International Journal of Plant & Soil Science

Volume 35, Issue 18, Page 716-721, 2023; Article no.IJPSS.103677
ISSN: 2320-7035

Characteristics of Organic Manures and Its Effect on Physical Properties of Soil in Pearl Millet

Bharti Yadav [a,b*], S. R. Naga [a], B. L. Yadav [a], Santosh Yadav [a], Shalu Kumari Meena [a], Astha Pandey [b] and Sachin Sharma [b]

[a] Department of Soil Science and Agricultural Chemistry, COA, SKNAU, Jobner, Rajasthan, India.
[b] Department of Soil Science and Agricultural Chemistry, IAS, BHU, Varanasi, Uttar Pradesh, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i183338

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/103677

Original Research Article

Received: 19/05/2023
Accepted: 21/07/2023
Published: 22/07/2023

ABSTRACT

Organic manures are rich source of nutrients such as nitrogen, phosphorus, and potassium, as well as micronutrients such as calcium, magnesium, and sulfur, which are essential for plants. It also contains organic matter that improves soil structure, water-holding capacity, and aeration. The study focused on evaluating two types of organic manures, i.e. Farmyard manure (FYM) and vermicompost. Results showed that vermicompost had higher nutrient content them FYM. A field experiment was conducted during *kharif* season 2018 at Agronomy farm, S.K.N. College of Agriculture Jobner (Rajasthan). The design of experiment was factorial randomized block design with three replications. The experiment comprised five treatments of organic manures (Control, vermicompost @ 2.5 t ha^{-1}, vermicompost @ 5 t ha^{-1}, FYM @ 5 t ha^{-1} and FYM @ 10 t ha^{-1}) and four treatments of fertility levels (Control, 50 per cent RDF (recommended dose of fertilizer), 75 per

**Corresponding author: E-mail: 15bhartiyadav@gmail.com;*

cent RDF and 100 per cent RDF). The variety used for experiment was RHB-173 of pearl millet. Results showed that the application of FYM @ 10 t ha $^{-1}$ significantly decreased the bulk density and increased the saturated hydraulic conductivity over control. The maximum water retention of soil (12.86 per cent and 3.28 per cent) at 33kPa and 1500 kPa were recorded under the treatment vermicompost @ 5 t ha^{-1} being at par with FYM @ 10 t ha $^{-1}$. Thus, addition of FYM @ 10 t ha $^{-1}$ improves the physical soil properties.

Keywords: Vermicompost; FYM (Farm Yard Manure); bulk density; moisture retention; saturated hydraulic conductivity.

1. INTRODUCTION

Increased chemical fertilizer usage without sufficient organic recycling not only made multi-nutrient deficiency in soil plant systems worse but also damages soil health and polluted the environment. Additionally, the price of chemical fertilizers is rising as an agricultural input. Therefore, the moment is perfect to assess the viability and effectiveness of using organic waste, both to improve and build up soil fertility and to improve the effectiveness of chemical fertilizers. Comparing the use of each component separately with the integration of chemical fertilizer and organic manures, it has been found that the latter is more effective at stabilizing crop production and maintaining soil health and productivity [1]. Organic stuff, such as animal dung, agricultural leftovers, food waste, and other plant elements, decomposes to generate organic manure. During the decomposition process, microorganisms such as bacteria and fungi break down the organic matter into simpler compounds and release nutrients into the soil.

Much has been written on soil quality in relation to food security in recent years because of rise in awareness of the relationship between the human population and the Earth's potential to produce enough food to sustain the world's increasing population [2]. It is important to put the global food situation in perspective in the context of this brief discussion of organic fertilizers and soil health.

According to a number of studies, Farmyard Manure (FYM) applications in irrigation systems increased soil structure and microbial populations while reducing bulk density and increasing SOC and hydraulic conductivity [3]. Vermicompost is a type of organic fertilizer that has been enhanced with all the good soil bacteria and all the necessary plant nutrients including N, P, and K. Vermicomposting, which is used to produce organic manure, is the process of turning compost through the action of earthworms. Vermicompost is created by an eco-biological process that takes energy-dense, complex organic materials and stabilizes them. An effective and simple method of compost preparation is the creation of vermicompost. In addition to helping to maintain a higher nutrient status in composted materials, this composting method is capable of breaking down a sizable volume of organic waste. An environmentally friendly method of creating nutrient composts for crop development is by using earthworms (as adaptable natural bioreactors for effective recycling of organic wastes to the soil) in the vermicomposting process (as adaptable natural bioreactors for effective recycling of organic wastes to the soil) [4]. Additionally, by digesting trash, this technology turns a problem into a resource and produces high-quality manure that may be used to improve the soil's quality [5].

Farmers have long employed organic compounds like FYM in their operations. All of the major nutrients—N, P, K, Ca, Mg, and S—as well as the micronutrients—Fe, Mn, Cu, and Zn—necessary for plant growth are provided by FYM. As a result it serves as a multi-nutrient fertilizer. FYM enhances the physical, chemical, and biological characteristics of soil. A better environment for root development results from the FYM application's improvement in soil structure. FYM increases the soil's ability to hold water. Interest in organic farming has increased due to the fact that using organic fertilizers enhances soil structure, promotes nutrient exchange, and maintains soil health. Generally speaking, applying organic amendments like crop leftovers and/or farmyard manure greatly raises soil organic carbon (SOC). SOC is crucial for cycling plant nutrients and enhancing the physical, chemical, and biological qualities of the soil. Due to its connection to crop productivity, SOC is a significant indicator of soil quality [6]. The structural integrity of the soil decreases when SOC drops [7]. A potential sink for atmospheric CO_2 is also represented by the

regeneration of SOC in agricultural fields [8]. Farmyard manure (FYM) in particular has been used in agriculture as an organic substance for quite some time [9]. It raises the level of organic C in the soil. Organic carbon affects the physical qualities of the soil both directly and indirectly. The purpose of the current research is to comprehend the characteristics of organic manures and how they affect the physical characteristics of soil.

2. MATERIALS AND METHODS

The experiment was conducted at an Agronomy farm, Sri Karan Narendra College of Agriculture, Jobner during "*kharif*", 2018 to find out the "Characteristics of organic manures and its effect on physical properties of soil in Pearl millet". Agronomy farm is situated at 75^0 28' East longitude and 26^0 05' North latitude at an altitude of 427 m above mean sea level (MSL) in Jaipur district of Rajasthan. The soil was sandy loam. The experiment comprised five treatments of organic manure (Vermicompost @ 2.5 t ha^{-1}, Vermicompost @ 5.0 t ha^{-1}, FYM @ 5.0 t ha^{-1} and FYM @ 10.0 t ha^{-1}) and four levels of RDF (control, 50%, 75% and 100%).

Organic manure was analysed for chemical and physical properties. The analysis included pH [10]; Electrical conductivity [11]; Bulk density, Moisture content (Gravimetric method) and Organic Carbon [12]. Total macronutrients (N, P and K) micronutrients were digested and measured as described by [13]. Soil samples were analysed for Bulk density [14], Water retention [15] and Hydraulic conductivity [16]. Statistical analysis was done through analysis of variance technique (ANOVA) to find out the effect of each treatment of organic manure on soil properties.

3. RESULTS AND DISSCUSION

3.1 Properties of FYM

The results present in Table 1 showed that pH of FYM is 6.84 indicating the neutral nature of the amendment. The bulk density is 0.91g per cm^{-3} which will improve soil physical condition. The organic carbon content is 14.71 %, indicating a good supply of organic carbon for the soil. It was discovered that the amounts of nitrogen, phosphorus, and potassium were respectively 0.50 percent, 0.25 percent, and 0.50 percent. According to this finding, plants can also receive nutrients from farmyard manure.

3.2 Properties of Vermicompost

Table 1 showed that the vermicompost from the Sri Karan Narendra College of Agriculture Jobner (Rajasthan) agronomy farm had a pH of 7.09 and an organic carbon content of 19.45 percent, which was somewhat higher than FYM. It was discovered that the amounts of nitrogen, phosphorus, and potassium were respectively 1.64 percent, 0.89 percent, and 1.07 percent. This finding suggests that the crop plant may also receive nutrients from the vermicompost. These findings all support the idea that vermicompost can provide the soil with both organic matter and nutrients. These outcomes concur with those attained by [17].

3.3 Effect of Fertility Levels

According to data in Table 2, when fertility levels increased, bulk density declined and saturated hydraulic conductivity increased barely. While F_3 (100 percent RDF) application considerably improved soil water retention at 33 kPa and 1500 kPa in comparison to the control.

Table 1. Chemical Characterization of FYM and Vermicompost

Properties	FYM	Vermicompost
pH	6.84	7.09
EC (dS m^{-1})	3.17	3.98
Bulk Density (g per cm^{-3})	0.91	0.79
Moisture content (%)	15.13	16.51
OC (%)	14.71	19.45
N (%)	0.50	1.64
P_2O_5 (%)	0.25	0.89
K_2O (%)	0.50	1.07

Increased soil water retention resulted from fertilizer application. Selvi et al. [18] and Verma et al. [19] have reported findings with a similar pattern.

3.4 Effect of Organic Manures

Data also showed that the application of FYM @ 10 t ha^{-1} greatly increased the saturated hydraulic conductivity of soil while decreasing the bulk density of soil. Vermicompost applied at a rate of 5 t ha^{-1} and FYM applied at a rate of 10 t ha^{-1} both had an identical impact on lowering soil bulk density in comparison to control. The statistics (Table 2) make it clear that the use of organic manures significantly increased water retention at 33 kPa and 1500 kPa following pearl millet harvest. Under the vermicompost treatment @ 5 t ha^{-1}, highest soil water retention (12.86% and 3.28%) at 33kPa and 1500kPa were observed.

It is commonly recognized that organic manure helps to improve physical characteristics. According to Benbi et al. [20], soil organic manure has a positive impact on soil structure, which is indicated through soil porosity, aggregation, bulk density, and water storage capacity. As a result of the complex series of polysaccharides produced by the bacteria flourishing in the decomposing organic manure and by their secondary products which operated on soil building material, decomposition of organic manure improved soil permeability and increased water soluble aggregates. Thus improvement in soil structure and increase aggregation is brought by addition of organic manure by reducing bulk density. As a result, the rise in aggregation and improvement in soil structure brought about a fall in bulk density. The results are in agreement with those of Prakash et al. [21], Selvi et al. [18], and Singh et al. [22], who also noted a drop in bulk density as a result of a rise in the soil's organic carbon content.

Due to the light texture of the soil, there was no fluctuation in the water retention in the soil after applying FYM and vermicompost treatments (Table 2). This is explained by the fact that at lower tensions, the pore size distribution has a major influence on water retention. The aggregation resulting in favorable pore geometry of soil promotes water retention in soil [23].

Table 2. Effect of different fertility level and organic manures on bulk density, saturated hydraulic conductivity and water retention at 33 and 1500 kPa

Treatments	Bulk density (Mg m^{-3})	Saturated hydraulic conductivity (cm h^{-1})	Water retention at 33 kPa (%)	Water retention at 1500 kPa (%)
Fertility Levels				
F_0 (Control)	1.55	7.00	10.16	2.66
F_1 (50% RDF)	1.53	7.25	11.29	2.88
F_2 (75% RDF)	1.51	7.33	12.11	3.03
F_3 (100% RDF)	1.49	7.37	12.59	3.15
SEm±	0.02	0.10	0.16	0.04
CD (P=0.05)	NS	NS	0.47	0.12
Organic manures				
M_0 (Control)	1.61	6.02	10.09	2.54
M_1 (Vermicompost @ 2.5 t ha^{-1})	1.52	6.87	11.51	2.93
M_2 (Vermicompost @ 5 t ha^{-1})	1.44	7.83	12.86	3.28
M_3 (FYM @ 5 t ha^{-1})	1.55	7.25	10.96	2.78
M_4 (FYM @ 10 t ha^{-1})	1.46	8.21	12.26	3.12
SEm±	0.02	0.11	0.18	0.05
CD (P=0.05)	0.06	0.32	0.52	0.13

4. CONCLUSION

The present investigation showed that the characterization of organic manures helps in understanding the behavior of organic manure in soil and the way it will affect the soil fertility status. Application of organic manures have positive effects on soil. Therefore it can be inference out that, improved physical soil properties by lowering soil bulk density, increasing total porosity, water holding capacity can be achieved by application of organic manures. Application of FYM @ 10 t ha^{-1} and vermicompost @ 5 t ha^{-1} significant improvement in soil physical properties. This approach can be effective to improve soil properties in long term.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Vipul Beniwal, Ajay Tomer. Effect of Integrated Nutrient Management on Growth Parameters of Black Gram (*Vigna mungo* L.). Int. J. Curr. Microbiol. App. Sci. 2019;8-06:2045-2053.
2. Lal, Rattan, and Bobby Alton Stewart, eds. Food security and soil quality. CRC Press; 2010.
3. Bhattacharyya, Ranjan S, Chandra RD, Singh S, Kundu AK, Srivastva, Gupta HS. Long-term farmyard manure application effects on properties of a silty clay loam soil under irrigated wheat–soybean rotation. Soil and Tillage Research. 2007; 94(2):386-396.
4. Yadav, Kunwar D, Vinod Tare, Mansoor Ahammed M. Vermicomposting of source-separated human faeces by Eisenia fetida: effect of stocking density on feed consumption rate, growth characteristics and vermicompost production. Waste Management. 2011;31(6):1162-1168.
5. Azarmi, Rasool, Mousa Torabi Giglou, and Rahim Didar Taleshmikail. Influence of vermicompost on soil chemical and physical properties in tomato (*Lycopersicum esculentum*) field. African Journal of Biotechnology. 2008;7(14).
6. Rani, Neeraj. Rejuvenating soil health using organic manures for sustainable agriculture. New and Future Developments in Microbial Biotechnology and Bioengineering. Elsevier. 2022;181-198.
7. Le Bissonnais, Yves, Dominique Arrouays. Aggregate stability and assessment of soil crustability and erodibility: II. Application to humic loamy soils with various organic carbon contents. European Journal of Soil Science. 1997;48(1):39-48.
8. Lal, Rattan, Kimble JM. Conservation tillage for carbon sequestration. Nutrient Cycling in Agroecosystems. 1997;49: 243-253.
9. Alam M, Mishra A, Singh K, Singh SK, David A. Response of sulphur and FYM on soil physico-chemical properties and growth, yield and quality of mustard (*Brassica nigra* L.). J. Agric. Phys 2014;14:156-160.
10. Sparks DL. 1.4 Bioavailability of Soil Potassium. Handbook of Soil. CRC Press, New York; 1996.
11. Richards LA. (Ed.). Diagnosis and improvement of saline and alkali soils (No. 60). US Government Printing Office; 1954.
12. Walkley A, Black IA. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. Soil Science. 1934;37(1):29-38.
13. Page AL, Miller RH, Keeney DR. Methods of soil analysis. Part 2. Chemical and Microbiological properties 2nd ed. American Soc. of Agronomy, Inc. Soil Science Society of America, Inc. Madison, Wisconsin, USA. 1982;1159.
14. Black GR, Hartge KH. Bulk density. In: Methods of soil analysis part-I (Kulte, A. Ed.). American society of Agronomy and Madeson, Wisconsin, USA. 1986;363-375.
15. Gardner WH. Water content. In methods of soil analysis part-I (A. Klute, Ed.), American Society of Agronomy Madison, Wisconsin, U.S.A. 1986;493-544.
16. Klute A, Dirksen C. Hydraulic conductivity and diffusivity: Laboratory methods. In: Methods of Soil Analysis Part–I (A. Klute, Ed.), American Society of Agronomy Madison, Wisconsin, U.S.A. 1986;687-734.
17. Zhang CA, Wang YQ, Yuan CB, Yao L, Liu Y. Analysis on the difference of nutrition contents between different anaerobic fermentation residue from different raw materials. Modern Agricultural Sciences. 2009;1:44-46.
18. Selvi D, Santhy P, Dhakshinamoorthy M. Effect of inorganics Alone and in Combination with FYM on Physical Properties and Productivity of Vertic Haplustepts under Long-term Fertilization.

Journal of the Indian Society of Soil Science. 2005;53:302-307.
19. Verma G, Mathur AK, Bhandari SC, Kanthaliya PC. Long-term effect of integrated nutrient management on properties of a Typic Haplustept under maize-wheat cropping system. Journal of the Indian Society of Soil Science. 2010;58:299-302.
20. Benbi DK, Biswas CR, Bawa SS, Kumar K. Influence of farm yard manure, inorganic fertilizers and weed control practices on some soil physical properties in long- term experiment. Soil Use and Management. 1998;14: 52-54.
21. Prakash YS, Bhadoria PBS, Rakshit A. Comparative effeciency of organic manures on the changes in soil properties and nutrient availability in alfisol. Journal of the Indian Society of Soil Science. 2002;50:219-221.
22. Singh A, Singh VK, Chandra R, Srivastava PC. Effect of the integrated nutrient management on pigeonpea based intercropping system and soil properties in Mollisols of the tarai region. Journal of the Indian Society of Soil Science. 2012;60: 38-44.
23. Acharya CL, Bishnoi SK, Yaduvanshi HS. Effect of long-term application of fertilizers, organic and inorganic amendments under continuous cropping on soil physical and chemical properties in an Alfisol. Indian Journal of Agricultural Sciences. 1988;58: 509 – 516.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/103677