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IMPROVING SOIL HEALTH BY APPLICATION OF ORGANIC NUTRIENTS

Peeyush Srivastav and Suchi Gangwar*

Faculty of Agriculture, R.K.D.F. University, Bhopal - 462 038 (M.P.), India.

*Corresponding author E-mail : singh.suchi40@gmail.com

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ABSTRACT

The present study evaluates the impact of organic nutrients on soil fertility and microbial activity, with a focus on the combined application of 20 t/ha vermicompost and 2.5 kg/ha Biomix-I through soil application. Results revealed that this treatment significantly improved key soil parameters, including organic carbon, available nitrogen, phosphorus, and potassium, and was statistically at par with other integrated nutrient management treatments. The gradual nutrient release from vermicompost, coupled with enhanced microbial activity stimulated by Biomix-I, led to improved nutrient availability and organic matter buildup. Additionally, treatments incorporating organic inputs promoted higher microbial populations, indicating improved soil biological health. Although not directly assessed, literature supports the role of microbial formulations like Jeevamrit in further enhancing microbial activity. Overall, the findings highlight the potential of organic and integrated nutrient strategies to sustain soil fertility, support microbial ecosystems, and contribute to environmentally sound agricultural practices.

Key words : Soil health, Organic nutrients, Vermicompost.

Introduction

Global agricultural production more than tripled, in between 1960 and 2015, largely due to the adoption of productivity-enhancing technologies introduced during the Green Revolution along with increased use of land, water, and other natural resources. However, the indiscriminate use of agrochemicals over the past five to six decades has led to significant degradation of soil health, declining soil fertility, reduced crop productivity and adverse environmental impacts.

Maintaining favorable physical, chemical and biological conditions in soil has become an urgent necessity. In India, the soil organic carbon content—a key indicator of soil health—has alarmingly declined from 1.2% to 0.6% by the year 2000 and continues to decrease (Devasenapathy *et al.*, 2008). The unscientific application of chemical inputs has not only disrupted soil ecosystems by harming beneficial microorganisms such as *Rhizobium* and phosphorus-solubilizing bacteria (PSB), but has also led to stagnation in crop productivity (Dadmal and Dongale, 2004). Agricultural experts warn that continued reliance on chemical-intensive farming may cause long-term, irreversible damage to both soil and environmental

health.

In this context, organic nutrient management emerges as a sustainable alternative to chemical agriculture. It enhances soil longevity and is gaining popularity worldwide, currently practiced in over 120 countries. Globally, approximately 30.4 million hectares of agricultural land are under organic cultivation. Although, India ranks 33rd in terms of area under organic farming (Mahapatra *et al.*, 2009; Prasad and Gill, 2009). Organic nutrient management is part of a broader suite of eco-friendly agricultural practices that prioritize sustainability and ecological balance.

To further enhance efficacy, mixed biofertilizer formulations such as BIOMIX—which combine nitrogen fixers and plant growth-promoting rhizobacteria (PGPR)—have shown promising results in cereals, legumes, and oilseeds. While above ground yield increases are somewhat modest compared to underground crops, foliar application techniques may help bridge this gap, offering a practical approach to maximize biofertilizer benefits.

This paper explores the role of organic nutrients, particularly biofertilizers, in improving soil health and

enhancing sustainable agricultural productivity.

Materials and Methods

The experiment was carried out in randomized block design comprising of ten treatments; application of T_1 -Control, T_2 -100% NPK RDF (Recommended Dose of Fertilizers), T_3 -20 t Vermi-compost, T_4 - 4.5 kg/ ha Soil application of Biomix-I, T_5 -4.5kg/ha Foliar application of Biomix-V, T_6 -50% NPK RDF +10 t Vermi-compost, T_7 -50 % NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Soil application of Biomix-I, T_8 -50% NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Foliar application of Biomix-V, T_9 -20 t vermin-compost + 2.5 kg/ha Soil application of Biomix-I, T_{10} -20 t vermin-compost + 2.5 kg/ha Foliar application of Biomix-V.

Each treatment was allocated randomly and replicated three times. The experiment site is located in the central part of Madhya Pradesh at 23.31250 North latitude and 77.35960 East longitudes with an altitude of 11.78 m above the mean sea level. The experiment was conducted at during *rabi* season 2024-25, Faculty of Agriculture RKDF University Bhopal. The soil of the experimental site had a pH 7.97, EC 0.27 dS/m and organic carbon 0.52%. The available soil nitrogen, phosphorus and potash were 217, 17 and 306 kg/ha, respectively. The bulk density of the soil was 1.40 gm/cm³.

For soil analysis, the soil samples were collected from 0-15 cm depth from each net plot after harvesting of crop. These samples were dried, processed and analyzed for organic carbon using Wet digestion method (Walkley and Black, 1934), available nitrogen using Alkaline permanganate method (Subbiah and Asija, 1956), phosphorous using Olsen's method (Olsen *et al.*, 1954) and potassium using Ammonium acetate extraction method (AOAC, 1970).

For microbial analysis, soil samples were collected from the rhizosphere of the soil profile at harvest. Population of soil bacteria, fungi and actinomycetes were determined by the standard serial dilution plate count method using nutrient agar for bacteria, krustose agar for actinomycetes and Rose Bengal agar for fungi. Plates were incubated at $28 \pm 20^\circ\text{C}$ in an incubator and colony counts were recorded after six days of incubation. The population was expressed as number of colony forming units per gram (cfu/g) dry weight of soil.

Results and Discussion

Effect of organic nutrients on organic carbon, Available N, P and K (kg/ha)

The highest organic carbon content (0.60%) was

recorded in the treatment (T_9), which involved the application of 20 t/ha vermicompost along with 2.5 kg/ha of Biomix-I through soil application. This value was statistically at par with the T_7 receiving 50% of the recommended dose of NPK (RDF) combined with 10 t/ha vermicompost and 2.5 kg/ha of Biomix-I, as well as the T_{10} involving 20 t/ha vermicompost and 2.5 kg/ha of Biomix-V applied as a foliar spray. The improvement in organic carbon content may be attributed to the high organic matter input from vermicompost, which enhances microbial activity and contributes to the buildup of soil organic carbon.

A significantly higher level of available nitrogen (230.8 kg/ha) was also observed in the T_9 (20 t/ha vermicompost + 2.5 kg/ha soil application of Biomix-I). This increase is likely due to the slow and sustained release of nitrogen from vermicompost, which helps maintain a consistent nitrogen supply in the soil. Additionally, the improved microbial activity facilitated by Biomix-I may have contributed to the enrichment of the nitrogen pool. Similar findings were reported by Shwetha (2008) in wheat and Kiran (2014) in chickpea, where higher levels of available nitrogen were observed under organic or liquid manure-based treatments.

The highest available phosphorus content (25.6 kg/

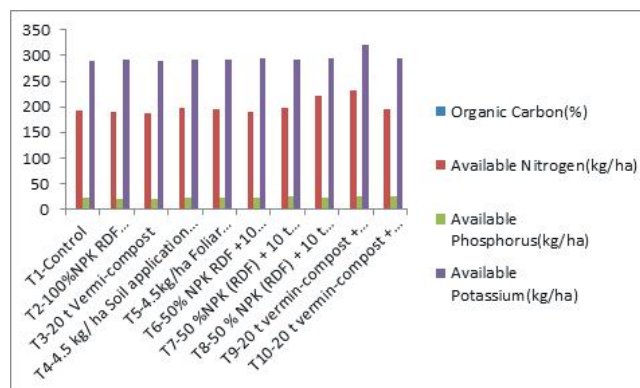


Fig. 1 : Effect of Organic nutrients on organic carbon, available N, P and K (kg/ha).

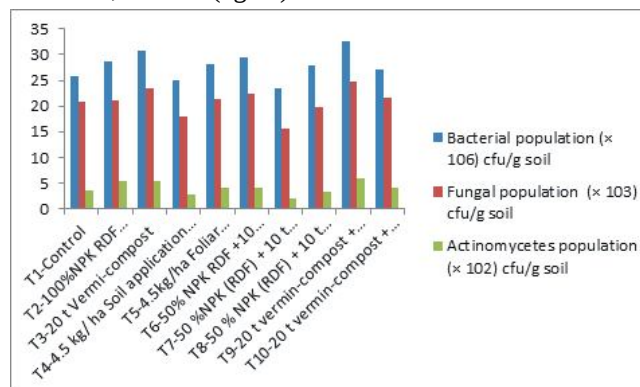


Fig. 2 : Effect of organic nutrients on soil microbial flora after harvest of wheat crop.

Table 1 : Effect of Organic Nutrients on organic carbon, available N, P and K (kg/ha).

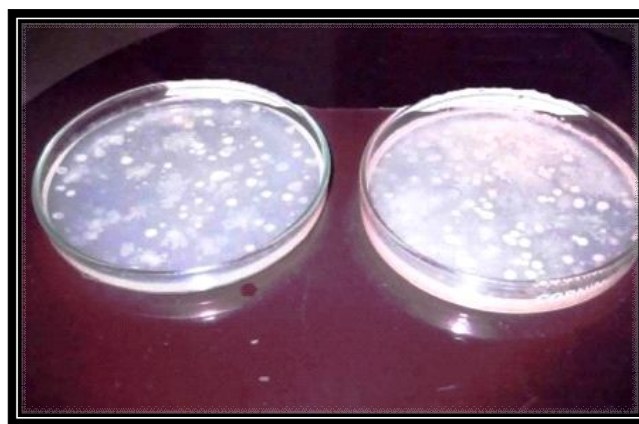
Treatment	Organic Carbon (%)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
T ₁ -Control	0.52	193.6	21.7	289.6
T ₂ -100%NPK RDF (Recommended Dose of Fertilizers)	0.53	190.1	21.2	290.8
T ₃ -20 t Vermi-compost	0.55	187.6	19.6	290.3
T ₄ -4.5 kg/ ha Soil application of Biomix-I	0.55	196.9	22.1	291.7
T ₅ -4.5kg/ha Foliar application of Biomix-V	0.54	194.1	22.5	291.4
T ₆ -50% NPK RDF +10 tVermi-compost	0.55	191.2	22.9	294.1
T ₇ -50%NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Soil application of Biomix-I	0.59	198.4	24.4	290.9
T ₈ -50% NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Foliar application of Biomix-V	0.56	220.8	23.3	294.9
T ₉ -20 t vermin-compost + 2.5 kg/ha Soil application of Biomix-I	0.60	230.8	25.6	321.9
T ₁₀ -20 t vermin-compost + 2.5 kg/ha Foliar application of Biomix-V	0.57	195.6	24.1	295.7
S.Em ±	0.11	7.32	6.53	11.14
CD at 5%	0.33	21.72	19.42	33.11

ha) was recorded in the same T₉ treatment. This significant increase may be due to the release of organic acids during the decomposition and mineralization of vermicompost, which aids in the solubilization of native phosphate compounds. The resulting increase in the available phosphorus pool demonstrates the effectiveness of organic nutrient sources in improving phosphorus availability in the soil.

Similarly, the highest available potassium level (321.9 kg/ha) was recorded in the T₉ treatment. The application of vermicompost and Biomix-I likely contributed to this increase by enhancing microbial activity and promoting the mineralization of potassium from soil minerals. The improved availability of potassium may also result from the interaction of organic matter with clay particles, which helps release K₂O into the soil solution. Yadav and Mowade (2004) noted similar trends, attributing increased potassium availability to the use of liquid manures that stimulate microbial activity.

Microbial population

A significantly higher population of soil microorganisms—including bacteria, fungi, and actinomycetes—was observed with the application of 20 t vermin-compost + 2.5 kg/ha Soil application of Biomix-I. This treatment was statistically at par with both the T₃-20 t Vermi-compost treatment and the combined

**Plate 1 :** View of microbial population of Bacterial.

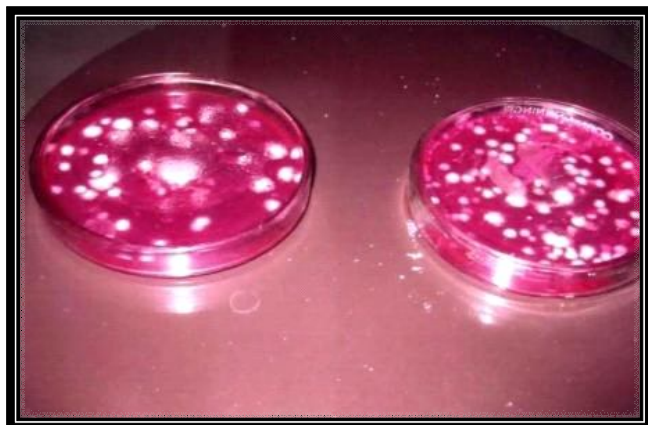
application of 50% NPK RDF + 10 t/ha vermicompost.

These findings align with the results reported by Siddappa (2015) in field bean, where the application of 20 t vermin-compost + 2.5 kg/ha Soil application of Biomix-I significantly increased the populations of bacteria, fungi, and actinomycetes. The enhanced microbial activity in these treatments can be attributed to the high organic matter content and nutrient availability provided by vermicompost, which supports microbial proliferation.

In addition, the use of organic inputs such as Jeevamrit has been reported to significantly boost soil microbial

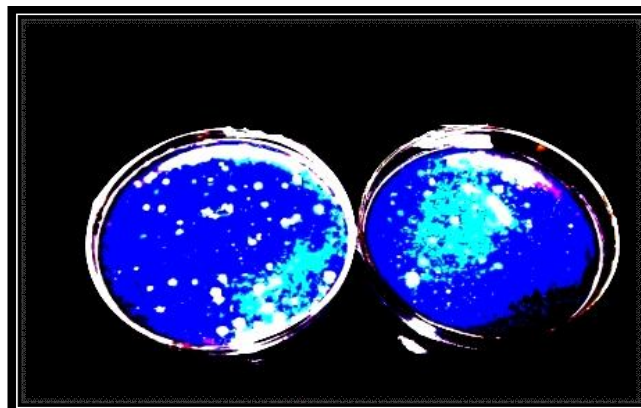
Table 2 : Effect of organic nutrients on soil microbial flora after harvest of wheat crop.

Treatment	Bacterial population ($\times 10^6$) cfu/g soil	Fungal population ($\times 10^3$) cfu/g soil	Actinomycetes population ($\times 10^2$) cfu/g soil
T ₁ -Control	25.76	20.82	3.47
T ₂ -100%NPK RDF (Recommended Dose of Fertilizers)	28.58	21.18	5.40
T ₃ -20 t Vermi-compost	30.69	23.53	5.46
T ₄ -4.5 kg/ ha Soil application of Biomix-I	25.05	17.93	2.70
T ₅ -4.5kg/ha Foliar application of Biomix-V	28.10	21.38	4.14
T ₆ -50% NPK RDF +10 tVermi-compost	29.34	22.33	4.15
T ₇ -50 %NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Soil application of Biomix-I	23.46	15.61	1.98
T ₈ -50 % NPK (RDF) + 10 t Vermi-compost + 2.5 kg/ha Foliar application of Biomix-V	27.99	19.70	3.38
T ₉ -20 t vermin-compost + 2.5 kg/ha Soil application of Biomix-I	32.69	24.86	6.02
T ₁₀ -20 t vermin-compost + 2.5 kg/ha Foliar application of Biomix-V	27.01	21.52	4.08
S.Em $\pm$	4.01	1.75	0.71
CD at 5%	11.91	5.21	2.09

**Plate 2 :** View of microbial population of Fungal.

activity. Jeevamrit is rich in indigenous microbial populations and serves as a microbial tonic that enhances soil biological health (Palekar, 2006). According to Joshi (2012), its application stimulates microbial processes and contributes to the improvement of soil fertility. While Jeevamrit may not directly supply large quantities of nutrients, it plays a crucial role in revitalizing soil ecosystems by promoting the growth of beneficial microflora and fauna (Yadav and Mowade, 2004).

Overall, the integration of organic amendments such as vermicompost and Jeevamrit plays a vital role in enhancing soil microbial populations, which in turn contributes to improved soil structure, nutrient cycling, and overall soil health.

**Plate 3 :** View of microbial population of Actinomycetes.

Conclusion

The treatments demonstrate that the application of organic amendments, particularly the combination of 20 t/ha vermicompost and 2.5 kg/ha Biomix-I through soil application, significantly improved key soil fertility parameters—organic carbon, available nitrogen, phosphorus, and potassium. This treatment consistently outperformed or remained statistically at par with other integrated nutrient management approaches, highlighting the value of organic sources in sustaining soil health.

The slow and steady nutrient release from vermicompost, along with enhanced microbial activity facilitated by Biomix-I, contributed to greater nutrient availability and soil organic matter buildup. The elevated

microbial populations observed under organic and integrated treatments further emphasize the importance of organic inputs in promoting biological activity in soil.

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