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Comparing the Effect of Organic and Inorganic Amendments on Soil Health

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ABSTARCT

Background: Fertilizers are important source of nutrients required by plants at different growth stages. These fertilizers can be organic and inorganic. Organic and inorganic fertilizers are different from each other in their action and contain different types of nutrients. Each fertilizer has its own effect on soil and plants. Excessive use of chemical fertilizers reducees the soil fertility by affecting the soil physical, chemical and biological properties, so it is essential to balance the negative effect of inorganic fertilizers with the use of organic fertilizers. Organic fertilizers contain nutrients required for optimum plant growth. With the increase in soil organic matter, the percentage of nitrogen and phosphorus in soil also increases.

Methods: A pot culture experiment was conducted to study the effect of organic and inorganic fertilizers on soil properties. Experiment consisted of six treatments, comprising of organic and inorganic treatments and absolute control. Inorganic treatment received recommended dose of fertilizer (RDF). Organic treatments received different dose of organic manures like vermicompost and farm yard manure.

Result: Application of organic manure *viz* vermicompost remarkably improved in soil fertility. Soil pH was not significantly influenced by organic and inorganic treatments. However, relatively higher EC was recorded with the application of 100 per cent RDF. Application of organic manure *viz* vermicompost resulted in the buildup of soil organic carbon and markedly enhanced the nutrient availability of nitrogen, phosphrous and potassium in soil. Soil microbial population *viz.,* bacteria, fungi and actinomycetes were increased due to the application of organic manure through vermicompost.

Key words: Inorganic amendments, Organic manures, Soil health.

INTRODUCTION

Continuous application of inorganic fertilizers under intensive crop production systems resulted in multiple nutrient deficiency in the soil. But use of organic amendment stimulates the soil microbial processes and increase crop yield as compared to inorganic fertilizers, leading to the increase in organic matter and soil fertility after long-term repeated application of organic amendments. Nutrients present in organic manure are supplemented with inorganic nutrients that are readily available to plants (Ayoola *et al.* 2008). Nutrients released more slowly from organic manure and stored in the soil for longer time periods, thus ensuring a long residual effect (AbouelMagd *et al.* 2005). Organic amendments increase soil microbial biomass through the supply of carbon rich organic compounds to the generally carbon limited microbial communities in arable soils (Diacono and Montemurro, 2010). Under organic fertilizers vermicompost is commonly used and is easily available. Vermicompost is an organic source of essential nutrients of soil and the mineral nutrients available in vermicompost can easily be absorbed by plants (Atiyeh *et al.* 2000). It is a process of interaction between earthworms and microorganisms that lead to the bio-oxidation and stabilization of the organic wastes. Keeping all above information in view, a present study was carried out to compare the effect of organic and inorganic amendments on soil physio-chemical and biological properties.

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MATERIALS AND METHODS

The pot culture experiment was conducted at Faculty Center for Agricultural Education and Research, Ramakrishna Mission Vivekananda Educational and Research Institute, Coimbatore campus November 2018 to April 2019. The pot culture experiment was conducted using tomato plant (variety PKM1) in a completely randomized design. The experiment was laid out in six treatments with four replications.

Treatment details

T_1- Control (Soil alone 4kg)
T_2 - Soil (4 kg) +100% RDF (Recommended dose of fertilizer)

T_3- Soil (4 kg) +FYM (1 kg)-25%
T_4- Soil (4 kg) +FYM (2 kg)-50%
T_5- Soil (4 kg) +Vermicompost (1 kg)-25%
T_6- Soil (4 kg) +Vermicompost (2 kg)-50%

The organic manures like Vermicompost (VC) and farmyard manures (FYM) were used in the study. The nutrient contents of organic manures *viz.*, nitrogen, phosphorus and potassium were analyzed as per the standard methods (Subbiah and Asija 1956, Olsen *et al.* 1954 and Stanford and English 1949). Each pot was filled with four kg of processed soil and recommended doses of fertilizers and required level manures. Manures and fertilizers were thoroughly mixed with soil. Twenty-one days old healthy seedlings were transplanted in each pot and maintained two plants per pot. The initial and post harvest soil samples were collected for analysis and soil properties were analyzed as per the standard procedure. The data on various characters studied during the investigation was statistically analyzed (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The initial characteristics of soil parameters are presented in Table 1. The pH and EC of soil were 7.65 and 0.27 dSm^{-1}, respectively. The organic carbon content of experimental soil was 0.31 per cent. The soil had nutrient content *viz* available nitrogen, available phosphorus and available potassium of 224, 12.5 and 540 kg ha^{-1}, respectively. The soil microbial populations namely bacteria ($\times 10^6$ cfu g^{-1} of soil), fungi ($\times 10^4$ cfu g^{-1} of soil) and actinomycetes ($\times 10^3$ cfu g^{-1} of soil) was 32.2, 16.5 and 21.4, respectively. The major nutrients content of organic manures used in the experiment *viz* nitrogen, phosphorus and potassium of vermicompost was 2.90, 0.90 and 1.30 per cent and farm yard manure was 0.50, 0.25 and 0.40 per cent, respectively (Table 2).

The post-harvest soil chemical and biological properties are presented in Table 3,4 and 5. The highest soil pH value of 7.62 was recorded in T_1 (Control) and lowest soil pH value of 7.44 was observed in, T_6 (Soil + Vermicompost 50%). There was no significant effect of treatments observed on soil pH. However, the treatment which received organic manures showed very slight decrease in soil pH could be ascribed to the acidifying effects due to the organic acid produced during the course of decomposition of organic amendments. Similar to the above findings, Guidi and Hal (1998) also observed that the application of various organic materials decreased the soil pH value due to the organic and inorganic acids produced during decomposition of organic matter in soil. The highest soil EC value of 0.41 dSm^{-1} was recorded in T_2 (Soil+RDF) and lowest soil EC value of 0.25 dSm^{-1} was observed in, T_6 (Soil + Vermicompost 50%). The electrical conductivity (EC) of soil was significantly influenced by both organic and inorganic manures. The highest value of soil EC was recorded by the application of 100 per cent RDF. These results are in line with the findings of Tiwari *et al.* (1995), who observed that the soil EC was increased due to the application of recommended dose of fertilizers through inorganic sources. The highest soil organic carbon content of 0.45 per cent was recorded in T_6 (Soil + Vermicompost 50%), followed by T_5 (Soil + Vermicompost 25%) and T_4 (Soil + FYM 50%). The lowest soil organic carbon content of 0.28 per cent was observed in control (T_1). The soil organic carbon content was differed significantly among the treatments. The treatment receiving organic manures was recorded highest value of organic carbon content in soil, which might be due to

Table 1: Initial characteristics of experimental soil.

Parameters	Values
pH	7.65
EC (dSm^{-1})	0.27
Organic carbon (%)	0.31
Available nitrogen (kg ha^{-1})	224
Available phosphorus (kg ha^{-1})	12.5
Available potassium (kg ha^{-1})	540
Total bacteria ($\times 10^6$ cfu g^{-1} of soil)	32.2
Total fungi ($\times 10^4$ cfu g^{-1} of soil)	16.5
Total actinomycetes ($\times 10^3$ cfu g^{-1} of soil)	21.4

Table 2: Nutrient content of organic manures.

Organic manures	Nitrogen (%)	Phosphorus (%)	Potassium (%)
Vermicompost	2.90	0.90	1.30
Farm yard manure	0.50	0.25	0.40

Table 3: Effect of organic and inorganic amendments on soil properties at harvest stage.

Treatments	Soil pH	Soil EC (dSm^{-1})	Soil organic carbon (per cent)
T_1	7.62	0.25	0.28
T_2	7.71	0.41	0.30
T_3	7.52	0.34	0.38
T_4	7.48	0.32	0.42
T_5	7.50	0.32	0.45
T_6	7.44	0.31	0.45
SEd	0.078	0.023	0.021
CD (0.05%)	0.158	0.048	0.043

Table 4: Effect of organic and inorganic amendments on soil nutrient status at harvest stage.

Treatments	Available nitrogen (kg ha^{-1})	Available phosphorus (kg ha^{-1})	Available potassium (kg ha^{-1})
T_1	214	10.8	528
T_2	222	12.0	535
T_3	226	11.8	542
T_4	232	12.6	545
T_5	238	13.2	548
T_6	241	13.5	548
SEd	0.965	0.305	1.519
CD (0.05%)	1.811	0.620	3.103

the increase in organic carbon content by the application of organic manure compared to application of RDF through fertilizers. Badale and More (2000) also reported the application of organic manures increased the organic carbon content over inorganics. Natarajan (2003) also reported, increase in organic carbon content due to the addition of organic manures through poultry manures, compost and oil cakes.

The highest available nitrogen, available phosphorus and available potassium content of 241, 13.5 and 548 kg ha^{-1} were recorded in T_6 (Soil + Vermicompost 50%), followed by T_5 (Soil + Vermicompost 25%) and T_4 (Soil + FYM 50%). The lowest available nitrogen, available phosphorus and available potassium content of 214, 10.8 and 528 kg ha^{-1} were observed in control (T_1), respectively. The soil nutrient content *viz* available nitrogen, available phosphorus and available potassium were differing significantly among the treatments. Generally, the available nutrient content of soil was more in organic manure received treatment. It might be due to the availability of higher macro and micro nutrients from higher quantities of organic manures. Similarly, Canali *et al.* (2000) also reported that organic manure application through compost, poultry manure and oil cakes enhance the availability of nitrogen in soil. These results are in line with the findings of Warncke and Srigar (1992), who reported that the application of organic manures through oil cakes increased the soil available phosphorus in soil. Mathan *et al.* (2000) also reported the organic manure amendments (FYM, poultry manure, oil cakes and cotton waste) increased the higher potassium availability in soil than inorganic amendments. Application of different organic manures like vermicompost and FYM was significantly increase the soil available nutrient contents (Deepa Joshi *et al.,* 2016). Sharma *et al.* 2016 also reported, soil nutrients status was improved by the addtition of different organic manures.

The highest total bacteria, total fungi and total actinomycetes population of 35.1 ($\times 10^6$ cfu g^{-1} of soil), 18.0 ($\times 10^4$ cfu g^{-1} of soil) and 23.8 ($\times 10^3$ cfu g^{-1} of soil) were recorded in T_6 (Soil +Vermicompost 50%), followed by T_5 (Soil + Vermicompost 25%) and T_4 (Soil + FYM 50%). The lowest total bacteria, total fungi and total actinomycetes population of 20.8 ($\times 10^6$ cfu g^{-1} of soil), 13.7 ($\times 10^4$ cfu g^{-1} of soil) and 16.4 ($\times 10^3$ cfu g^{-1} of soil) were observed in control (T_1), respectively. The treatments received organic manure particularly vermicompost recorded highest population of bacteria, fungi and actinomycetes after harvest of the crop as compared to other treatments. It might be due to the availability of nutrients obtained from the organic manures. Somasundaram and Sankaran (2004) also reported that the soil applied with organic manures recorded the maximum microbial population and enzyme activity than compared to recommended dose of inorganic fertilizers. Population of microbes under organic treatments acted as an index of soil fertility because it serves as a temporary sink of nutrient flux as reported by Hassink *et al.* (1991). The lowest soil microbial load was registered under control, which might be due to low availability of nutrients and organic carbon content of soil.

Table 5: Effect of organic and inorganic amendments on soil biological properties at harvest stage.

Treatments	Total bacteria ($\times 10^6$ cfu g^{-1} of soil)	Total fungi ($\times 10^4$ cfu g^{-1} of soil)	Total actinomycetes ($\times 10^3$ cfu g^{-1} of soil)
T_1	20.8	13.7	16.4
T_2	26.4	15.2	20.5
T_3	33.6	16.8	22.3
T_4	34.5	17.5	22.8
T_5	34.8	17.5	23.5
T_6	35.1	18.0	23.8
SEd	1.927	1.364	1.445
CD (0.05%)	3.865	2.584	2.815

CONCLUSION

Application of organic manure *viz* vermicompost resulted in the buildup of soil organic carbon and markedly enhanced the nutrient availability of nitrogen, phosphrous and potassium in soil. Soil microbial population *viz.,* bacteria, fungi and actinomycetes were also got increased. Application of organic manure *viz* vermicompost was sustaining the soil health. However, multi-location field trails to be conducted, to confirm these findings and recommendation for adoption.

Conflict of interest: None.

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