect has been detected in most cases and it is typically associated with an increase in porosity.

Table 3.0: Physical Properties of the Soil after amendment

TRT.	SAND (%)	SILT (%)	CLAY (%)	TEX	MC (%)	FC (%)	AWC (%)	PWP (%)	BD (g/cm³)	TP (%)
T1	52.40	23.27	24.33	SCL	27.77	19.15	13.50	5.65	1.60	39.62
T2	51.73	24.60	23.67	SCL	28.53	20.95	14.04	6.90	1.56	41.02
T3	53.73	22.60	23.67	SCL	31.07	23.44	14.98	8.45	1.53	42.13
T4	50.07	24.93	25.00	SCL	32.30	25.63	16.60	9.02	1.51	43.01
LSD (0.05)	**NS**	**NS**	**NS**		**0.85**	**0.73**	**0.65**	**0.47**	**0.01**	**0.67**

NOTE: TEX= Textural class, MC=Moisture content, FC=Field capacity, AWC=Available water content, PWP=Permanent wilting point, BD=Bulk density, TP=Total porosity, T1=0t/ha, T2=3.5t/ha, T3=7t/ha, T4=10.5t/h

EFFECT OF NEEM-BASED COMPOST RATE ON SOIL CHEMICAL PROPERTIES

The effects of 0 t/ha (T1), 3.5 t/ha (T2), 7 t/ha (T3), 10.5 t/ha (T4) on soil chemical properties are shown in Table 4.0. From the results of the ANOVA, soil chemical properties that were significantly different have their corresponding L.S.D values shown in the table below

Soil Reaction (pH): There was a positive ($p < 0.05$) increase in the pH of the soil treated with different compost rate. This increase was observed with increasing rate of compost application. The highest mean value of both pH was recorded in T4 (6.20) as shown in Table 4.0, The increased soil pH could be due to the higher base cation content of the compost used.. The result also is the same with the report of Meelu *et al*, (1994) who observed that organic materials have an overall tendency to move the pH towards neutrality. Kluge (2006) also confirmed a significant increase of the pH value even at moderate compost applications.

Available Phosphorus (Av.P): The result in Table 4.0 indicates that there was a significant ($p < 0.05$) effect in Available Phosphorus with the application of different compost rate. The highest Available Phosphorus value of 21.90 mg/kg obtained from beds amended with 10.5 t/ha (T4) was significantly higher than the values 19.50, 16.97, and 13.63 (mg/kg) obtained from beds treated with 7 t/ha, 3.5 t/ha, and control(T3, T2, and T1 Respectively). This result is in agreement with a study conducted by Butler *et al*, 2008 that showed a 10-fold increase in soil-P with the addition of 70 Mg/ha of composted dairy manure relative to the treatment with no compost application. The literature generally shows a linear increase in available phosphorus (P) with an increase in the amount of manure applied to soil.

The increase in available P after manure application to soil is a function of various soil characteristics including soil pH, organic matter content, and clay type (Chatterjee *et al*, 2014).

Total Nitrogen: The soil Total Nitrogen content was significantly ($p < 0.05$) increased with application of compost (Table 4.0). Application of 5 t/ha, 7 t/ha and 10 t/ha significantly ($p < 0.05$) increased the soil Total Nitrogen when compared to control (T1) and soil before treatment application (Table 1.0). The highest value of 0.22 % was obtained from beds treated with 10.5 t/ha (T4) while the least value of 0.08 % was obtained from the control beds(T1). This result is in line with a study by Adeli *et al*. 2011 however, which showed that the application of 2.2 Mg of manure per ha increased the total soil N by 110 mg kgg 1; doubling the application to about 4.5 Mg ha-1 increased soil N by an additional 30 mg kgg 1relative to the control.

Organic Carbon (OC): Table 4.0 indicates that there was a significant ($p< 0.05$) difference in soil Organic Carbon content with the application of compost. The highest organic carbon value of 1.97 %, obtained from beds treated with 10.5 t/ha was significantly higher than the values of 1.68, 1.44, and 1.01 (%) obtained from beds treated with 7 t/ha, 3.5 t/ha, and control. This could be due to the presence of high organic carbon content in the compost used. This result confirms that of Bouajila and Sanaa (2011) who reported that application of manure and household wastes compost resulted in significant increase of organic carbon, with the compost treatment being the most efficient. Their result showed that the application of 120 t/ha household wastes compost and manure improved an organic carbon (1.74 and 1.09 (%), respectively) when compared with control (0.69 %). Soheil et al. (2012) was investigated, applying compost to soil increases the amount of soil OC with increases rate of compost application.

Exchangeable Bases: There were positive ($p < 0.05$) effects in the accumulation of soil exchangeable Ca, K, Mg, and Na at the end of the study highest value of 6.73, 2.66, 0.50 (cmol/kg), and (Ca, Mg, K, and Na Respectively) obtained from beds treated with 10.5 t/ha(T4) were significantly higher than values obtained from 7 t/ha, 3.5 t/ha, and control (Table 4.0), this could be due to the possessing of valuable plant nutrients including N, P, K, Ca, and Mg of the compost. This result corroborates the findings by several researchers (Tiwari 2002; Singh *et al*, 2006; Ayeni 2010) that amended soils improve soil availability of Ca, Mg, K and Na.

Effective Cation Exchange Capacity (ECEC): The soil Effective cation exchange capacity content was significantly ($p < 0.05$) increased with application of compost (Table 4.0). Application of 3.5 t/ha, 7 t/ha and 10.5 t/ha significantly ($p<0.05$) increased the Effective cation exchange capacity when compared to control (T1). The highest value of 10.92 cmol/kg was obtained from beds treated with 10.5 t/ha (T4) while the least value of 5.77 cmol/kg was obtained from the control beds this could be attributed to the increase in soil pH. This result is in agreement with the research conducted on rumen digesta. As the rate of rumen digesta application increased, the soil pH, exchangeable sodium (Na), exchangeable potassium (K), effective cation exchange capacity (ECEC), and organic matter content increased, while the exchangeable acidity decreased (Ifeoma *et al, 2015).*

Exchangeable Acidity (EA) and Exchangeable Aluminum (Al^{3+}): The Exchangeable Acidity was significantly ($p < 0.05$) influence by the rate of compost. The highest Exchangeable Acidity value of 1.72 cmol/kg was obtained from the soil without amendment (T1) whiles the least Exchangeable Acidity value of 0.62 cmol/kg (T4). The result from Table 4.0 shows a decreasing Exchangeable Acidity with increasing compost rate. This result confirms the findings as proposed by Biruk *et al*, 2017 who observed that the exchangeable acidity of the soil where the treatment without compost, without lime and without P showed the highest exchangeable acidity (2.41 cmol/kg) with significant difference to all treatments. Application of compost (5 t/ha) with lime (3 t/ha) with and without Phosphorus showed lower exchangeable acidity. The treatment with compost at 5 t/ha, limes at 3 t/ha without Phosphorus reduced the exchangeable acidity by 1.90 cmol/kg compared to the control. The exchangeable aluminum was significantly affected by the rate of compost ($p < 0.05$). Result from Table 4.0 show the highest Exchangeable Aluminum value of 0.5800 cmol/kg was obtained from the soil without amendment (T1) while the least Exchangeable Aluminum value of 0.17 cmol/kg was obtained from beds treated with 10.5 t/ha (T4). The Exchangeable Aluminum value decreased with increasing rate of compost application (3.5 t/ha, 7 t/ha, and 10.5 t/ha progressively). This result support the findings of Biruk *et al,* 2017 who observed that, compost applied at rate of 5 t/ha showed lower exchangeable aluminum (0.32 cmol/kg) compared to the treatment without compost (0.51 cmol/kg), decreasing the exchangeable Al of the soil by 0.19 cmol/kg·

Base Saturation (BS): The base saturation content of the soil at the end of the field study was significantly influenced by the amendments applied with the highest mean value of 94.25 % obtained from beds amended with 10.5 t/ha (T4) which was significantly ($p < 0.05$) higher than all the other amended plots except plots amended with 7 t/ha, 3.5 t/ha and control as shown in Table 4.0**.**

Table 4.0: Chemical Properties of the Soil after amendment

Treatment	Ph	Av.P (%)	N (%)	OC (%)	Exchangeable bases (cmol/kg)				EA (cmol/kg)	Al^{3+} (cmol/kg)	ECEC (cmol/kg)	BS (%)
					Ca	Mg	K	Na				
T1	5.267	13.63	0.08	1.01	3.10	0.70	0.12	0.11	1.72	0.58	5.77	70.18
T2	5.667	16.97	0.12	1.44	4.83	1.20	0.21	0.18	0.99	0.32	7.43	86.59
T3	6.033	19.50	0.17	1.86	6.03	2.06	0.33	0.28	0.73	0.22	9.71	92.44
T4	6.200	21.90	0.22	1.97	6.73	2.66	0.50	0.38	0.62	0.17	10.92	94.25
LSD (0.05)	**0.32**	**2.59**	**0.011**	**0.17**	**0.46**	**0.33**	**0.02**	**0.01**	**0.12**	**0.01**	**0.67**	**1.44**

NOTE: pH=potential hydrogen ion, Av.P=Available phosphorus, N=Nitrogen, OC=Organic carbon, Ca= Calcium, Mg= Magnesium, K= Potassium, Na= Sodium, EA=Exchangeable Acidity, ECEC=Effective Cation Exchange Capacity, BS=Base Saturation, Al^{3+}= exchangeable aluminum, T1=0t/ha, T2=3.5t/ha, T3=7t/ha, T4=10.5t/ha

Effect of Neem-Based Compost Rate on yield of Amaranthus viridis:

Fig. 1 shows the influence of the treatment on the germination rate collected at 1 WAT, Plant height, leaf width and number of leaves was recorded at harvesting. Statistically there was significant difference among the growth parameters of Amaranthus viridis with respect to rate of compost application. However, the highest Plant height and number of leaves mean value of 25.8", and 30.9 respectively was observed from beds treated with T3 (7 t/ha), whereas leaf width highest mean value of 3.43" was obtained from beds treated with T1 (0 t/ha). This result can be supported by that of Walter E et al, (2006) who reported that Amaranthus viridis was greater with acidic than with basic pH conditions.

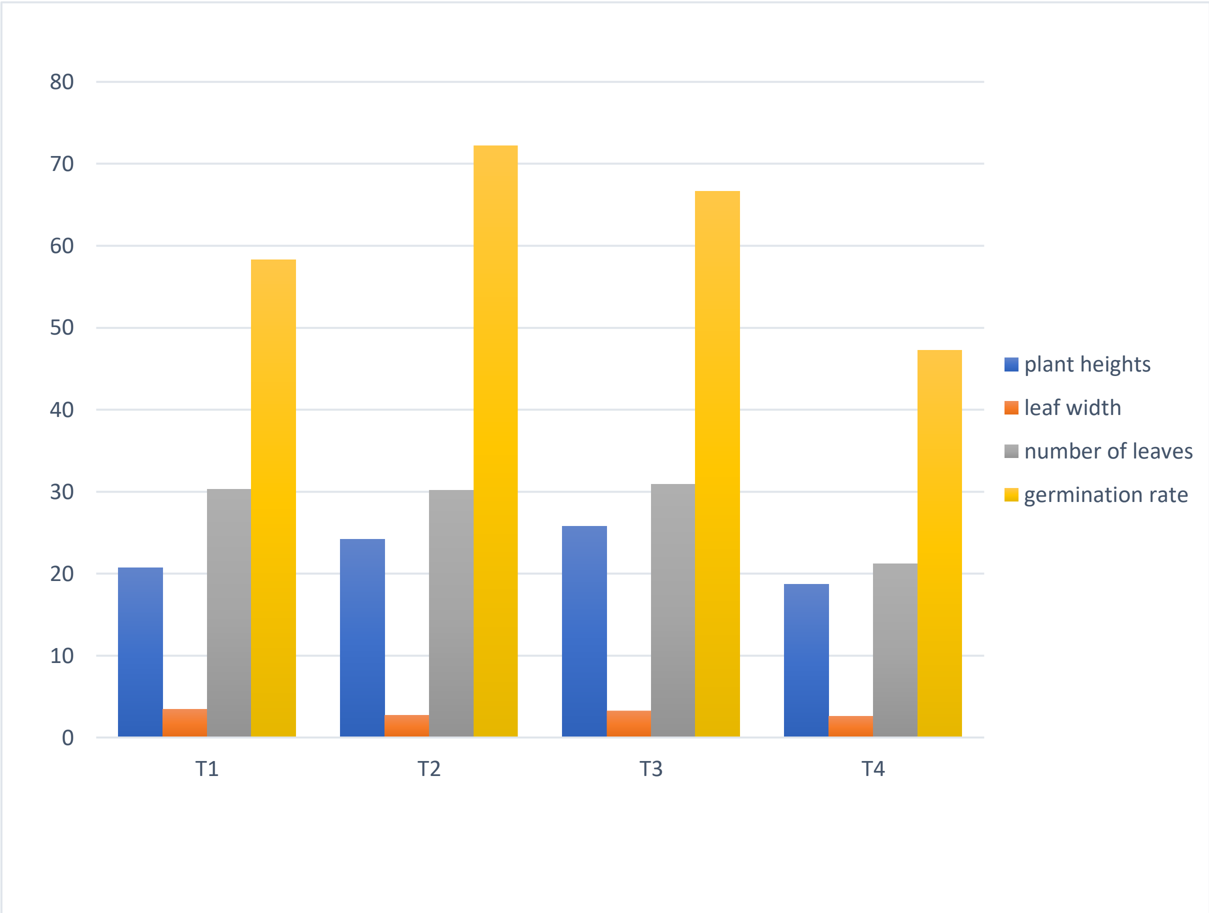

Fig. 1: The distribution of the growth parameters of Amaranthus viridis among the treatments

5. CONCLUSION AND RECOMMENDATION

This study evaluated the effects of Neem-based compost rate on the physicochemical properties of soil and growth responses of Amaranthus viridis. The results obtained showed that the application of compost significantly improved the soil properties at the rate of 10.5 t/ha (T4). It also revealed that there were variations among the different rates of compost application which in turn influenced the germination rate, plant height, leaf width and number of leaves. These responses could largely be due to the progressive increment of compost rate.

Furthermore, this study revealed that the application of compost at 7 t/ha on average affected the highest growth and development of Amaranthus viridis with increased values for plant height and number of leaves, which could be attributed to meeting the requirement for the growth and development of Amaranthus viridis.

Beyond the common application of compost as soil amendment, this research has demonstrated the efficacy of 7 t/ha compost to enhance vegetative growth and development of Amaranth, and also improve soil fertility.

Hence, it is recommended for farmers particularly for annual crops with short growth cycle such as Amaranthus viridis to obtain relative higher yields.

It is recommended that further research should be made by mixing higher compost in varying rates so as to further reveal their effects.

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