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Elucidating Potential Application of Vermicompost on Alluvial Soil (Entisols) Physico-chemical Properties of Gwalior District, Madhya Pradesh

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ABSTRACT

The CRC farm was the site of a field investigation, at ITM University in Gwalior during 2022-23 to investigate the impact of Physico-chemical effects of vermicompost on soil for which seven different treatments were implemented, and the results indicated that treatment T6 (RDF@50%+ vermicompost@100%) led to a reduction in soil pH (7.71) and EC (0.364 ds m^{-1}) while improving soil physical properties such as bulk density (1.24 g cm^3), porosity (51.37%), and moisture (11.76%) furthermore treatment T6 also outperformed the control plot (T1) in terms of organic carbon (0.25%), accessible nitrogen (263.42 kg ha^{-1}), phosphorus (18.44 kg ha^{-1}), and potassium (481.4 kg ha^{-1}). The results of this research shows that adding vermicompost significantly and favorably affected the physico-chemical properties of soil.

***Key words**: Chemical properties, Physical properties, Soil health, Vermicompost*

Introduction

The alluvial soil profiles belong to entisols which are shallow in nature. These soils are referred to as immature soils because the soil profile is still evolving. They are relatively young in comparison to other soil types, and the soil texture is loamy. It is distinguished primarily by a mixture of sand and clayey elements. As a result, alluvial soils frequently have low levels of organic carbon and nitrogen. However, this soil contains high levels of alkalis and potash. As a result, adding organic amendments to this soil increases its organic matter and nitrogen levels.

A fertile and healthy soil is the foundation for a happy life for plants, animals, and humans. Healthy and productive soil is built on organic matter. For the development of ecologically friendly farming practices, it is essential to understand how important soil is to organic matter as health. using chemical fertilizers in place of organic inputs, which also pollutes the environment, and compromises the physical, chemical, and biological qualities of soil over time (Albiach *et al*., 2000). The ability of soil organic matter to adsorb contaminants and have a positive effect on soil quality metrics, Cation exchange capacity and water-holding capacity are crucial for the sustainability of agricultural output. (Liu *et al*., 2006). Humic compounds have a complex effect on organic matter and help to remove soil pollution. Organic colloids in soil organic matter have a

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high capacity for cation and water adsorption. As a result, It can enhance the soil's capacity to hold onto nutrients and water. It might improve the soil's resistance to situations that are both acidic and basic.

Vermicompost is an organic material that is abundant in nutrients and a soil conditioner., when added to soil, enhances the physical, chemical, and biological characteristics (Ashokan, 2008). By increasing the nutrient content, soil organic matter, and cation exchange capacity, it can be utilized to enhance soil structure and fertility (Srivastava *et al.,* 2011). Vermicompost improves soil structure by increasing porosity and water storage capacity, making it easier for roots to breathe and expand. Parthasarathi and colleagues (2008). By improving the soil's organic and chemical properties, vermicompost increases the soil's fertility (Purakeyastha and Bhatnagar, 1997). It has been discovered that vermicompost has significant levels of microbial and enzyme action, total and accessible nitrogen, phosphorus, potassium (NPK), micronutrients, and growth regulators (Parthasarathi and Ranganathan, 1999; Chaoui *et al*., 2003). The exchangeable potassium (K) levels in vermicompost were over 95% higher. A significant the quantity of calcium (Ca), magnesium (Mg), zinc (Zn), and manganese (Mn) are also present. (Mn) (Suhane, 2007). Organic fertilizers, such as vermicompost, are highly recommended in agricultural production to enhance the chemical, physical, and biological qualities of soil and to give plant nutrients to soils.

Materials and Methods

Vermicompost Processing

Earthworms and microorganisms collaborate during the breakdown process known as vermicomposting. A variety of agricultural wastes, including cow and buffalo dung, urine, wheat straw, and paddy straw, were used as raw materials in the preparation of vermicompost. The raw material to buffalo dung ratio was 2:1 for optimal earthworm and microorganism growth. Separate vermibeds are carefully filled, and materials are mixed in a predetermined ratio. Vermibed was 2 m x 1 m x 0.75 m in size. After escaping the heat of the raw material, 150gm earthworms were released on each vermibed. Jute bags or dry grasses were placed on top of the vermibed to protect it from birds, insects, and direct sunlight. Maintaining an appropriate temperature and humidity during vermicomposting, Water frequently to maintain the compost's healthy moisture content (35-45%). *Eisenia fetida*, the most common earthworm species, was used for vermicomposting. They can withstand temperatures ranging from 15 to 48 degrees Celsius. The material was turned after 15, 30, and 50 days after the worms were released. Watering was stopped 4-5 days early when the vermicomposting reached maturity, and sieving was done on alternate days. The compost was collected after 70 to 90 days. A sample of vermicompost was taken and analyzed from each unit. This vermicompost's effects on the physical characteristics of the soil were examined.

Experimental setup

The research was conducted at ITM University, Gwalior, during the summer season of 2022-23, to assess the impact of vermicompost on the physicochemical changes of soil. Three replications of a randomized block design were used to build up the experiment. Okra (*Abelmoschus esculentus*) was grown as an experimental crop.

Treatments combinations under study

T1-@CONTROL, T2- RDF @100%, T3- V.C, T4-RDF @50% + V.C @50%, T5- RDF @25% + VC @75%, T6 - RDF @50% + V.C @100%, T7- RDF @100% + V.C @50%

*RDF-(100:50:50), *VC@100% -Vermicompost @100% (12 tonns/ha.)

Investigation of physicochemical parameters

After harvesting the experimental crop, samples of the upper layer of soil (0-15 cm) were taken from the field. These dirt samples underwent additional processing and were applied to numerous physical and chemical investigations. The core sampler technique was used to calculate the soil bulk density, porosity was calculated using the formula described by Richard (1968), and moisture (%) is determined by the box method (Chopra and Kanwar, 1986). The pH of the soil was measured with glass electrodes in suspensions of 1:2 soil and water (Piper, 1967), and the Conductivity Bridge was used to detect electrical conductivity (EC). The Walkley and Black (1934) method was used to determine organic carbon (OC), while the Subbiah and Asija (1956), Olsen *et al.* (1954), and Jackson (1973) ammonium acetate flame photometer process were used to determine available nitrogen, phosphorus, and potassium respec-

tively.

Findings and Discussion

Effects on physical properties of the alluvial soil

Bulk density, Porosity, and Moisture percentage (%) Table 1 shows that the application of vermicompost significantly affects the physical properties of soil. A significant change was observed in properties similar to bulk density, porosity, and moisture holding capacity were observed, among all the lowest bulk density (1.24 g cm^{-3}) and the maximum porosity (51.37%) were found in the experimental plot with the application of RDF @50% + V.C @100%. Similarly, during the experiment, it was found that the treatment T6 has the highest moisture percentage (11.76%). The addition of vermicompost increases macro and micro pores by decreasing bulk density, which improves soil moisture (%). Similar results were observed by (Weber, 2007) in their long-term studies i.e. composting enhances soil physical qualities by reducing bulk density and increasing soil water holding capacity

Table 1. Effects of various treatments on the soil physical characteristic.

Treatments	Bulk Density g/cm^3	Porosity (%)	Moisture (%)
T1	1.31	48.62	9.66
T2	1.32	48.23	9.75
T3	1.25	50.97	11.24
T4	1.29	49.40	10.14
T5	1.277	49.93	10.27
T6	1.24	51.37	11.76
T7	1.30	49.01	10.10
CD±0.05	0.04	1.72	0.84

Impact on the soil's reaction

Soil pH

The most significant soil physicochemical characteristic is considered to be the soil response because it controls the availability and uptake of nutrients by the crop. In the current study, the data given in Table 2 shows that the soil pH was significantly reduced when compared to the initial soil pH (8.137) in the treatments that received 100% vermicompost i.e. T6 (7.713). Applications of vermicompost and organic fertilizer consistently and noticeably reduced soil pH, according to Chand *et al.,* (2011) and Kumar *et al*. (2011).

Soil EC

Vermicompost was found to have no significant effect on electrical conductivity during testing (EC) represented in Table 2. During the experiment, T2 had the highest electrical conductivity (0.378 ds m-1) and T6 had the lowest (0.364 ds m^{-1}). Vermicompost was found to have no significant effect on electrical conductivity during testing (EC). Reduced EC could be the result of salts being leached as a result of increased permeability (Srikanth *et al.,* 2000).

Effect on Soil Organic Carbon

The significant increase in organic carbon (%) was observed under treatments with vermicompost application. T6 i.e., 100% VChas the highest organic carbon (0.25%), in comparison to T1 (0.17%) i.e., control, as represented in Table 2. The fact that organic material greatly affected mineralization rates and directly increased soil carbon could cause the significant change in OC (%) level observed in plots treated with organic manure. According to various studies. The percentage of organic carbon in the soil rise with the addition of organic wastes and manures (Manivannan *et al.,* 2009).

Effect on Nutrient status of soil

Soil Nitrogen

Treatments had a significant impact on the amount of macro nutrients present in soil. Nitrogen levels in the soil were found to be significantly improved with the application of vermicompost, given in Table 2, the highest amount was found in the treatment with application of 100% VC and 50 %RDF i.e. T6 (263.42 kg ha^{-1}) and lowest in the treatment T1 (196.52 kg ha^{-1}), (Manivannan *et al*., 2009). The findings concur with those of Lim *et al*. (2015), who found out that vermicompost application significantly increases soil N content, plots that received organic manures, such as vermicompost, had significantly higher levels of accessible P; the amount of phosphorous obtained in T6 was 100.87% higher than in T1.

Soil Phosphorus

The application of vermicompost, either alone or in combination, improved the level of phosphorus availability as represented in Table 2 the treatment with 100%VC and 50%RDF i.e. T6 is identified to have the highest phosphorus content, (18.44 kg ha^{-1}).

Table 2. Effects of various treatments on the soil's chemical characteristics

Treatments	pH	EC (ds m^{-1})	OC (%)	N (kg h^{-1})	P (kg h^{-1})	K (kg h^{-1})
T 1	8.13	0.373	0.17	196.51	9.18	425.6
T 2	8.03	0.378	0.187	221.60	12.09	440.53
T 3	7.78	0.365	0.237	234.15	13.66	451.73
T 4	7.93	0.369	0.213	225.79	12.54	448
T 5	7.87	0.366	0.227	230.63	14.70	459.2
T 6	7.71	0.364	0.25	263.42	18.44	481.4
T 7	7.92	0.371	0.22	246.25	17.02	462.93
CD±0.05	0.21	ns	0.045	31.71	0.58	30.76

After applying vermicompost, the soil's pH may have fallen due to the increased availability of P. Marinari *et al.* (2000) and Azarmi (2008). Both researchers noticed comparable rises in soil P after adding organic amendments.

Soil Potassium

Similar increases in soil K were observed by both teams after adding organic amendments. T6 was the treatment with the highest measured K content (481.4 kg ha^{-1}) represented in Table 2. The direct addition of potassium to the potassium pool in the soil may be the cause of the beneficial effects of vermicompost and farmyard manure on the level of accessible K. (Sharma *et al.*, 2003).

The current experimental results show that the application of vermicompost has a higher impact on the main soil nutrients nitrogen, phosphorus, and potassium than other soil properties. Alluvial soils frequently have low nitrogen and less organic matter due to their immature soil structure, making organic additives with a high organic matter content essential for strengthening soil features in this state. Additionally, it was discovered that the combined use of organics and fertilizers produced higher levels of accessible K than the alone use of fertilizers under the high hills and moderate climate of the North-Western Himalayas (Sharma *et al.*, 2003).

Conclusion

The results of this experiment clearly show that, the combination of 50%RDF+100%VC can be employed as a substitute to 100 RDF% which reduced the pH of the soil, while also boosting nutrient availability and had an positive effect on the soil physical properties as well. The trial's findings revealed that combining organic additives like vermicompost with low amounts of inorganic fertiliser improved soil quality, reduces pressures of soil deterioration and leads to maintaining soil health, fertility and productivity.

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