Variation of Bulk Density and WHC of Vermicompost Exposed to Selective Commercial Fertilizers

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Abstract: ***Soil's physical properties can be used as indicators for making soil -quality assessments and for determining the sustainability of farming systems. There is at present a lack of comparative research into soil physical properties between organic and conventional management in agriculture. It has been observed that continuous use of chemical fertilizers in imbalanced form deteriorates soil physical properties. Conventional management of soils with intensive cultivations and the use of synthetic agrochemicals have often been associated with degradation in soil quality whereas organic farming has been suggested as an approach to conserve and protect the soil environment. Present study aimed at studying the effect of selective inorganic and organic based commercial fertilizers on physical properties of the final vermicompost.***

Keywords: Vermicompost, Earthworms, Agriculture, Soil, Fertilizers

1. Introduction

Earthworm casts have a higher moisture content, pH, and levels of organic carbon and inorganic nutrients compared to adjacent soil (Bhadauria & Ramakrishnan 1989; Edwards 1988; Scullion *et al.* 2002). Temperate and tropical regions has been evaluated previously, with most of the available information indicating that earthworm casts have a higher nutrient content than adjacent soil (Araujo *et al.* 2004; Basker *et al.* 1993; Bossuyt *et al.* 2005; Krishnamoorthy 1989). The excretory wastes of these worms have been found to contain rich proportions of water soluble nutrients. Due to this reason, incredible results have been obtained in providing increased soil fertility on their use. Soil from the subsurface horizons is translocated by these animals to the upper horizons, where it is mixed with the surface soil, resulting in a more uniform distribution of plant nutrients (Darwin 1881). Earthworm casts generally have a higher water-holding capacity than bulk soil samples (Elliot *et al.* 1990). Most earthworms consume, at the best, half their body weight of organics in the waste in a day. *Eisenia fetida* is reported to consume organic matter at the rate equal to their body weight every day. Earthworm casts typically have high amount of total and available nitrogen, organic matter, total and exchangeable calcium, magnesium, potassium and available phosphorus compared to surface soils (Lavelle and Martin, 1992). Apart from providing the more available nutrient to plants, plant growth regulators belonging to the auxins, gibberlin and cytokinins groups present in the earthworm worked materials are produced by wide range of soil microorganisms, many of which live within the casts (Tomati et al., 1983). Earthworm casts had higher number of celluloytic aerobes and hemi celluloytic, amylolytic, nitrifying and denitrifying bacterial than the soil in which they lived (Elliot et al., 1990). Hendriksen (1997) found that worm casts ingested with soil may create an even more favourable environmental because of the higher moisture content and available nitrogen found in fresh casts. Worm casts ingested soils often have much higher content of soil organic carbon and nutrients than the surrounding soil (Lee, 1985).

2. Soil Bulk Density and Water Holding Capacity

It is the soil texture that finally influences the earthworm population density and species richness. Soil texture refers to the relative amounts of *sand*, *silt* and *clay* that are present in a soil. The physical nature of the soil affects the growth of an established plant through its influence on various factors such as aeration and moisture supply. In addition, such physical properties alter the resistance offered to root elongation and enlargement, proliferation and water uptake, which in turn affect plant nutrition. The bulk density is an indirect measure of pore space within a soil. Celik et al. (2010) and Zebarth et al. (1999) reported a decline in bulk density (BD) after long-term application of organic fertilizers. It has been observed that continuous use of chemical fertilizers in imbalanced form deteriorates soil physical properties (Biswas et al., 1971; Prasad et al., 1983). Detrimental effects of chemical fertilizers even in balanced form on soil physical properties are also being observed.

Soil texture influences to a large extent several components of soil fertility such as the amount of nutrient reserves and their proportions to the available nutrient fraction. It also influences several properties such as aeration, pore space distribution, WHC and drainage characteristics. Earthworm activity depends on availability of soil moisture. Soil "holds" water available for crop use, retaining it against the pull of gravity. This is one of the most important physical facts for agriculture. Soil texture and organic matter content are the key components that determine soil water holding capacity (WHC). Management practices designed to improve soil structure are the main way to improve WHC. Application of wastes, either for plant nutrient supply or for disposal purposes, increases the C content of the soil. The increased water holding capacity may be due to aggregate nature of worm castings (Jadia et al., 2008).

3. Experimental Set Up

Our study aimed on assessing the effect of few chemical fertilizers on physical parameters as WHC and BD of the final vermicompost using the Earthworm sp. *Eisneia foetida* which were procured from the vermicomposting unit of Rajasthan College of Agriculture, Udaipur. Worm beds were prepared with 1: 1 ratio of soil and cow dung in which 20 mature worms of *Eisenia foetida* were introduced. For each of the experimental pots three replicates were set.

Three and four doses of chemical fertilizers Urea and DAP were set respectively, these were 0.75gm/ kg, 1.5gm/ kg, and 2.25gm/ kg and 2.75gm/kg soil. Also, two experimental sets of commercial organic fertilizers namely Kala Sona and Micro-AD solution were set. In addition to these, one control set without any treatment was also set parallel. The observation and results of the same has been depicted below.

4. Results & Discussion

In our experiment, the initial soil bulk density was found as 1.353 ± 0.006. After 60 days, when the soil in the control set was taken for checking the bulk density, it was calculated to be 1.280 ± 0.000. In the chemical fertilizer Urea, the BD (bulk density) value obtained was 1.330 ± 0.010, 1.320 ± 0.000, 1.340 ± 0.010 under 0.75gm, 1.5gm & 2.25gm of the chemical respectively. This value was 1.283 ± 0.006, 1.293 ± 0.006, 1.290 ± 0.000 & 1.300 ± 0.000 under DAP treated sets with 0.75gm, 1.5gm, 2.25gm and 2.75gm of the fertilizer respectively. In the organic fertilizer treated sets with „Kala Sona‟ 0.45gm & 0.9gm, the BD was 1.310 ± 0.010 & 1.330 ± 0.010. Whereas, the BD were calculated as 1.320 ± 0.000 and 1.333 ± 0.006 under „Micro-AD‟ concentration of 0.2ppm & 0.4ppm respectively.

Table 1: Chemical Analysis of Vermicompost

Parameters	Initial	Control	Kala Sona 0.45gm/kg	Kala Sona 0.9gm/kg	Micro-AD 0.2ppm	Micro-AD 0.4ppm	Urea 0.75 gm/kg	Urea 1.5 gm/kg	Urea 2.25 gm/kg	DAP 0.75 gm/kg	DAP 1.5 gm/kg	DAP 2.25 gm/kg	DAP 2.75 gm/kg
Bulk Density	1.353 ± 0.006	1.280 ± 0.000	1.310 ± 0.010	1.330 ± 0.010	1.320 ± 0.000	1.333 ± 0.006	1.330 ± 0.010	1.320 ± 0.000	1.340 ± 0.010	1.283 ± 0.006	1.293 ± 0.006	1.290 ± 0.000	1.300 ± 0.000
WHC	54.210 ± 0.053	58.720 ± 0.061	62.530 ± 0.061	63.300 ± 0.046	56.980 ± 0.053	58.600 ± 0.040	55.363 ± 0.318	54.800 ± 0.061	54.360 ± 0.046	57.220 ± 0.053	56.840 ± 0.056	55.600 ± 0.052	55.220 ± 0.338

Soil bulk density among Exp. sets Control, fertilizers Kala Sona, Micro-AD, Urea and DAP was analyzed. Test result shows highly significant difference in the soil bulk density values of Control, Kala Sona, Micro- AD, Urea and DAP (F=33.62, p<0.001) which has been shown in Table 6.2.10. Soil bulk density was highest for Urea treated sets and it was slightly lower for Micro AD fertilizer exposed vermicompost than Urea fertilizer. Soil bulk density was seen minimum for control set.

Table 1.1: Soil Bulk Density

Group	N	Mean	SD	F	Result
Control	3	1.280	0.000	33.62	***
Kala Sona	6	1.320	0.014		
Micro AD	6	1.327	0.008		
Urea	9	1.331	0.012		
DAP	12	1.292	0.007		

*** = *p < 0.001*

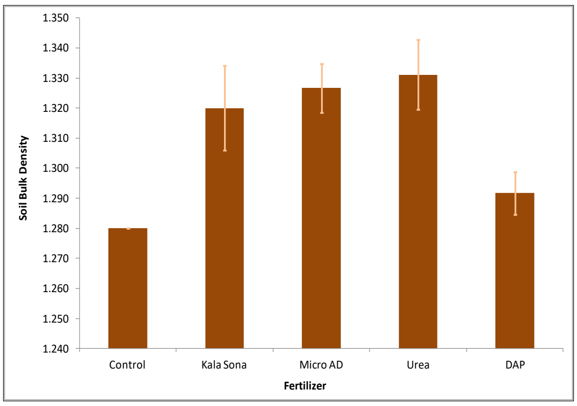

Figure 1 (a): Bulk Density

Water holding capacity of the vermicompost in all the experimental set was calculated. The WHC in the control set was found to be 58.720 ± 0.061 % which was found to be increased from that of the initial value which was 54.210 ± 0.053 %. In the chemical fertilizer set Urea 0.75gm, 1.5gm and 2.25gm, the calculated value for WHC (Water holding capacity) was observed to be 55.363 ± 0.318, 54.800 ± 0.061 % & 54.360 ± 0.046 % respectively. The other fertilizer DAP in its four different Exp. sets viz. 0.75gm, 1.5gm, 2.25gm and 2.75gm was found with WHC value as 57.220 ± 0.053 %, 56.840 ± 0.056 %, 55.600 ± 0.052 % and 55.220 ± 0.338 %. In the two organic fertilizers „Kala Sona‟ & „Micro-AD‟ with their respective doses 0.45gm, 0.9gm, 0.2ppm and 0.4ppm, the WHC was calculated to be 62.530 ± 0.061 %, 63.300 ± 0.046 %, 56.980 ± 0.053 % and 58.600 ± 0.040 %. Water holding capacity was compared for different Exp. sets Control, Kala Sona, Micro-AD, Urea and DAP. Highly significant difference in the values of water holding capacity of these groups was found (F = 136.32, p<0.001) which has been shown in Table 6.2.11. The water holding capacity was found to be highest for soil in Kala Sona Exp. set whereas it was least for Urea treated sets. An increase in C content of the soil increases aggregation, decreases bulk density, increases water holding capacity.

Table 1.2: Water Holding Capacity

Group	*N*	*Mean*	*SD*	*F*	*Result*
Control	3	58.73	0.06	136.32	***
Kala Sona	6	62.92	0.42		
Micro AD	6	57.79	0.89		
Urea	9	54.90	0.52		
DAP	12	56.25	0.84		

*** = *p < 0.001*

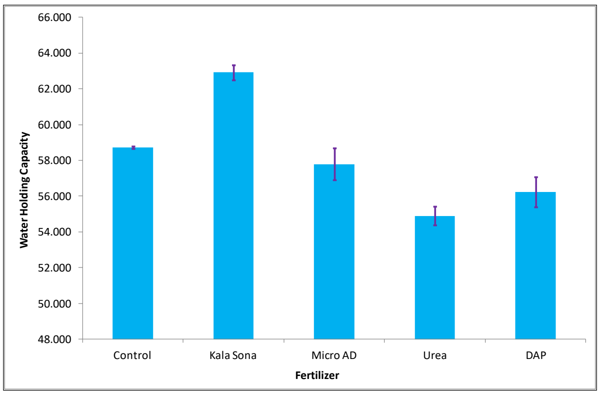

Figure 1 (b): Water Holding Capacity

Several workers have documented changes in soil physical properties following additions of phosphatic fertilizer materials to soils (Lutz et al., 1960; Thein, 1976) For example, approximately one year after initiating several phosphate trials (base rate = 150 kgP ha-1) on North Carolina podzolic soils Lutz et al observed that the P-treated plots were moist, loose and easy to plough whereas control plots were hard, dry and very difficult to plough. Measurements confirmed that P-treated plots had a lower bulk density and higher soil moisture content throughout the growing season. Ashja (2002) stated that increased soil bulk density caused a reduction of abundance and biomass of earthworms. The maximum bulk density was found in the inorganic treatment followed by organic treatments and control. Similar findings have been recorded by the Sharma *et al*. (2001) and Malik et al., (2014). Studies have observed lower soil bulk density and improved soil porosity as a consequence of organic fertilizers application (Agbede et al., 2008; Hati et al., 2006); although some research found no significant effect on bulk density in soils receiving compost composed of a mixture of chicken dung and sawdust (Yusuff et al., 2007), or receiving organic fertilizers combined with inorganic fertilizers (Benbi et al., 1998). Soil bulk density was significantly lower in plots where organic fertilizers compared to control were applied in previous crop. These results might be related to the significant difference among treatments found for soil organic C (Aguilera et al., 2012). Clements et al. (1991) and Hoogerkamp et al. (1983) found a higher bulk density when earthworms were absent. Laboratory studies showed that additions of P to samples favoured flocculation of soil colloids and increased the water holding capacity of the soils. Since soil organic matter content and soil biological activity increases when manures are applied to soils it is not surprising that soil physical properties also typically improve (Sanchez et al., 1989). Indeed, direct relationships have been established for changes in bulk density and water holding capacity as a function of net increases in soil organic C caused by organic waste applications (Khaleel et al., 1981).

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