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Influence of Composted Poultry Manure on Organic Carbon and Selected Soil Properties under Tomato Cultivation

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Abstract

Soil quality improvement provides an environment for plant nutrient uptake that impacts the development and yield of crop. Thus, this study evaluated the effect of applied poultry composted organic manure (PCOM) on selected soil physical attributes and soil organic carbon content (SOC) under two tomato (UC82B and BESKE) varieties planted in succession. Three rates 0, 10 and 20 t ha^{-1} of compost were applied to two tomato varieties. The experiment was arranged in a 2x3 factorial experiment fitted into a randomized complete block design with three replicates. The soil physical parameters considered were - bulk density, aggregate stability, total porosity and SOC. It was observed that application of PCOM increased SOC, total porosity, aggregate stability and decreased the bulk density in the cropped tomato area. The SOC was highest in 10t ha^{-1} of PCOM. Application of 10 t ha^{-1} compost is adequate to improve carbon content and soil physical properties for a fragile soil.

Introduction

Soil degradation poses a major threat to sustainable agricultural practices and a major environmental threat among others due to excessive soil erosion, nutrient run-off and loss of soil organic matter. Its ineffective management has resulted in soil quality deterioration and consequently impedes crop development. Therefore, soil organic matter (SOM) improvement and stability is one major discussion in sustainable agriculture. According to Arriaga and lowery, (2003) reported that SOM enhances water holding capacity and aggregation of the soil which limits erosion and provides nutrients reservoir that can be released into the soil. This helps provide ease of cultivation, penetration, seedbed preparations, and greater aggregate stability and improve water holding capacity at low suction. For this reason, additional of organic material with high organic matter such as fresh and composted urban waste (Ron *et al*., 2003) shredded and composted plant material derived from municipal landscapes (Walker, 2003) and cotton gin compost and poultry manure (Tejada *et al*., 2006) to soils has become an environmental practice for soil restoration, maintaining SOM, reclaiming degraded soils and supplying plant nutrients (Walker, 2003).Previous studies have consistently found that application of manure can increase soil aggregation (Paglai *et al*., 2004) and total porosity (Schjonning *et al*., 2002). Miller *et al*., (2002) reported that manure amendment significantly ($P<0.05$) increased soil water retention compared to the

control across the whole matric potential range between 0 and 1500 kPa. It had also been observed that changes in water retention may depend more on the soil type (Edmeades, 2003) and its initial carbon content than the addition of organic material i.e. soil porosity (Ros *et al*., 2003). The objective of this study was to compare the residual effect of organic manure i.e. composted poultry manureon the following physical properties: hydraulic conductivity, water retention, soil aggregate stability, soil bulk density and total porosity of soil previously planted with tomato.

Materials and Methods

The experiment site was located behind Fadama area in Alabata, Ogun state which lies on latitude $7^0$22' 84"N to 7^0 22' 91"N North of the equator and longitude $3^0$45' 55"E to 3^0 45' 64"EEast of the Greenwich maritime. Land preparation was done by ploughing and harrowing. Compost was applied at the rate of 0, 10 and 20 t/ha which was thoroughly mixed with the soil before tomato varieties was transplanted at three week after planting (UC82B and BESKE). The plots weeds were cleared manually and free of weed throughout the first and second transplanting. The crop residues of the tomato varieties were left to decay on the plot after first planting. Land preparation for the succeeding tomato varieties (UC82B and BESKE were transplanted accordingly) was carried out by hoeing before transplanting. No compost was applied to the succeeding tomato at the spacing of 80 X 30cm with planting population of 56,000 plants per hectare. Weed control took place twice at 3 and 7 weeks after transplanting using Africa hoe. The total plot size was 720m^2 (36plots) and each experimental plot is 4m x 5m laid in 2 x 3 factorial experiment in randomized complete block design replicated three times.

Initial soil samples were collected before and after first and second planting which were analyzed. Soil sample were equally collected at 0 – 20cm and 20 – 40cm depth from each experimental plots. Core samplers are used for the undisturbed sample and shovel were used for the disturbed sample. The Total Organic Matter was determined using Walkey-Black method (1964) to estimate the organic carbon content and its value was multiplied by a standard factor (1.724) in getting the corresponding percent organic matter. Aggregate Stability was estimated using wet sieving techniques as described by Emerson, 1997.Saturated Hydraulic Conductivity was determined using constant head method (Klute and Dirksen 1986).Bulk Density was determined by using the core method (Harte and Horn, 1989). Total Porosity was determined in undisturbed water saturated cores assuming no air was trapped in the pores.

Statistical Analysis

Data generated were subjected to analysis of variance. The analysis of variance was carried out using Genstat statistical package release 7.2 DE (2007) and significant difference was reported at $P \leq 0.05$.

Results and Discussion

Pre-planting soil analysis

Soil reaction of the studied site was slightly acidic (6.04 and 5.59) before planting and after first planting (Table 1). The analyzed results also revealed that the soil of the studied site had very low Av. P, TN, K and OC according to Federal Department of Agricultural Land Resources fertility range (1990) before planting. This was however amended reasonably after the first planting of tomato varieties as shown in the Table 1. Therefore, there was good response to soil amendment form the crop and soil.

Soil Organic Carbon

The soil organic carbon (SOC) concentrations within two depths i.e. 0 – 20cm and 20 – 40cm, were significantly higher than the control in both tomato varieties. The tomato plot amended with 10 t ha^{-1} showed higher SOC at both depths. The increase in SOC due to the application of organic manure is in line with Sharma *et al*., 2002 finds which inferred that application of organic matter encourage higher root biomass accumulation and increased mineralization in fertilized plot than in control plot.

Soil Bulk Density

The soil bulk density (BD) at 0 – 20 cm and 20 – 40 cm revealed that poultry composted manure decreased soil bulk density compare with the control plot in both crop (Table 3). The BD in surface layer 0 – 20cm was significantly lower than that of the subsurface layer (20 – 40cm) (Table 3). This conform with Schjonning *et al*., (2002) findings that there is reduction in the BD of the soil due to application of animal manure; while Rose (1991) also found decreased in BD in plots receiving farmyard manure.

Table 1. **Soil analysis results of the studied sites before planting and after first planting**

Parameters	Value	
	Pre planting soil Analysis	After first planting Analysis
pH (H_2O)	6.04	5.59
Total Nitrogen, TN (g/Kg)	0.09	0.46
Potassium, K^+ (Cmol/Kg)	0.42	1.01
Available Phosphorus, Av. P (mg/Kg)	1.55	1.25
Sodium, Na^+ (Cmol/Kg)	0.23	0.18
Magnesium, Mg^{2+} (Cmol/Kg)	1.47	1.16
Calcium, Ca^{2+} (Cmol/Kg)	2.35	1.87
Total Exchangeable Acidity, TEA (Cmol/Kg)	0.17	0.14
Cation Exchangeable Capacity, CEC (Cmol/Kg)	4.62	3.47
Organic Carbon, OC (%)	1.01	2.17
Base Saturation, BS (%)	96.1	89.1
Bulk density (g/cm^3)	1.63	1.47
Sand (g/Kg)	805	800
Clay (g/Kg)	80	92
Silt (g/Kg)	105	108
Texture	Loamy Sand	Loamy Sand
Porosity (%)	46	48
Permeability (cm/hr)	4.50	5.15

Table 2. **Organic carbon (%) as affected by poultry manure under tomato cultivation**

Tomato varieties	Compost rate (t/ha)	Depth (cm)	
		0 – 20	20 - 40
UC82B	0	1.257	0.883
	10	1.917	1.368
	20	1.765	1.173
	0	1.207	0.870
BESKE	10	2.378	1.082
	20	2.298	1.063

lsd at ($p>0.05$) for treatment[a] x depth is 0.6440
treatment[a]= tomato varieties x compost rate

Table 3. **Soil bulk density as affected by poultry manure under tomato cultivation**

Tomato varieties	Compost rate (t/ha)	Depth (cm)	
		0 – 20	20 - 40
UC82B	0	1.357	1.593
	10	1.340	1.487
	20	1.312	1.502
	0	1.435	1.457
BESKE	10	1.252	1.410
	20	1.375	1.380

lsd at (p>0.05) for treatment[a] x depth is 0.1244
treatment[a]= tomato varieties x compost rate

Total Porosity

The total porosity (TP) was higher in treated plots compared with the control (Figure 1). The highest TP were recorded in the plots amended with 20 t/ha organic manure for both tomato varieties (49.83-UC82B and 49.75-BESKE respectively). Thus, the trend of the TP for the applied soil amendment rate was 20 t/ha > 10 t/ha > 0 t/ha. This is in agreement with Celik *et al*., (2004) report that total porosity with soil organic amendments depends on the amount added.

Aggregate Stability

The aggregate stability expressed in terms of mean weight diameter (MWD) increased with increased in application rate. Plot amended with 20 t ha^{-1} showed a decrease in the trend in both tomato varieties at both depths (Figure 2). The MWD was highest in plot treated with 10t/ha. The MWD at the sub surface (20-40cm) was higher compare with the surface (0-20cm)(Figure 2). This was due to absence of tillage practice which induces disruption of soil aggregate in deeper soil layer and compaction of soil due to over-burden pressure, which induced close contact of soil particle and consequently better adhesions of soil particle to form stable aggregate (Ghuram and Sur, 2001).

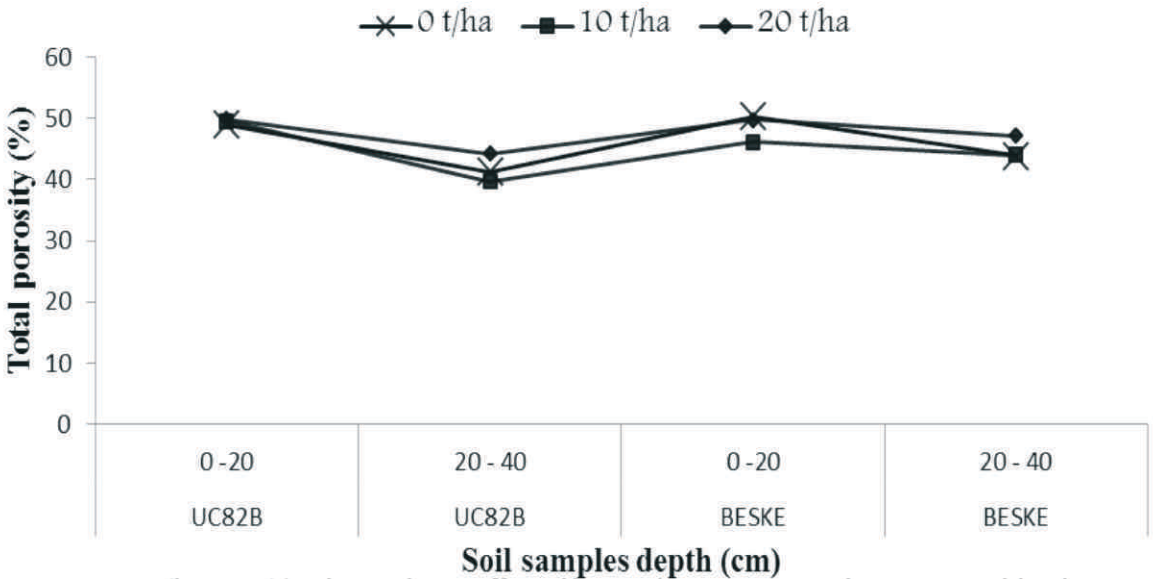

Figure 1. **Total porosity as affected by poultry manure under tomato cultivation**

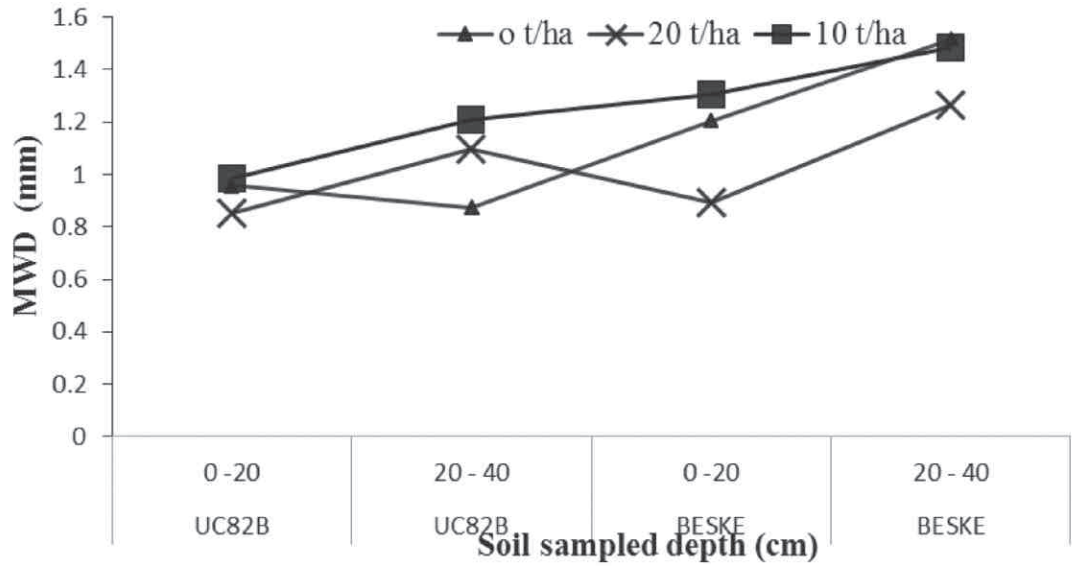

Figure 2. **Mean weight diameter (MWD) as affected by poultry manure under tomato cultivation**

Conclusion

This study showed that application of composted poultry manure to soils increased soil organic carbon and decreased soil bulk density thereby causing an increase in total porosity of the soil. Generally, high soil organic matters promote increased selected soil physical properties. The plot amended with 10 t ha^{-1} composted poultry manure has the highest organic carbon content and shows increased in soil physical properties than either the control or plot amended with 20t/ha. Application of organic manures at 10 t ha^{-1} is adequate to improve carbon content and other soil physical properties for fragile soils characteristics of the area.

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