**Effect of Different Compost Weights on Soil Microorganisms, Properties and Growth Parameters of *Capsicum chinense* (Habanero Pepper)**

**ABSTRACT**

Compost plays major role in the quality of soil parameters and the microbiological diversity. The effect of compost rates on microorganisms and growth parameters of *Capsicum chinense* was investigated. Organic compost with concentrations: 0, 200, 400, 600, 800 and 1000g was transferred into separate polyethene bags containing 15kg soil and kept at the greenhouse of the Faculty of Agriculture, University of Port Harcourt. The bacterial and fungal parameters were determined using standard plate count on Nutrient and Sbouraud Dextrose agar plates while the physicochemical and growth parameters were measured using standard method. Results of the total heterotrophic bacteria ranged from 2.96x106– 6.42x106 CFU/g, total heterotrophic fungi ranged from 1.41x103– 4.56x103 SFU/g, respectively. A total of 11 Bacteria and 10 fungi species were isolated and identified. *Bacillus* spp and *Pseudomonas* sppwas the most predominant bacterium; *Penicillium* spp was the most predominant fungus in the samples. Highest microbial diversity was observed under the 1000 g. Conversely, lowest microbial diversity was found under 0 g compost rates. All six compost rates had effect on the microbial community structure and plant height.

**Keywords: *compost, microorganisms, growth parameters, C. chinense***

**Introduction**

Compost amendment has been widely recognized as a sustainable practice to enhance soil fertility and promote plant growth (Lal, 2015; Tong *et al*., 2024). Compost, a mixture of decomposed organic matter, influences soil microbial communities, which play a crucial role in decomposing organic matter, cycling nutrients, and suppressing plant diseases (Brady & Weil, 2017). The effects of compost amendment on soil microbial communities have been extensively studied, with findings indicating that compost can alter soil microbial community structure and diversity (Zhang *et al*., 2022). Compost can slowly release nutrients for plants and microbes and help maintaining a medium - nutrient availability (Scotti, 2016; Abubakar *et al*., 2023). Composting is an effective biological method to improve soil texture and crop yield (Shen *et al*., 2019). Compost addition promotes plant growth and enhances carbon allocation to fungi (Don *et al*., 2014). Garcia *et al*. (2017) reported that compost amendment improved soil fertility and increased plant growth. Soil microorganisms interact with plants in various ways, influencing plant growth and health.

*Capsicum chinense* originated from the Amazon belonging to the solanaceae family with a thick shape, and its fruits produces with different degrees of pungency (Costa *et al*., 2023). Studies showed that fertility and macro nutrients required by *Capsicum chinense* are scare, but regarding micro nutrients the highest demand for micro nutrients came from the chemical compounds in descending order Fe < B < MN < Zn < Cu, (Silva *et al*., 2018). Beneficial interactions include symbiotic relationships, such as mycorrhizae and nitrogen-fixing bacteria, which enhance nutrient uptake and provide protection against pathogens (Smith & Read, 2008). Soil microbial communities are dynamic and respond to changes in environmental conditions and land management practices. Understanding these dynamics is essential for predicting the impacts of environmental change on soil health and ecosystem functioning (Fierer *et al*., 2013).

**Materials and Method**

**Soil Sampling**

Soil samples from different compost treatment (0, 200, 600, 800, and 1000g), were collected using hand trowel and hand glove at a depth of 0 to 10 cm in depth. A total of 20 samples including the initial soil (control) and compost were collected, packaged in a well labelled polyethene bag and was transferred to the laboratory for analysis.

**Enumeration of Bacteria from Soil Samples**

The standard plate count method as described by Douglas & Robinson, (2021) was used in cultivating the soil samples so as to enumerate the bacteria loads including isolating the bacteria types in the sample after diluting the samples in a 10-fold serial dilution technique. Aliquot (0.1ml) of 10-2 dilution was inoculated on pre-dried Eosin methylene blue agar and cetrimide agar plates while aliquot of 10-3 was inoculated on nutrient agar plates. Plates were inoculated in duplicates and were spread using sterile bent glass rod before they were incubated at 37℃ for 24-48 hours. After the incubation, plates were observed for growth and the colonies were counted for enumeration of bacterial populations in the soil samples. Pure cultures of bacteria were obtained by aseptically streaking representative discrete colonies of different morphological types which appeared on the cultured plates onto freshly prepared pre-dried Nutrient agar plates and were later incubated at 37$℃$ for 24hours. After pure cultures were obtained, preservation of the isolates was preserved frozen in 10% glycerol in bijou bottles for later use.

**Characterization and Identification of Bacteria Isolates**

The bacterial isolates were characterized by observing them microscopically and subjecting them to series of biochemical tests such as Gram stain, catalase, citrate, oxidase, coagulase, Methyl Red, Motility, indole, starch hydrolysis, Voges Proskauer and sugar fermentation tests. Further confirmation was done by comparing their characteristics with those of known taxa as outlined in Bergey’s Manual of Systematic Bacteriology and advanced bacterial identification system (ABIS) online identification tool (Williams et al., 2023)

**Enumeration of Heterotrophic Fungi**

The fungal counts were determined using the standard plate count method Aliquot (0.1ml) of 10-2 dilution was inoculated in duplicates on freshly prepared Sabouraud dextrose agar (SDA) plates which has been pre-dried. Plates were spread using sterile bent glass rod before they were incubated at 25℃ for 72 hours. After incubation, plates which showed fungal growth were used to obtain the fungal population in the soil samples by counting the fungal colonies on the plates (Douglas & Robinson, 2021)

**Isolation and Identification of Fungi**

Discrete fungal spores/colonies were isolated by inoculating fungal isolates on fresh SDA plates using sterile inoculating loop. After inoculation, plates were later incubated at 25$℃$ for 72hours. This method was repeated until pure fungal cultures were obtained. The pure fungal isolates were later preserved in bijou bottles containing sterile SDA slants and stored in the refrigerator for further use. Isolates were identified on the basis of macroscopic features on SDA plates (such as shape of colony, texture, spore type and reverse pigmentation) followed by microscopic examination of their wet mounts (using lactophenol cotton blue stain). The microscopic examination was done by placing a drop of lactophenol cotton blue stain on a clean grease free slide after which inoculating needle was used in picking the aerial mycelia from the representative fungi cultures and placed on the drop of lactophenol on the slide. The slide was then mounted and viewed under the light microscope at ×10 and ×40 objective lenses (Robinson et al., 2021). The morphological characteristics and appearance of the fungal isolates seen were identified in accordance with the standard scheme for the identification of fungi and references were made to the fungal identification manual (Sarah *et al.,* 2016).

**Soil pH**

The pH of the sample was determined with a glass electrode in a 1 : 2 : 5 soil/water and kcl solution (APHA, 2012).

**Electrical conductivity**

Electrical conductivity were measured in 1 : 2 : 5 soil/water aqueous extract at 25⁰c as described by Black *et al*., (1965). Electrical conductivity ( Ece) was measured with conductivity meter and

 Calculated as : Ece ( mmhoscm–¹) at 25⁰c 0.0014118 x Text/ Rstd X 100

Where, 0.0014118 = electrical conductivity of the standard 0.01N kcl solution at 25⁰c

Rext= specific conductance of the extract ( Scm–¹)

Rstd = specific conductance of the standard Scm–¹

**Organic Carbon**

Organic carbon was determined by the Walkey and Black wet oxidation method as modified by Nelson and sommers (1982). The organic matter content of each sample was determined by multiplying % carbon by a factor 1.724

**Total Nitrogen**

The total nitrogen content of the soil was determined by the macro - kjedahl method (Bremer and Mulvancey, 1982)

**Available Phosphorus**

Bray No. 1 method as modified by Olsen and Sommers (1982) was used. The percentage transmittance of the extracted samples was measured in the spectrometer at 660mm wavelength, a standard curve ranging between 0 and 1mg/kg was plotted

**Exchangeable Bases (Ca, Ma, Na, And K)**

Exchangeable K of the soil samples was extracted with neutral normal ammonium acetate buffered at pH 7 after shaking for 2 hours (Rhoades 1982). Exchangeable cation was determined by EDTA complexometric titration (Heald 1965) while Na was determined by flame photometry (Knudsen *et al*., 1982).

**Determination of soil Texture.**

The disturbed soil samples were air-dried and passed through 2mm sieve to separate gravel from fine earth. 50g of soil was used to determine particle size distribution by the hydrometer method (Gee and Bauder, 1986).

**Bulk Density**

Bulk density was determined with core samples by the method of Grossman and Reinsch (2002) as:using the formulae:

$Bulk density=\frac{Mass of oven-dried soil (g)}{Volume of bulk soil (Cm^{3})}$

**Total Porosity**

Total porosity was calculated with core samples using the core method

$$Total porosity=\frac{Volume of water at saturation (Cm^{3})}{Volume of bulk soil (Cm^{3})}$$

**Saturated Hydraulic Conductivity (Ksat)**

Saturated hydraulic conductivity (Ksat) was determined by the constant head core technique (Reynolds *et al*., 2002). Volume of water draining out was measured over time period until

flow was constant, at which time; the flow rate was determined by the equation:

$Ksat=\frac{Q}{AT}×\frac{L}{∆H}$

Where Q is the volume of water collected (cm3), A is cross-sectional area of core (cm2), T is time (h), Lis length of core (cm), and *∆H* is the hydraulic head difference (cm).

Aggregate Stability

Aggregate Stability was measured by the mean weight diameter (MWD) of water stable aggregates using the wet-sieving method. In this method, 50g of 4.75mm dry-sieved aggregates was placed in the topmost of a nest of sieves: 2.0, 1.0, 0.5, and 0.25mm. The aggregates were pre-soaked by capillary in distilled water for 15 minutes and oscillated vertically in water 20 times, using 4cm amplitude in a mechanical agitator. The remaining stable aggregates on each sieve was oven-dried at 50⁰c for 24 hours and weighed. The percentage of the stable aggregates on each sieve representing water stable aggregates (WSA) Calculated as:

$WSA=\frac{MR}{MT}×\frac{100}{1}$

Where MR mass of resistance aggregates (g) and MT total mass of wet-sieved soil (g). The mean weight diameter (MWD) of the stable aggregates was calculated by the following equations $\sum\_{i-1}^{n}Xiwi$

Where xi is the mean diameter of each size fraction, and wi is the weight of aggregates in that size range as a fraction of the dry weight of the sample analysis.

**Water Holding Capacity**:

Was calculated with the Volume of water at saturation

Using the formula:

$$WHC (g)=\frac{Mw-Md}{Md}$$

Where W.H.C is the water holding capacity, Md is the mass of oven-dried soil and MW the mass of wet soil.

**Plant Parameters**

The number of leaves and plant heights of the various plants at different compost rates were analyzed. The plant height was achieved by taking measurements of the plant for various weeks (Silva *et al.,* 2018).

Statistical Analysis

The mean and standard deviations of the microbial counts and the physicochemical parameters were analysed using SPSS (version 27). The ANOVA was used in checking for significant difference and the Duncan test was used to separate means in areas where there were significant differences at 95% confidence intervals.

**Results**

Results of the tested soil physical properties under various compost rates in Table 1 showed that the effect of various compost rates on the particle size distribution were significantly different (P<0.05). Sand particles ranged from 62.30%-63.61%. Silt particles ranged from 21.57-26.40 %, while clay particle ranged from 10.19-14.59%, respectively. Bulk density had a range of 1.79-1.82 gcm-3, the highest value of 1.82g/cm³ was observed at 800 g and 1000 g compost rates, while the lowest value of 1.79 gcm-3 was observed at 0 g and 200 g respectively. Similarly, Total porosity ranged from 32.90 %-46.07 %. the highest value of 46.07% was recorded at 200 g compost rate and was significantly different (P<0.05) with values of 45.53%; 40.14%, 37.90%, 36.30%, 32.90%, for 400 g, 600 g, 0 g, 800 g and 1000 g, respectively. Saturated Hydraulic Conductivity had a range of 8.07-12.26 cm. It was observed that the permeability class was generally very slow.

Results of the physicochemical properties: in Table 2 showed that the pH values ranged from 5.22-6.43 and were not significantly different (p<0.05). The highest pH value of 6.43 was observed under 1000 g while the lowest pH value of 5.22 was observed under 200 g, respectively. Generally, the soils under the different compost rates were acidic. Organic matter was significantly different ranging from 1.71 to 2.52%, its highest value was recorded at 1000 g (2.52) compost rate, while the lowest value at 200 g (1.71), respectively. Total Nitrogen values were not significantly different (p>0.05) across all compost rates with values ranging from 0.20-0.30%. The highest Total Nitrogen value of 0.30 % was observed under 800g and 1000 g while its lowest value of 0.20 % was observed under 0 g, 200 g, and 400 g. Available phosphorus ranged from 31.63-59.78 mg kg-1 having its highest significant value of 59.78 g/cmol at 600 g compost rate while the lowest value was recorded at 31.63 g/cmol at 200 g. Sodium had a range of 0.27-0.71 C mol kg-1. The highest sodium value of 0.71 c mol/kg was observed at the 1000 g compost rate, while its lowest value of 0.27 c mol/kg was observed under 0 g respectively. Similarly, Potassium values ranged from 0.12-0.40 C mol kg-1 with significantly higher value of 0.40 c mol/kg, at the 1000 g compost rate, and lowest value of 0.12 c mol/kg at 0 g respectively. Values of Calcium were significantly different, 7.30 C mol kg-1, 6.60 C mol kg-1,5.70 C mol kg-1, 5.60 C mol kg-1, 3.72 C mol/kg and 3.37 C mol kg-1 for 1000 g, 400 g, 800 g, 600 g, 0 g, and 200 g respectively.

Magnesium ranged from 0.20-1.65 C mol kg-1, and followed the order 400 g (1.65 C mol kg-1) >600 g (1.63 C mol kg-1)>800 g(0.60 C mol kg-1)>1000 g(0.59 C mol kg-1)>0 g(0.30 C mol kg-1)>200 g(0.20 C mol kg-1) respectively. Exchangeable Cation Exchange Capacity ranged from 3.96-9.10C mol kg-1. The highest ECEC value of 9.10C mol kg-1 was observed under 1000 g compost rate while the lowest value of 3.96C mol kg-1 was observed under 200 g compost rate respectively.

**Table 1: Physical Properties of Soils across the Compost Rates**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Compost Rates | Sand(%) | Silt(%) | Clay(%) | Tp (%) | Ksat(cm/hr) | Pc | Bd(g/cm | Whc(gg) | Mwd(Mm) |
| 0 g | 62.30a | 26.40e | 10.60b | 37.90c | 12.26e | V. Slow | 1.79a | 28.62a | 0.75a |
| 200 g | 62.74ab | 25.25d | 11.66c | 46.07f | 11.30d | V. Slow | 1.79a | 35.74b | 1.04bc |
| 400 g | 63.20bc | 21.57b | 14.59e | 45.53e | 9.58b | V. Slow | 1.80a | 26.35a | 1.09c |
| 600 g | 63.34c | 22.44c | 13.68d | 40.14d | 10.31c | V. Slow | 1.80a | 27.62a | 0.79a |
| 800 g | 63.50c | 23.60c | 10.69b | 36.30b | 8.07a | V. Slow | 1.82a | 33.69b | 0.78a |
| 1000 g | 63.61c | 24.39c | 10.19a | 32.90a | 9.49b | V. Slow | 1.82a | 28.77a | 0.86a |

Means with the same letters were not significantly different at p<0.05

Ksat = Saturated Hydraulic Conductivity, SL = Sandy Loam, Pc = Permeability Class

**Table 2: Chemical Properties of Soils across the Compost Rates**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Treatment | Ph | OC | OM | TN | AV.P | K | Na | Ca | Mg | Acidity | CEC |  |  |
| 0 g | 5.66bc | 1.25b | 2.16b | 0.20a | 31.67a | 0.12a | 0.27a | 3.72a | 0.30a | 1.13b | 4.18b |  |  |
| 200 g | 5.22a | 0.95a | 1.71a | 0.20a | 31.63a | 0.19b | 0.38b | 3.37a | 0.20a | 1.09b | 3.96a |  |  |
| 400 g | 5.42ab | 1.44cd | 2.34c | 0.20a | 45.73d | 0.27c | 0.45c | 6.60c | 1.65b | 1.19a | 9.09e |  |  |
| 600 g | 5.87c | 1.42cd | 2.32c | 0.26a | 59.78e | 0.29d | 0.53d | 5.60b | 1.63b | 0.98a | 8.24d |  |  |
| 800 g | 5.88c | 1.34bc | 2.34c | 0.30a | 42.14c | 0.38e | 0.64e | 5.70b | 0.60a | 1.32d | 7.45c |  |  |
| 1000 g | 6.43d | 1.52d | 2.52d | 0.30a | 38.41b | 0.40f | 0.71f | 7.30d | 0.59a | 1.08b | 9.10e |  |  |

Means with the same letters were not significantly different at p<0.

Results on the mean bacterial and fungal population of the various compost rates in Table 3 showed that the total bacteria population ranged from 2.32x106 – 6.42 x 106 CFU/g. The highest total bacteria population (6.42×106 CFU /g) was observed under the 1000 g compost rate, while the lowest was observed under the 400 g compost rate with a value of 2.32×106 cfu/g. The total bacterial population followed the order 1000 g>0 g>200 g>800 g>600 g>400 g respectively. Fungal population ranged from 1.41×104 -8.83×104 CFU /g. The highest population (8.8×104 CFU /g) was observed under the 1000 g compost rate, while the lowest was observed under the 400 g compost rates with a value of 1.41×104 CFU /g. The total fungal population followed the order 1000 g>800 g>0 g>200 g>600 g>400 g, respectively. Mean Bacterial and Fungal population showed significant differences (p<0.05) across the different compost rates.

The diversity and distribution of bacterial isolates under the different compost rates in Table 4 showed that there was no uniform distribution of the eleven (11) bacterial isolates identified across the various compost rates. The bacterial isolates included: *Alcaligenes* sp*, Pseudomonas aeruginosa, Serratia* sp*, Staphylococcus* sp*, Bacillus* sp*, Micrococcus* sp*, Cronobacter* sp*, Tatumella* sp*, Cedecae* sp*, Proteus* sp*, Providentia* sp.

Results of the diversity and distribution of fungi isolates across the various compost rates in Table 5 showed that the nine (9) fungal isolates identified across the various compost rates were unevenly distributed. The fungal isolates included; *Penicillin* spp*, Trichoderma* spp*, Aspergillus lentulus, Mucor* spp*,* *Aspergillus niger*, *Geotrichum* spp, *Candida* spp, *Scopulariopsis* spp and *Rhizopus* spp (Plate 1). *Penicillin* spp was the most predominant of all fungal isolates, occurring at five compost rates, while Aspergillus specie was the least occurring and was only isolated from the initial soil sample.

**Table 3: Microbial Population (cfu/g) of Soils with the Different Compost Rates**

|  |  |  |
| --- | --- | --- |
| Compost rates | Bacteria (x106cfu/g) | Fungi (x104cfu/g) |
| 0 g | 5.78b | 4.27c |
| 200 g | 3.59a | 2.27a |
| 400 g | 3.32a | 1.41ab |
| 600 g | 2.96a | 2.23ab |
| 800 g | 3.36b | 4.30b |
| 1000 g | 6.42b | 4.56c |

**Means with the same letters were not significantly different at p<0.05**

**Table 4: Diversity and Distribution of Bacteria across all compost rates**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Isolates** | **Initial Soil**  | **Compost**  | **0 g** | **200 g** | **400 g** | **600 g** | **800 g** | **1000 g** |
| *Staphylococcus* sp | **+** | **+** | **-** | **-** | **-** | **-** | **-** | **+** |
| *Serratia* sp | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| *Pseudomonas* sp | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| *P. aeruginosa* | **-** | **-** | **-** | **-** | **-** | **-** | **+** | **+** |
| *Bacillus* sp | **+** | **+** | **+** | **+** | **+** | **+** | **+** | **+** |
| *Micrococcus* sp | **+** | **-** | **+** | **+** | **+** | **-** | **-** | **-** |
| *Alcaligenes* sp | **+** | **+** | **-** | **+** | **-** | **+** | **-** | **+** |
| *Cronobacter* sp | **+** | **+** | **-** | **+** | **+** | **-** | **+** | **-** |
| *Tatumella* sp | **-** | **-** | **-** | **-** | **+** | **+** | **-** | **-** |
| *Cedecea* sp | **-** | **-** | **-** | **-** | **-** | **-** | **+** | **+** |
| *Proteus* sp | **+** | **-** | **+** | **+** | **-** | **-** | **+** | **+** |

**Keys: + = isolated; - = not isolated**

**Table 5: Diversity and Distribution of Fungi across the Different Compost Rates**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Isolates** | **Initial Soil**  | **compost** | **0 g** | **200 g** | **400 g** | **600 g** | **800 g** | **1000 g** |
| *Rhizopus* sp | **+** | **+** | **-** | **-** | **-** | **-** | **-** | **+** |
| *Aspergillus niger* | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| *Rhodotorula* sp | **+** | **-** | **-** | **-** | **-** | **-** | **-** | **-** |
| *Gliocladium* sp | **-** | **-** | **-** | **-** | **-** | **-** | **+** | **+** |
| *Aspergillus flavus* | **-** | **+** | **-** | **-** | **-** | **-** | **-** | **-** |
| *Candida* sp | **+** | **+** | **-** | **+** | **-** | **+** | **-** | **+** |
| *Geotrichum* sp | **-** | **-** | **-** | **+** | **-** | **-** | **-** | **-** |
| *Penicillium sp* | **+** | **+** | **+** | **+** | **-** | **+** | **+** | **+** |
| *Scopulariopsis* sp | **-** | **-** | **-** | **-** | **+** | **-** | **-** | **-** |
| *Mucor* sp | **+** | **+** | **-** | **-** | **+** | **-** | **-** | **+** |

**Keys: + = isolated; - = not isolated**

The results on plant height after 4, 6, and 8 weeks of planting under various compost rates in Table 6 showed that the plant height at 4, 6, and 8 weeks of planting ranged from 13.20 – 24.67 cm. The results on number of leaves at 4, 6 and 8 weeks after planting under various compost rates in Table 7 showed that the number of leaves at 4, 6 and 8 weeks of planting ranged from 2.67 – 9.33 cm.



Plate 1: Pure culture of *A. niger*

**Table 6: Plant Height for Week 4 To Week 8**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment  |  | 4WAP | 6WAP | 8WAP |
| 0 g |  |  | 13.2000a | 18.0600a | 23.1833a |
| 200 g |  |  | 14.4000a | 18.1500a | 23.5767a |
| 400 g |  |  | 14.4867a | 19.0467a | 24.1933a |
| 600 g |  |  | 14.5133a | 19.1867a | 24.3333a |
| 800 g |  |  | 15.1067a | 19.5433a | 24.4733a |
| 1000 g |  |  | 15.2100a | 19.6167a | 24.6733a |

Means with the same letters were not significantly different at p<0.05

**Table 7: Number of Leaves for Week 4 to Week 8**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatment  |  | 4WAP | 6WAP | 8WAP |
| 0 |  |  | 2.6667a | 4.3333a | 7.6667a |
| 200 |  |  | 3.0000a | 5.0000a | 8.0000a |
| 400 |  |  | 3.0000a | 5.0000a | 8.3333a |
| 600 |  |  | 3.0000a | 5.0000a | 9.0000a |
| 800 |  |  | 3.3333a | 5.0000a | 9.0000a |
| 1000 |  |  | 3.3333a | 5.3333a | 9.3333a |

Means with the same letters were not significantly different at p<0.05

**Discussion**

Generally, the soils were dominated by high sand fractions followed by silt and finally clay, the soil were generally Sandy loam. The soils in the study area may have been formed through the weathering of quartz-rich parent materials, such as sandstone and granite which led to the development of sandy soils (Bruand *et al*., 2005). This result is consistent with findings by Ferriera *et al*., (2013). The experimental result clearly revealed that bulk density varied with various compost rates. It is also observed from the result that an increase in the organic matter content of the soil, led to a corresponding increase in the bulk density and vice versa. This could be as a result of the greenhouse covering which prevents exposure of the soil surface to impact of rainfall, which may have led to increase organic matter thereby reducing bulk density. This agreed with Sorensen and larsen (2023), who stated that higher organic matter on the surface soil makes the soil loose, porous and well aggregated, thereby reducing bulk density. Reduction in bulk density from the result agrees with the findings of (Yadav *et al*., 2020). Total porosity was significantly different under the different compost rates. Each compost rate had specific effect on the total porosity. The increased total porosity observed from the result may be due to the crop rooting system, or the leave number. This result is in consonant with the findings of Yadav *et al*., (2020); Sorensen and Larsen (2019) opined that fine particle fractions in the soil is responsible for high total porosity.

The high value of hydraulic test observed could be attributed to the fact that the soils was characterized by leaves cover and associated with higher rates of water infiltration (Mastro *et al*., 2020; Bruns *et al*., 2008) and lower surface runoff generation (Bruns *et al*., 2008) than soils under other vegetation types. The similarity in permeability class could be attributed to the randomization of the pots in the screen house. This is similar to the findings of Williiams (2008), who stated that topsoil has good structure and macro pores than subsoil.

The acidic nature of the soil (pH range: 5.22–6.43) under the various compost rates could be due to the available nutrient. According to bruns *et al*. (2008) nutrient content in soil can be altered to some extent by soil pH, thereby shaping the vegetation composition or diversity. The relative acidity observed, could be as a result of decomposition of plant residue or organic waste into organic acids. The soils of the different compost rates showed acidic nature which may also be due to the formation of organic acid from addition of compost (Liu *et al*., 2019). The result is similar to the findings of Rusu and Dimitru, (2023) who reported a pH less than 5.5 in soils treated with compost amendment. The organic matter content of the soils was not significantly different (P.0.05) at the different compost rates. This is so because crops raised in the green house with different various compost rates vary in their response to soil chemical makeup, generating a divergence in soil properties, which may influence the soil microbial community (Mastro *et al*. 2020). The total Nitrogen were generally high under the various compost rates, this could be due to the fact that crops in the screen house show preference for NH4+ (Liu *et al*., 2017). Also, all compost rates showed high value for TN which indicates high intake rate of these inorganic forms of N (NH4+ and NO3-) and organic form (glycin) from the soil. Available phosphorus was significantly different under the different compost rates, ranging from 31.63-59.78mg kg-1. Available phosphorus value was high under the different compost rates, this could result from phosphorus being readily available in inorganic forms, or it could be due to increased tree species diversity, annual litter input and soil organic carbon (Zhang *et al*., 2020). This could also be as a result of weathering of parent material (Geo *et al*., 2019). Exchangeable cation was significantly different at each compost rates ranging from 3.96-9.10 mol/kg. This result collaborates with the findings of Brady and Weil, (2008), who stated that on the other hand soil pH is affected by the concentration of the exchangeable acids and bases in the soil, as the pH level reduces with an increase in Al+ + H+ and a decrease in Ca, Mg and K.

This study showed that the evaluated compost rates had effect on the microbial population because there was significant difference in the population of bacteria and fungi and this variation is consistent with previous study (Jovanne *et al.,* 2021). It was observed that 1000 g compost ratehad high bacterial population compared to the other compost rates, which could have been because 1000 g had more compost quantity and the randomization of the pots (Prescott and Grayston, 2013) compared to others which had lower bacterial population. It could also be due to the 1000 gstand type and spatial arrangement, this is in accordance with Klimek *et al.,* (2016) and Uroz *et al.,* (2016), that stated that the degree of influence on soil bacterial structure and diversity depends on the, stand type, and spatial arrangement. The relative abundance of fungi in the rhizosphere of 1000 g compost ratemight be an indication of more quantity of compost, the specific leaf number of 1000 gis higher compared to 400ngwhich had the lowest fungi population. This is consistent with previous studies (Walther *et al.,* 2002; Martiny *et al.,* 2006), that stated that species traits such as leaf nutrients, leaf toughness and specific leaf area are known to contribute to the rate of decomposition of organic matter, which may drive the microbial community under the different compost rates (Walther *et al.,* 2002; Martiny *et al.,* 2006).

There microbial diversity in the soils at different compost rates could be attributed to variation in the compost rates applied to the soils. Results from this study showed more diversity in bacterial isolates in the soils with 800 g and 1000 g compost rates compared to the other compost rates, while diversity in fungi isolates was identified at 1000 g compost rate. The difference in the diversity of these soil organisms across the various compost rates could be due to the microclimate of each of the research environment. The amplitude of temperature fluctuations encountered and variation amongst the different compost rates, a factor that has been documented to affect soil microbial community (Lee *et al.,* 2019). The difference in the bacteria and fungi diversity and distribution could be due to the changes in temperature and soil moisture.

At 4 WAP, the control treatment (0) shows a mean value of 2.6667. As the compost rate increases, there is a slight increase in the mean values, with the highest treatment level (1000) showing a mean value of 3.3333. This suggests that even at early stages, compost application begins to positively influence plant growth. The SEM at this time point is 0.432, indicating some variability in the data.

By 6 WAP, the control treatment shows a mean value of 4.3333. The mean values for the treatments of 200, 400, 600, and 800 are all 5.0000, suggesting a plateau effect at these treatment levels. The highest treatment level (1000) shows a slightly higher mean value of 5.3333. The SEM at this time point is 0.181, indicating less variability compared to 4 WAP. This plateau effect might indicate that beyond a certain compost rate, additional compost does not significantly enhance growth within this period.

At 8 WAP, the control treatment shows a mean value of 7.6667. The mean values increase with higher compost rates, with the highest treatment level (1000) showing a mean value of 9.3333. The SEM at this time point is 0.090, indicating even less variability compared to the previous time points. This trend suggests that the benefits of compost application become more pronounced over time, with higher compost rates leading to greater plant growth.

The data indicates that increasing compost rates generally lead to higher mean values at each time point, with the most significant increases observed at 8 WAP. This aligns with findings from various studies that highlight the benefits of compost in improving soil structure, nutrient availability, and water retention, which collectively enhance plant growth (Mastro *et al*., 2020). However, it is also important to consider that excessive compost can lead to nutrient imbalances and other issues (Ekelund *et al*., 2024).

**Conclusion**

The study has demonstrated that moderate to high compost rates significantly improved nutrient uptake and plant growth. The compost amendments also increased soil organic matter content, which is crucial for maintaining soil fertility and health. Compost rates generally enhance bacterial populations, with the highest rates (1000 g) showing the most significant increases.

**Disclaimer (Artificial intelligence)**

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Details of the AI usage are given below:

1.

2.

3.

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