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Effect of Different Organic Sources on Soil Properties of Vertisol

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Abstract

The present investigation was undertaken to study the "Effect of different organic sources on soil properties of Vertisol". The experiment was conducted at research field of Post Graduate Institute Research Farm, Department of Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri, during *kharif* 2023. The experiment was conducted in Randomized Block Design (RBD) with three replications and nine treatments. The treatments comprised of T_1: Absolute control, T_2: GRDF (50:75:45 kg $N:P_2O_5:K_2O$ ha^{-1} + 10 t FYM ha^{-1}), T_3: RDF + Urban Compost @ 2.5 t ha^{-1}, T_4: RDF + Urban Compost @ 5 t ha^{-1}, T_5: RDF + PMC Compost @ 2.5 t ha^{-1}, T_6: RDF + PMC Compost @ 5 t ha^{-1}, T_7: RDF + Bagasse ash @ 2.5 t ha^{-1}, T_8: RDF + Bagasse ash @ 5 t ha_{-1}, T_9: RDF + Vermicompost @ 5 t ha^{-1}. Organic manures were applied aspertreatments 30 days before sowing in all treatments except treatment T_1 which was absolute control. As regards significantly highest organic carbon (0.53 %), nutrient availability (Nitrogen 214.86 kg ha^{-1}, Phosphorus 18.65 kg ha^{-1}, Potassium 475 kg ha^{-1} and Sulphur 11.85 mg kg^{-1}), Micronutrient availability of Fe, Mn, Zn and Cu (4.88, 6.75, 0.85 and 0.90 mg kg^{-1} respectively) were recorded in the treatment T_6 (RDF + PMC Compost @ 5 t ha^{-1}). Significantly highest microbial population (23.79 cfu x 10^4, 31.58 cfu x 10^6, 40.20 cfu x 10^7 g^{-1} of total fungi, actinomycetes and bacteria, respectively) were recorded in treatment T_6 (RDF + PMC Compost @ 5 t ha^{-1}).

Key words : Soybean, organic sources, PMC compost, urban compost, vermicompost.

Soybean (*Glycine max*. (L.) Merill), family leguminaceae is a unique crop of versatile nutritional attribute, yielding both protein and oil. It is one of the most important oilseed crops in the world. It is second most important oil seed crop in India. It is having high nutritional value as it contain on dry weight basis 40-44% protein, 18-20 % oil, 30 % carbohydrates, 5% fibre, 4% saponin (Masciarelli *et al*., 2014). The soybean is called vegetarian meat and wonder crop.The use of organic manures has been traditional mean to maintain soil fertility. Most organic manures provide balanced sources of nutrients for crops. Organic manures have direct effect on plant growth as like commercial fertilizer. These manures contain nutrients in small amount; therefore, the quantity requirement of these organic sources is more to fulfill the crop needs. Besides the major nutrients, organic manures also contain micro-nutrients and provide food for soil micro-organisms. This increases activity of microbes which in turn helps to convert unavailable nutrients into available form and fixing atmospheric nitrogen. Organic manures boost soybean nutrition by improving soil health and providing essential nutrients. They enhance soil structure, microbial activity and nutrient availability. This leads to higher yields, better nutrient uptake and potentially increased protein and micronutrient content in soybeans. Key areas for research include manure composition, application rates and integration with other sustainable practices.

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Materials and Methods

The field experiment was conducted during kharif season of 2023 at PGI Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra (India). The experiment was conducted in Randomized Block Design (RBD) with three replications and nine treatments. The treatments comprised of (T_1) - Absolute control, (T_2) - GRDF (50:75:45 kg N:P_2O_5:K_2O ha^{-1} + 10 t FYM ha^{-1}), (T_3) - RDF + Urban Compost @ 2.5 t ha^{-1}, (T_4) - RDF + Urban Compost @ 5 t ha^{-1}, (T_5) - RDF + PMC Compost @ 2.5 t ha^{-1}, (T_6) - RDF + PMC Compost @ 5 t ha^{-1}, (T_7) - RDF + Bagasse ash @ 2.5 t ha^{-1}, (T_8) - RDF + Bagasse ash @ 5 t ha^{-1}, (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Organic manures were applied as per treatments 30 days before sowing in all treatments except treatment T_1, which was absolute control. Soybean seeds of Cv. Phule Sangam variety obtained from the Chief Scientist (Seed), Mahatma Phule Krishi Vidyapeeth, Rahuri. The recommended spacing of 45 cm x 05 cm was adopted for sowing. The recommended dose of fertilizers (50:75:45 kg ha^{-1} N, P_2O_5 and K_2O, respectively) were given as per treatment details except absolute control (T1) at the time of sowing.

Results and Discussion

Organic Carbon : The data presented (Table 1) revealed that significantly higher organic carbon (0.53%) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with organic carbon (0.52%) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and organic carbon (0.51%) observed in treatment (T9)RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest organic carbon (0.45%) was recorded in treatment (T_1) absolute control.

The increase in organic carbon content of soil might be due to an increase in the microbial population, which is responsible for the degradation of organic manures and release of CO_2. It may also be attributed to the rapid decomposition of readily water-soluble constituents of added organic matter. The highest soil organic carbon was observed due to PMC Compost application with recommended dose of fertilizers. The above observations are close in agreement with the observations of Nagar *et al*. (2016).

Available nitrogen : The data presented (Table 1) revealed that available nitrogen was ranged from 165.88 to 214.86kg ha^{-1}. The results at harvest of soybean revealed that significantly higher available nitrogen (214.86 kg ha^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with available nitrogen (210.35 kg ha^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and available nitrogen (208.34 kg ha^{-1}) observed in (T_9) treatment RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest available nitrogen (165.88 kg ha^{-1}) was recorded in treatment (T_1) absolute control.

The increased in available nitrogen content in soil might be due to the release of nitrogen after decomposition of organic manures due to which increased in available pool of the soil nutrients. Similar trend of observations were also reported by Kamble *et al*. (2018).

Available phosphorus : The data presented (Table 1) revealed that available phosphorus was ranged from 13.78 to 18.65kg ha^{-1}. The results at harvest of soybean revealed that significantly higher available phosphorus (18.65 kg ha^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with available phosphorus (18.37 kg ha^{-1}) recorded in (T_4) treatment RDF + Urban Compost @ 5 t ha^{-1} and available phosphorus (18.14 kg ha^{-1}) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest available phosphorus

(13.78 kg ha^{-1}) was recorded in treatment (T_1) absolute control.

Application of organic manures significantly increased the available P content in soil over absolute control. The mineralization and decomposition process of organic sources might have created favourable effects on built-up of the microbial population especially-P solubilizing microbes in soil and less fixation of P by soil constituents and release of various weak acids might have enhanced the available P status of soil. Above results are in consonance with those of Choudhary *et al*. (2011).

Available potassium : The data presented (Table 1) revealed that available potassium was ranged from 387 to 475 kg ha^{-1}. The results at harvest of soybean revealed that significantly higher available potassium (475 kg ha^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with available potassium (461 kg ha^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and available potassium (446 kg ha^{-1}) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest available potassium (387 kg ha^{-1}) was recorded in treatment absolute control (T_1).

The available K was higher in organic manures applied soil plot than control plot because organic acids and inorganic acids produced during decomposition of organic manures help in releasing mineral bound insoluble potassium and also reduce potassium fixation (Vasant *et al*. 2012). The similar results on soil available K were also reported by Gupta *et al*. (2020).

Available sulphur : The data presented (Table 1) revealed that available sulphur was ranged from 8.65 to 11.85 mg kg^{-1}. The results at harvest of soybean revealed that significantly higher available sulphur (11.85 mg kg^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with available sulphur (11.72 mg kg^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and available sulphur (11.37 mg kg^{-1}) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest available sulphur (8.65 mg kg^{-1}) was recorded in treatment (T_1) absolute control.

Table 1. Effect of different organic sources on organic carbon, nitrogen, phosphorus, potassium and sulphur in soil at harvest of soybean in Vertisol.

Treatment	Organic carbon (%)	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	Sulphur (kg ha^{-1})
T_1 - Absolute control	0.45	165.88	13.78	387	8.65
T_2 - GRDF (50:75:45 kg N:P_2O_5:K_2O ha^{-1} + 10 t FYM ha^{-1})	0.49	205.35	17.32	433	10.93
T_3 - RDF + Urban Compost@ 2.5 t ha^{-1}	0.47	198.43	16.64	421	10.62
T_4 - RDF + Urban Compost @ 5 t ha^{-1}	0.52	210.35	18.37	461	11.72
T_5 - RDF + PMC Compost @ 2.5 t ha^{-1}	0.48	201.36	16.87	427	10.78
T_6 - RDF + PMC Compost @ 5 t ha^{-1}	0.53	214.86	18.65	475	11.85
T_7 - RDF + Bagasse ash @ 2.5 t ha^{-1}	0.46	186.61	16.33	409	9.91
T_8 - RDF + Bagasse ash @ 5 t ha^{-1}	0.47	192.32	16.57	418	10.42
T_9 - RDF + Vermicompost @ 5 t ha^{-1}	0.51	208.34	18.14	446	11.37
SE(m) ±	0.011	2.60	0.25	11.71	0.27
C.D. at 5 %	0.033	7.80	0.77	34.11	0.83
Initial	0.47	184	19.44	481	12.24

The increased in available sulphur content of the soil might be due to more vegetative and root growth with application of sulphur through pressmud compost and was made released to plant by microbial activity in association with the roots in the rhizosphere. Application of both organic and inorganic fertilizers released nutrients slowly and steadily to the plant for a considerable period of time resulting in favorable effect on the crop. Similar results were confirmed by Indiraraj and Raj, (1979), Pandalai *et al*. (1958) and Poonkodi, *et al*. (2018).

DTPA extractable Fe : The data presented (Table 2) revealed that DTPA extractable Fe was ranged from 4.22 to 4.88 mg kg^{-1}. The results at harvest of soybean revealed that significantly higher DTPA extractable Fe (4.88mg kg^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with DTPA extractable Fe (4.85mg kg^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and DTPA extractable Fe (4.83 mg kg^{-1}) observed in (T_9) treatment RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest DTPA extractable Fe (4.22 mg kg^{-1}) was recorded in treatment (T_1) absolute control.

Increase in available Fe content of soil may be due to the conversion of ferric iron to ferrous iron. This increase in Fe may be due to different chemical and biochemical changes occurred as application of organic manures. The similar observations with respect to DTPA iron were also made by Dey *et al*. (2019).

DTPA extractable Mn : The data presented (Table 2) revealed that DTPA extractable Mn was ranged from 5.79 to 6.75 mg kg^{-1}. The results at harvest of soybean revealed that significantly higher DTPA extractable Mn (6.75 mg kg^{-1}) was observed in treatment (T6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with DTPA extractable Mn (6.71mg kg^{-1}) recorded in (T4) treatment RDF + Urban Compost @ 5 t ha^{-1} and DTPA extractable Mn (6.69mg kg^{-1}) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest DTPA extractable Mn (5.79mg kg^{-1}) was recorded in treatment (T1) absolute control.

This is might be attributed to the conversion of higher oxides of manganese to Mn2+ as a result of microbial and chemical reduction and certain organic acids released during

Table 2. Effect of different organic sources on DTPA extractable micronutrients in soil at harvest of soybean inVertisol

Treatment	DTPA micronutrients (mg kg^{-1})			
	Fe	Mn	Zn	Cu
T_1 - Absolute control	4.22	5.79	0.45	0.60
T_2 - GRDF (50:75:45 kg N:P_2O_5:K_2O ha^{-1} + 10 t FYM ha^{-1})	4.72	6.58	0.72	0.78
T_3 - RDF + Urban Compost @ 2.5 t ha^{-1}	4.59	6.53	0.63	0.70
T_4 - RDF + Urban Compost @ 5 t ha^{-1}	4.85	6.71	0.82	0.86
T_5 - RDF + PMC Compost @ 2.5 t ha^{-1}	4.63	6.56	0.67	0.72
T_6 - RDF + PMC Compost @ 5 t ha^{-1}	4.88	6.75	0.85	0.90
T_7 - RDF + Bagasse ash @ 2.5 t ha^{-1}	4.51	6.43	0.51	0.65
T_8 - RDF + Bagasse ash @ 5 t ha^{-1}	4.56	6.48	0.57	0.67
T_9 - RDF + Vermicompost @ 5 t ha^{-1}	4.83	6.69	0.79	0.83
SE(m) ±	0.041	0.054	0.038	0.029
C.D. at 5 %	0.12	0.15	0.116	0.087
Initial	4.95	6.92	0.97	0.96

decomposition of organic matter present in organic manures. The similar observations on DTPA Mn were made by Dey *et al*. (2019).

DTPA extractable Zn : The data presented (Table 2) revealed that DTPA extractable Zn was ranged from 0.45 to 0.85 mg kg^{-1}. The results at harvest of soybean revealed that significantly higher DTPA extractable Zn (0.85 mg kg^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with DTPA extractable Zn (0.82 mg kg^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and DTPA extractable Zn (0.79mg kg^{-1}) observed in treatment RDF + Vermicompost @ 5 t ha^{-1} (T_9). Significantly lowest DTPA extractable Zn (0.45mg kg^{-1}) was recorded in treatment (T_1) absolute control.

The increase in Zn might be due to addition of organic manures resulted in high rate of mineralization over the time which enhanced the Zn availability to soil. Similar results were reported by Dey *et al*. (2019).

DTPA extractable Cu : The data presented (Table 2) revealed that DTPA extractable Cu was ranged from 0.60 to 0.90 mg kg^{-1}. The results at harvest of soybean revealed that significantly higher DTPA extractable Cu (0.90 mg kg^{-1}) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with DTPA extractable Cu (0.86 mg kg^{-1}) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and DTPA extractable Cu (0.83 mg kg^{-1}) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest DTPA extractable Cu (0.60 mg kg^{-1}) was recorded in treatment (T_1) absolute control.

The increase in availability of Cu attributed to the addition of organic manures. This increase in DTPA Cu content of soil might be due to addition of organic matter have increased the microbial proliferation, the microbes resulted in the release of chelating agents which prevented micronutrients from precipitation, oxidation and leaching. Similar observations were reported by Dey *et al*. (2019).

Fungi count : The data presented (Table 3) revealed that fungi count was ranged from 12.73 to 23.79 cfu x 10^4 g^{-1} soil. The results at harvest of soybean revealed that significantly higher fungi count (23.79 cfu x 10^4 g^{-1} soil) was

Table 3. Effect of different organic sources on soil microbial population at harvest of soybean in Vertisol.

Treatment	Total fungi (cfu x 10^4 g^{-1} soil)	Total actinomycetes (cfu x 10^6 g^{-1} soil)	Total bacteria (cfu x 10^7 g^{-1} soil)
T_1 - Absolute control	12.73	16.80	23.30
T_2 - GRDF (50:75:45 kg N:P_2O_5:K_2O ha^{-1} + 10 t FYM ha^{-1})	21.06	28.57	35.92
T_3 - RDF + Urban Compost @ 2.5 t ha^{-1}	18.88	26.55	31.80
T_4 - RDF + Urban Compost @ 5 t ha^{-1}	23.06	31.00	39.58
T_5 - RDF + PMC Compost @ 2.5 t ha^{-1}	19.82	28.13	34.57
T_6 - RDF + PMC Compost @ 5 t ha^{-1}	23.79	31.58	40.20
T_7 - RDF + Bagasse ash @ 2.5 t ha^{-1}	16.20	21.76	28.98
T_8 - RDF + Bagasse ash @ 5 t ha^{-1}	17.12	24.52	30.23
T_9 - RDF + Vermicompost @ 5 t ha^{-1}	22.87	30.61	38.10
SE(m) ±	0.65	0.75	1.08
C.D. at 5 %	1.97	2.25	3.26
Initial	11.86	14.57	20.45

observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with fungi count (23.06 cfu x 10^4 g^{-1} soil) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and fungi count (22.87cfu x 10^4 g^{-1} soil) observed in treatment (T9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest fungi count (12.73 cfu x 10^4 g^{-1} soil) was recorded in treatment (T_1) absolute control.

An increase in fungal population with addition of organics might be due to most of these organisms are chemo-heterotrophs, which require organic source of carbon as food and oxidation of organic sources provide energy, thereby increasing their population. The similar results on fungal population were reported by Arslan *et al*. (2008), Kumari *et al*. (2016) and Devi *et al*. (2012).

Actinomycetes count : The data presented (Table 3) revealed that actinomycetes count was ranged from 16.80 to 31.58 cfu x 10^6 g^{-1} soil. The results at harvest of soybean revealed that significantly higher actinomycetes count (31.58 cfu x 10^6 g^{-1} soil) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with fungi count (31.00 cfu x 10^6 g^{-1} soil) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and actinomycetes count (30.61 cfu x 10^6 g^{-1} soil) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest actinomycetes count (16.80 cfu x 10^6 g^{-1} soil) was recorded in treatment (T_1) absolute control.

The increased actinomycetes population may be due to the fact that organic manures provided necessary food and microenvironment for their quicker multiplication and growth. This may be attributed to the higher amount of growth promoting substances, vitamins and enzymes which in turn increases microbial population. Similar observations were reported by Arslan *et al*. (2008), Kumari *et al*. (2016) and Devi *et al*. (2012).

Bacteria count : The data presented (Table 3) revealed that bacteria count was ranged from 23.30 to 40.20 cfu x 10^7 g^{-1} soil. The results at harvest of soybean revealed that significantly higher bacteria count (40.20 cfu x 10^7 g^{-1} soil) was observed in treatment (T_6) RDF + PMC Compost @ 5 t ha^{-1} and it was statistically at par with bacteria count (39.58 cfu x 10^7 g^{-1} soil) recorded in treatment (T_4) RDF + Urban Compost @ 5 t ha^{-1} and bacteria count (38.10 cfu x 10^7 g^{-1} soil) observed in treatment (T_9) RDF + Vermicompost @ 5 t ha^{-1}. Significantly lowest bacteria count (23.30cfu x 107 g^{-1} soil) was recorded in treatment (T_1) absolute control.

The increase in bacterial population at the beginning may be attributed to the fact that organic manures shows superiority in enhancing the richness and diversity of soil bacteria and activities of organic treated soils. This might be ascribed to the organic sources which supplies large amount of readily available carbon, resulting in more diverse and dynamic system. This finding was in accordance to the observations of Arslan *et al*. (2008), Kumari *et al*. (2016) and Devi *et al*. (2012).

Conclusion

The application of RDF (50:75:45 kg $N:P_2O5:K_2O$ ha^{-1}) + PMC Compost @ 5 t ha^{-1} (T_6) to soybean obtained higher yield, total nutrient uptake, improvement in chemical and biological properties of soil and higher economic returns in Vertisol.

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