Original Research Article

Vermicompost Dosage Effects on Physical and Physico-Chemical properties of Non-GM Cotton in Vidarbha's Rainfed Farms

ABSTRACT:

The experiment, conducted at COART, Akola during *Kharif* 2021-22, evaluated the impact of various vermicompost doses on physical and physico-chemical properties of Non-GM cotton cultivars in rainfed agriculture. Employing an FRBD with eight treatments replicated thrice, the study revealed that the application of 60 kg N ha^{-1} through vermicompost (T4) led to the most significant improvements: reduced soil bulk density (1.24 Mg m^{-3}), increased water holding capacity (58.22%), and elevated organic carbon content (5.67 g kg^{-1}). The Hirsutum cultivar, Chetna J1, displayed the best results. Conversely, the lowest pH (7.57) and EC (0.25 ds m^{-1}) were observed in treatment T2, where 60 kg N ha^{-1} was supplied through vermicompost to the Arboreum cultivar, AVC 14.

Keywords: Vermicompost, Organic cotton, Rainfed Agricultural system

1. INTRODUCTION:

Cotton is one of the most important fibre and cash crop of India. It plays a key role in Indian agriculture and industrial economy. It is a backbone of textile industries. It is an important cash crop globally known as 'King of Fiber'. Cotton seed contain 15-20% oil and used as vegetable oil in soap industries. The leftover cake, a by-product of cotton mill is very important feed for livestock. Due to its importance in agriculture and industrial economics it is designated as "White Gold". Cotton is one of the most chemically intensive crops in the world. According to the U.S. Department of Agriculture, 84 million pounds of pesticides were applied to the nation's 14.4 million acres of cotton in the year 2000 and more than two billion pounds of fertilizers were spread on those same fields. Seven of the 15 pesticides commonly used on cotton in the United States are listed as "possible," "likely," "probable" or "known" human carcinogens by the Environmental Protection Agency. The intensive farming practices in cotton have shown a range of problematic side-effects on natural resources and farm households (Kooistra&Termorshui-zen,2006). As an attempt to improve the ecological and socio-economics sustainability of cotton production, organic cotton

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initiatives were started not only in India, but also in other Asian, African and South American countries. Vermicompost is organic fertilizer, it is an excellent source of nutrients for crops and helps to convert organic waste into rich humus. It is derived by composting organic waste by using various species of earthworms. Vermicompost enhance soil fertility physically, chemically, biologically. Vermicompost treated soil has better aeration, porosity, bulk density and water retention. Earthworms create vermicompost, which is a rich source of micro and macronutrients, vitamins, growth hormones, and enzymes. The nutrients present in it are readily water soluble for the uptake of micro flora. (Bhavalkar, 1991). Most of the soils are poor in nitrogen and organic matter. Particularly the soils of the cotton growing areas are low in organic carbon, nitrogen and available phosphorus (Rattan *et al.*1999). Increase in production and productivity can be achieved only through enhanced soil fertility which can be sustained if the nutrients removed from soil are replenished by way of addition. Supplying the entire quantity of nutrients required for cotton through fertilizer may not be possible. It is essential to develop strategies for utilizing all available organic resources and to develop crop management system for sustainable crop production.

2. MATERIALS AND METHODS:

Soil: The present investigation was conducted at Research Farm Centre for Organic Agriculture Research and Training (COART), Department of Agronomy and department of SSAC, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif* 2021-22. The topography of the experimental plot was fairly uniform.Soil of experimental field was classified as Vertisols, particularly montmorillonitic, hyperthermic a family of Typic Haplustert. It has smectite clay minerals with swell- shrink properties. The soil of the experimental field was clay loam in texture and moderately alkaline in reaction. Akola is situated in sub tropical region between 22 3 0 42' N latitude and 770 02' E longitudes. The altitude of the place is 304.42 m above 30 3 mean sea level. The climate of Akola is semi arid and characterized by three distinct season viz., hot and dry summer from March to May, warm humid rainy season from June to October and mild cold winter from November to February. The experimental rainfed cotton crop was sown on 24th June 2020 and harvested in December 4th. The total rainfall received during the crop growth period was 1084 mm in 54 rainy days.

Vermicompost application: 3 doses of vermicompost havebeen given to the crop at different rates i.e 40kg N/ha and 60kg N/ha to different cultivars of cotton.Vermicompost exhibits a nutrient composition characterized by a balanced ratio of 1.5 parts nitrogen (N), 0.5 parts

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phosphorus (P), and 0.5 parts potassium (K). This composition underscores its suitability as an organic fertilizer for enhancing soil fertility and promoting plant growth.

Analytical procedures: The clod coating method was used to calculate bulk density. Keen Reckzonski boxes were used to measure the soil's ability to hold water. Following a 30-minute equilibration period during which the soil was periodically stirred with water, the pH of the soil was measured in a suspension of soil and water (1:2.5 soil: water) using a glass electrode pH meter. After equilibrating the soil with water and leaving the sample undisturbed until the supernatant was recovered and measured using a conductivity meter, the electrical conductivity was assessed in soil suspension (1:2.5 soil:water). The wet oxidation method was used to determine the soil's organic carbon content of soil.

Statistical Analysis

The field experiment data collected throughout the investigation were statistically analyzed using the Analysis of Variance (ANOVA) technique for a Factorial Randomized Block Design (FRBD), following the guidelines outlined by Panse and Sukhame in 1978. This analysis was carried out using SPSS for Windows, version 13.0.

3. RESULTS:

Influence of varying levels of nitrogen through vermicompost on Physical properties of the soil like bulk density and water holding capacity:

3.1) Bulk density:

The data range from 1.24 to 1.32 Mg m^{-3}, however the influence of vermicompost on soil bulk density was not statistically significant (Table 2). It was discovered that adding more organic manures, such as vermicompost, causes the bulk density to gradually decrease. Lowest bulk density 1.24 Mg m^{-3} was recorded in the treatment T_4 received 60 kg N/ha through vermicompost to hirsutum cultivar, Chetna J1 variety. The highest (1.32 Mg m^{-3}) bulk density was recorded in the treatment T_7 where 40 kg N/ha was applied through vermicompost to hirsutum cultivar, GHV 8023 variety.

Table-1: Soil Properties at the Onset of the Experiment

S.No.	Particulars	Value
1	Bulk density (Mg m^{-3})	1.26
2	Water holding capacity (%)	50.3
3	pH (1:2.5)	7.6
4	Electrical conductivity (ds m^{-1})	0.3
5	Organic Carbon (g kg^{-1})	4.9

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Table 2: Impact of Varied Nitrogen Levels through Vermicompost on Soil Bulk Density, Water Holding Capacity, pH, Electrical Conductivity, and Organic Carbon

Treatments	**Bulk density (Mg m^{-3})**	**Water holding capacity (%)**	**pH (1:2.5)**	**EC (dS m^{-1})**	**Organic carbon (g kg^{-1})**
T_1- AV1N1- Arboreum cultivar + 40 kg N ha^{-1}	1.29	50.93	7.64	0.26	5.17
T_2- AV1N2- Arboreum cultivar + 60 kg N ha^{-1}	1.25	56.37	7.57	0.25	5.41
T_3- HV1N1- Hirsutum cultivar + 40 kg N ha^{-1}	1.27	51.77	7.66	0.3	5.29
T_4-HV1N2- Hirsutum cultivar + 60 kg N ha^{-1}	1.24	58.22	7.58	0.26	5.67
T_5-AV2N1- Arboreum cultivar + 40 kg N ha^{-1}	1.30	48.81	7.67	0.3	5.26
T_6-AV2N2- Arboreum cultivar + 60 kg N ha^{-1}	1.26	54.11	7.58	0.27	5.40
T_7 -HV2N1- Hirsutum cultivar + 40 kg N ha^{-1}	1.32	47.89	7.68	0.31	5.20
T_8-HV2N2- Hirsutum cultivar + 60 kg N ha^{-1}	1.26	52.60	7.60	0.28	5.60
SE (m) ±	0.008	1.151	0.004	0.005	0.013
CD at 5%	NS	NS	0.012	NS	0.039
Initial value	1.26	50.3	7.6	0.3	4.9

NOTE: 1. HV1-Chetna J1 2. HV2-GHV 80233. AV1-AVC 14 4. AV2-GAV 8011

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3.2) Water Holding Capacity:

Influence of vermicompost under different organic treatments on water holding capacity of soils was non-significant (Table 2)and it was ranged from 47.89% to 58.22 %. Lowest water holding capacity was observed in hirsutum cultivar, GHV 8023 variety T_7 where 40 kg N/ha was applied through vermicompost and highest water holding capacity was recorded inhirsutum cultivar Chetna J1 variety which is supplemented with 60kg N/ha.

Though there was improvement in the physical properties of the soil by the application of vermicompost, its effects are not seen immediately. It helps to boost the soil physical properties in the long run.

Influence of varying levels of nitrogen through vermicompost on Soil pH, Electrical conductivity and Organic carbon content:

3.3)Soil pH

The pH range of the test soil was 7.57 to 7.68. The T_7 recorded a pH value as its highest reading (7.68) where 40kg N ha^{-1} given through vermicompost to Hirsutum cultivar, GHV 8023 variety. however lowest value of pH 7.57 was recorded in treatment T_2 where 60 kg N/ha was supplied to Arboreum cultivar, AVC 14 variety. The soil p^H was presented in Table 2.

3.4) Electrical Conductivity:

The results regarding electrical conductivity of soil after harvest of cotton was presented in Table2. The values of electrical conductivity of soil were statistically non significant under various organic treatments.

The Electrical conductivity of the experimental soil ranged from (0.25 to 0.31) dSm^{-1}. The highest Electrical conductivity value (0.31dSm^{-1}) was recorded in the treatment T_7 received 40kg N ha^{-1} through vermicompost to Hirsutum cultivar, GHV 8023 variety. Electrical conductivity was found to be decreased as the doses of organic nutrient sources increases. The lowest value of Electrical conductivity (0.25 dSm^{-1}) was observed in the treatment T_2 received Vermicompost @60kg N ha^{-1} toArboreum, AVC 14 variety.

3.5) Organic carbon:

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The results indicated the impact of vermicompost on build up of soil organic carbon content. Significantly superior organic carbon (5.67 g kg^{-1}) build up in soil was noticed in treatment T_4 where 60kg N ha^{-1}supplied through vermicompost to Hirsutam cultivar, Chetna J1 Variety. However the lowest organic carbon (5.17 g kg^{-1}) was registered with treatment T_1 where 40kg N ha^{-1} was applied to Arboreum cultivar, AVC 14 variety.

4. DISCUSSION:

Influence of varying levels of nitrogen through vermicompost on Physical properties of the soil like bulk density and water holding capacity:

4.1) Bulk density

It is clear from the experiment that adding organic manures helps to lower soil weight by maintaining the right soil: moisture: air ratio, which ultimately results in a decrease in the bulk density of soils. The increase in organic manure application rates is directly correlated with the improvement in soil bulk density. Similar results were observed by Marathe and Bharambe (2005). Continuous application of FYM @ 10 t ha may lead to increased aggregation of 3 -1 1 soil particles followed by vermicompost @ 5 t ha-1 over control. In contrast, Laharia et al. (2013) found that applying 100% RDN by vermicompost + jeevamrut resulted in the soil having the lowest bulk density. Treatments using thoroughly decomposed organic materials, such as vermicompost, often shown a considerable reduction in bulk density of soil. Katkar et al. (2007) found a significant drop in bulk density with the application of FYM @ 10 t ha-1 above control. Bellakki and Badanur (1997), Surekha and Rao (2009), and Vora et al. (2015) reported similar findings reporting a significant decrease in bulk density of Vertisols with the addition of sunhemp and FYM above control.

4.2) Water Holding Capacity:

Vermicompost enhance soil structure and increase its water holding capacity. This is because vermicompost contains humus and organic matter, which improve soil aggregation, allowing it to retain more water. Additionally, the presence of beneficial microorganisms in vermicompost enhances soil porosity, allowing water to infiltrate and be stored more effectively. As a result, the application of vermicompost can lead to better water retention in the soil, benefiting plant growth and overall soil health.

According to Jadhavet al. (1993), the soil's ability to store more water was improved in the three plots that got vermicompost at a rate of 5 tonnes per hectare. Similar to this, Mastiholi (1994) reported that applying 2 tonnes of vermicompost per hectare to the soil increased its moisture content compared to applying 1 tonne. According to Patil (1998), FYM

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incorporation at 2.5 tonnes per ha and vermicompost application at 1.0 tonnes per ha improved the soil moisture content compared to simply fertilizer treatment in the vertisols of Bijapur. Bhatia and Shukla (1982) found that the use of FYM, either alone or in conjunction with fertilizers, greatly enhanced the water holding capacity and moisture retention at field capacity.

Influence of varying levels of nitrogen through vermicompost on pH, Electrical conductivity and organic carbon content:

4.3) Soil pH

pH was found to be decreased as the doses of organic nutrient increases. Various treatments have showed significant influence of H^+ concentration in soil and it was reduced towards neutrality as increment in doses of vermicompost.The pH decrease upon application of vermicompost is likely due to the presence of organic acids in the compost. Vermicompost contains various organic compounds, including humic and fulvic acids, which are acidic in nature. When vermicompost is added to the soil, these organic acids gradually get released into the soil, causing a slight decrease in pH.

Moreover, as the organic matter in the vermicompost decomposes, it undergoes microbial activity, and this process can also produce some acidic byproducts. As a result, the overall effect of vermicompost application is a slight reduction in soil pH. while there is a pH decrease upon initial application, over time, the buffering capacity of the soil may help stabilize the pH, resulting in a more balanced soil pH in the long run. The similar results were reported by Katkar*et al.* (2007) revealed that pH was decreased with application of FYM (10 t ha^{-1}). The findings are in line with observations recorded by Pawar *et al.* (2007), Halemani*et al.* (2004) and Oja *et al.* (2014).

4.4) Electrical Conductivity

The electrical conductivity (EC) of the soil can decrease upon the application of vermicompost due to its low salt content. Vermicompost is a type of organic matter that has undergone decomposition through earthworms. Unlike some synthetic fertilizers or mineral-rich composts, vermicompost typically has a lower concentration of soluble salts, which are the primary contributors to the soil's electrical conductivity.When vermicompost is added to the soil, it introduces more organic matter and nutrients, which can enhance soil structure and support microbial activity. As a result, the organic matter can help reduce the leaching of salts from the soil, leading to a decrease in electrical conductivity. Similar results

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were reported by Halemani*et al.* (2004), noted that organics alone and their combination had no significant influence on electrical conductivity of soil. Results are also in confirmity with findings of Badanur*et al*. (1990), Nehra & Hooda (2002) and Katkar*et al.* (2002).Similar results were reported by Halemani*et al.* (2004), noted that organics alone and their combination had no significant influence on electrical conductivity of soil. Results are also in confirmity with findings of Badanur*et al*. (1990), Nehra & Hooda (2002) and Katkar*et al.* (2002).

4.5) Organic carbon

Utilization of organic inputs like vermicompost, as source of plant nutrient to cotton reported significant improvement in the organic carbon content in soil.The increase in organic carbon in soil might be due to direct addition of organic matter through vermicompost and increasing root biomass of plant.Organic matter in vermicompost consists of partially decomposed plant and animal materials, which are rich in carbon-based compounds.When vermicompost is added to the soil, its organic matter is incorporated into the soil matrix. This organic matter serves as a food source for soil microbes, promoting microbial activity and decomposition. As the microorganisms break down the organic matter, they release carbon compounds into the soil, thus increasing the soil's organic carbon content.Higher organic carbon levels in the soil offer several benefits, such as improved soil structure, water holding capacity, nutrient retention, and enhanced microbial diversity. Additionally, organic carbon is crucial for the formation and stability of soil aggregates, which contributes to better soil aeration and root growth.Tadesse *et al.* (2013) reported that, organic carbon content of soil increased due to higher (15 t ha^{-1}) FYM application. Similar results were also reported by Badole*et al.* (2000), Sonune*et al.* (2003) and Oja *et al.* (2014).

Conclusion:

Based on the recorded observations, it is evident that the incorporation of vermicompost as a nutrient source has a pronounced positive impact on both the physical and physico-chemical properties of the soil. Notably, the application of 60 kg N ha^{-1} through vermicompost to Non-GM cotton cultivars yielded more favorable results compared to the application of 40 kg N ha^{-1}. The Hirsutum cultivar, specifically the Chetana J1 variety, exhibited superior responses in enhancing soil properties in comparison to arboretum cultivars. This underscores the effectiveness of utilizing vermicompost, particularly at a higher dosage, for the organic cultivation of cotton in rainfed agricultural systems.

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