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Research Article

INFLUENCE OF ORGANIC MANURES AND FERTILIZERS ON SOIL MICROBIAL BIOMASS-C, N AND P

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Abstract: The field experiment was undertaken to investigate the influence of organic manures and fertilizers on soil microbial soil microbial biomass-C, N and P. The research was conducted at ZARS, GKVK, Bangalore. There were 10 treatments and three replications in an RCBD design. The treatment contains different levels of organic manures like 5t, 10t, 12.5t, 15t, 17.5t and 20t fertilizers like 25%, 50%, 75% and 100%. Soil microbial biomass C, N and P were analysed in different treatments and these were found to be significantly higher in the treatment with application of 20t of FYM ha^{-1} compared to recommended NPK alone.

Keywords: *Organic Manures, Fertilizers, Soil Microbial Biomass-C, N and P*

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Introduction

Microbial communities are important for the functioning of the ecosystem [1], both in relation to direct interactions with plants and with regard to nutrient and organic matter cycling. They are involved in the fundamental activities that ensure the stability and productivity of both agricultural systems and natural ecosystems. They are the driving force of most terrestrial ecosystems, because of their capacity to control the rate of mineralization of organic substrates and can perform important functions in the ecosystem [2]. Soil organic matter dynamics play a major role in natural ecosystems and extensive agriculture. In intensive agricultural systems with high fertilization rates, the various organic components have potential for acting as a temporary nutrient reservoir. Organic matter is an indispensable component of soil and plays an important role in the maintenance and improvement of soil fertility and productivity. The proper management of this reservoir should make it possible to increase the efficiency of use of both soil an d fertilizer nutrients. The active soil organic component comprises of soil microbial biomass and microbial metabolites and recently added labile organic inputs. Soil amendments presents a comprehensive and balanced synthesis of current knowledge pertaining to the environmental effects of soil amendments on various biotic systems, including crops, livestock, wildlife, forestry *etc* [3]. The most practicable and general measure of biological status of soil is the soil microbial biomass [4]. It plays a key role in soil nutrient transformations and largely controls the rate of C, N and other nutrient cycles [5].The microbial activity is found to be influenced by the type of vegetation, substrate availability and abiotic factors in an ecosystem [6].

Material and Methods

The field experiment was undertaken to investigate the influence of organic manures and fertilizers on soil microbial soil microbial biomass-C, N and P. The research was conducted at ZARS, GKVK, Bangalore. The soil samples were air dried in shade, passed through two mm sieve and subjected to microbiological analysis in the laboratory of the Department of Agricultural Microbiology, UAS, GKVK, Bangalore. Treatments details. T_1-5t of FYM, T_2-10t of FYM, T_3-10t of FYM (partially decomposed), T_4-10t of FYM + mulching (glyricidia 2 t ha^{-1}), T_5-20t of FYM, T_6 - 17.5t of FYM + 25% rec. NPK, T_7 - 15t of FYM + 50% rec. NPK, T_8 - 12.5t of FYM + 75% rec. NPK, T_9 - Rec. NPK + rec. FYM + phorate + herbicide + fungicide, T_{10}-Rec. NPK and all the above treatments were replicated threes. Where: Rec. NPK- 25:60:25 Kg/ha, Rec. FYM- 10t ha^{-1}, soybean, variety- MAUS-2, spacing- 30 X 10 cm, Phorate 10G @ 1Kg a.i ha^{-1}, Herbicide-Lasso 50 EC@2.5 l ha^{-1}, Fungicide seed treatment (Thiram + Bavistin - each 2g kg^{-1} of seeds) and *Rhizobium* seed treatment common to all plots.

Microbial biomass C and N

Soil microbial biomass was estimated following the fumigation and extraction method as proposed by [7]. Ninhydrin-reactive N released during the fumigation of soil was determined by using ninhydrin reagent and was used as a measure of microbial biomass. Each soil sample was divided in to two sets. One set of moist soil sample (10g soil on oven dry basis) was fumigated with ethanol-free chloroform for 5 days in screw capped bottles. Then the screw caps were removed and kept in an oven at 40°C for overnight to remove all the chloroform and extracted with 2M KCl by placing these bottles on a reciprocal shaker for 30 min. The suspension was filtered using Whatman No.1 filter paper. In a similar manner unfumigated sample of the same soil was also extracted. To a known aliquot of soil extract, 4 ml of freshly prepared ninhydrin reagent was added and the mixture was boiled in a water bath for 20 min. The contents were allowed to cool and the volume was made up to 10 ml using a 1:1mixture of methoxy ethanol and distilled water. The intensity of purple colour developed was recorded using spectrophotometer at 570 nm wavelength. A standard curve was developed using five different concentrations of L-Leucine-N (3.5 to 16.8μg N/ml) dissolved in 2M KCl. Absorbance values were compared with a standard curve and the microbial biomass C and N were calculated using the formula.

$$Biomass\ C\ g^{-1} soil = \frac{\frac{Ninhydrin\ reactive-}{N\ in\ fumigated\ soil} - \frac{Ninhydrin\ reactive-}{N\ in\ unfumigated\ soil}}{Weight\ of\ soil\ sample} \times 24$$

$$Biomass\ N\ g^{-1} soil = \frac{Ninhydrin\ reactive\text{-}N\ in\ fumigated\ soil - Ninhydrin\ reactive\text{-}N\ in\ unfumigated\ soil}{Weight\ of\ soil\ sample} \times 2.8$$

Influence of Organic Manures and Fertilizers on Soil Microbial Biomass-C, N and P Soil Microbial biomass P

The soil microbial biomass P in soils was determined as per the procedure given by [8]. Three sets of each of the soil sample containing 10 g of air dried soil were used in the determination of biomass P. The first set was fumigated with $CHCl_3$ for five days as explained above and the other two sets were incubated aerobically for the same period. Following this, first and second sets were extracted with Bray's extracting solution (0.03 NH_4F in 0.025 N HCl) (Appendix-II) and the third set was extracted with Bray's extracting solution spiked with inorganic P (as KH_2PO_4) equivalent to 25 µg P g^{-1} of oven dry soil. The amount of P in the extractant was determined as per the procedure outlined by [9]. The suspension was filtered using Whatman No.1 filter paper. Chloromolybdic acid (5 ml) was added to a known aliquot of filtrate and the contents were mixed thoroughly till the evolution of CO_2 was ceased and one ml of stannous chloride working solution was added and the volume was made up to 50 ml using distilled water and the contents were mixed well. The intensity of color developed was read at 660 nm using a UV spectrophotometer and the concentration of available P in the sample was determined by comparing these values with a standard curve developed similarly using KH_2PO_4. If 'a' µg P g^{-1} of oven dry soil was extracted from the unfumigated soil, 'b' from fumigated soil and 'c' from the unfumigated soil spiked with inorganic P, then the soil microbial biomass P content of the soil was calculated by 25 (b-a)/0.4 (c-a) µg P g^{-1} of oven dry soil.

Results and Discussion

Soil microbial biomass-C

The influence of long-term application of manures and fertilizers on soil microbial biomass-C in the rhizosphere and bulk soils is presented in table-1. The microbial biomass-C in FYM series was found to be significantly higher in the treatment 20t of FYM (57.21 µg g^{-1} soil) before sowing compared to all other treatments. It was on par with 17.5t of FYM + 25% rec. NPK (54.84 µg g^{-1} soil), 15t of FYM + 50% rec. NPK (53.56 µg g^{-1} soil), 12.5t of FYM + 75% rec. (52.56 µg g^{-1} soil) respectively and rec. NPK + rec. FYM + phorate + herbicide + fungicide (51.43 µg g^{-1} soil). The least microbial biomass-C was found in control treatment with rec. NPK (8.68 µg g^{-1} soil). The soil microbial biomass-C at 45 DAS was found to be significantly higher in the treatment with 20t of FYM ha^{-1} (216.29 µg g^{-1} soil) in the rhizosphere and (138.15 µg g^{-1} soil) non-rhizosphere soils compared to all other treatments. These were on par with 17.5t of FYM + 25% rec. NPK in both rhizosphere and non-rhizosphere soils (207.03 µg g^{-1} soil and 130.55 µg g^{-1} soil), 15t of FYM + 50% rec. NPK (205.87 µg g^{-1} soil and 128.48 µg g^{-1} soil) and 12.5t of FYM + 75% rec. NPK (202.86 µg g^{-1} soil and 125.25 µg g^{-1} soil) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (198.77 µg g^{-1} soil and 124.69 µg g^{-1} soil). The least microbial biomass-C was found in control treatment with rec. NPK (130.95 µg g^{-1} soil and 85.74 µg g^{-1} soils). At harvest the soil microbial biomass-C in FYM series was found to be significantly higher in the treatment with 20t of FYM ha^{-1} (166.53 µg g^{-1} soil and 110.90 µg g^{-1} soils) in the rhizosphere compared to non-rhizosphere soil compared to all other treatments. This was followed by the treatment 17.5t of FYM + 25% rec. NPK (158.77 µg g^{-1} soil and 104.80 µg g^{-1} soils) respectively in both rhizosphere and non-rhizosphere soils. These were on par with the treatments 15t of FYM + 50% rec. NPK (153.96 µg g^{-1} soil and 101.20 µg g^{-1} soil), 12.5t of FYM + 75% rec. NPK (150.05 µg g^{-1} soil and 98.87 µg g^{-1} soil) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (148.66 µg g^{-1} soil and 94.30 µg g^{-1} soil). The least microbial biomass-C was found in treatment with rec. NPK in the rhizosphere and non-rhizosphere soils (86.02 µg g^{-1} soil, 60.17 µg g^{-1} soils respectively).

Soil microbial biomass-N

Effect of long-term application of manures and fertilizers on soil microbial biomass-N in the rhizosphere and bulk soils is presented in table-2. The soil microbial biomass-N was found to be significantly higher in FYM series in the treatment 20t of FYM ha-1 (6.40 µg g^{-1} soil) before sowing compared to all other treatments. It was on par with the application of 17.5t of FYM + 25% rec. NPK (6.01 µg g^{-1} soil), 15t of FYM + 50% rec. NPK and 12.5t of FYM + 75% rec. NPK (5.54 µg g^{-1} soil and 5.43 µg g^{-1} soil respectively) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (5.40 µg g^{-1} soil) respectively. The least microbial biomass-N was found in control treatment with rec. NPK (0.93 µg g^{-1} soil). The soil microbial biomass-N was found to be significantly higher at 45 DAS in treatment with 20t of FYM (29.40 µg g^{-1} soil) in the rhizosphere soil compared to non-rhizosphere soils (17.40 µg g^{-1} soils) respectively compared to all other treatments. It was on par with the application of 17.5t of FYM + 25% rec. NPK (27.10 µg g^{-1} soil and 16.67 µg g^{-1} soil) respectively in both rhizosphere and non-rhizosphere soils, 15t of FYM + 50% rec. NPK (25.67 µg g^{-1} soil and 15.48 µg g^{-1} soil), 12.5t of FYM + 75% rec. NPK (24.61 µg g^{-1} soil and 14.80 µg g^{-1} soil) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (24.33 µg g^{-1} soil and 14.68 µg g^{-1} soil) respectively in both rhizosphere and non-rhizosphere soils. The least microbial biomass-N was found in control treatment with rec. NPK (9.47 µg g^{-1} soil and 4.67 µg g^{-1} soils). The soil microbial biomass-N was found to be significantly higher at harvest in treatment with 20t of FYM ha^{-1} (29.05 µg g^{-1} soil and 10.87 µg g^{-1} soils) in the rhizosphere soil compared to non-rhizosphere soil respectively compared to all other treatments. It was on par with the application of 17.5t FYM + 25% rec. NPK (26.67 µg g^{-1} soil and 10.00 µg g^{-1} soil), 15t of FYM + 50% rec. NPK (24.84 µg g^{-1} soil and 9.97 µg g^{-1} soil), 12.5t of FYM + 75% rec. NPK (23.91 µg g^{-1} soil and 9.20 µg g^{-1} soil) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (23.89 µg g^{-1} soil and 9.10 µg g^{-1} soil) respectively in both rhizosphere and non-rhizosphere soils. The least microbial biomass-N was found in control treatment with rec. NPK in the rhizosphere and non-rhizosphere soils (6.83 µg g^{-1} soil and 3.60 µg g^{-1} soils respectively). In the present study, significantly higher soil microbial biomass-C and N were recorded with the application of organic manures and the least soil microbial biomass-C and N were recorded due to the application of rec. NPK treatment. The present findings coincides with the findings of [10] who reported that addition of FYM at 20.0 t ha1 increased the microbial population and improved soil properties compared to that of untreated plots. Significantly higher soil microbial biomass-C recorded at 45 DAS as compared to before application of treatments and at the harvest. The soil microbial biomass represents the living and most dynamic component of soil organic matter and indicates the potential biological activity of the soil. The soil microbial biomass is a labile source and sink of nutrients influencing predominant soil functions such as nutrient availability and their cycling and a good indicator of potential microbial activity [11-12]. Therefore, any management practice which helps in improving SMBC in soil would definitely contribute towards improvement of soil quality. The addition of compost or farm yard manure (FYM), significantly increased the SMBC in comparison to chemical fertilizers and integrated use of chemical fertilizers and organic fertilizers brings in more SMBC compared to their single application [13]. This upholds the results in this study also.

Soil microbial biomass-P

The soil microbial biomass-P as influenced by the long-term application of manures and fertilizers in the rhizosphere and bulk soils is presented in table-3. The soil microbial biomass-P was found to be significantly higher due to the application of 20t FYM ha^{-1} (10.06 µg g^{-1} soil) before sowing as compared to all other treatments. This was followed by the application of 17.5t of FYM + 25% rec. NPK (9.20 µg g^{-1} soil). The application of 15t of FYM + 50% rec. NPK (8.90 µg g^{-1} soil) and 12.5t of FYM + 75% rec. NPK (8.71 µg g^{-1} soil) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (8.04 µg g^{-1} soil) were on par with each other. The least soil microbial biomass-P (4.37 µg g^{-1} soil) was noticed due to application of rec. NPK. The application of 20 t of FYM ha-1 45 DAS recorded significantly higher soil microbial biomass-P in the rhizosphere and non-rhizosphere soils (28.71 µg g^{-1} soil and 18.67 µg g^{-1} soils respectively). It was found to be on par with the application of 17.5t of FYM + 25% rec. NPK (27.67 µg g^{-1} soil and 17.20 µg g^{-1} soil), 15t of FYM + 50% rec. NPK (26.13 µg g^{-1} soil and 17.10 µg g^{-1} soil). The application of 12.5t of FYM + 75% rec. NPK (25.14 µg g^{-1} soil and 16.72 µg g^{-1} soils) and rec. NPK + rec. FYM + phorate + herbicide + fungicide (25.01 µg g^{-1} soil and 16.04 µg g^{-1} soil) respectively were on par with each other. The least soil microbial biomass-P (17.23µg g^{-1} soil and 9.70µg g^{-1} soils) was found in rec. NPK.

Table-1*Effect of organic manures and fertilizers on soil microbial biomass-C ($\mu g\ g^{-1}$ soil)*

Treatments	Before sowing	45 DAS		At harvest)	
		Rhizosphere	Non Rhizosphere	Rhizosphere	Non Rhizosphere
T_1. 5t of FYM	12.36^{d}	136.75^{bc}	90.50^{bc}	95.81^{bc}	68.37^{cd}
T_2. 10t of FYM	30.77^{b}	146.02^{bc}	97.75^{bc}	108.56^{b}	77.00^{bcd}
T_3. 10t of FYM (Partially decomposed)	19.41^{c}	131.55^{c}	92.25^{bc}	98.29^{bc}	70.45^{cd}
T_4. 10t of FYM + Mulching (Glyricidia 2 t ha^{-1})	33.25^{b}	152.00^{b}	105.83^{b}	112.60^{b}	80.84^{bc}
T_5. 20t of FYM	57.21^{a}	216.29^{a}	138.15^{a}	166.53^{a}	110.90^{a}
T_6. 17.5t of FYM + 25% rec. NPK	54.84^{a}	207.03^{a}	130.55^{a}	158.77^{a}	104.80^{a}
T_7. 15t of FYM + 50% rec. NPK	53.56^{a}	205.87^{a}	128.48^{a}	153.96^{a}	101.20^{a}
T_8. 12.5t of FYM + 75% rec. NPK	52.56^{a}	202.86^{a}	125.25^{a}	150.05^{a}	98.87^{a}
T_9. Rec. NPK + rec. FYM + Phorate + Herbicide + Fungicide	51.43^{a}	198.77^{a}	124.69^{a}	148.66^{a}	94.30^{ab}
T_{10}. Rec. NPK	8.68^{d}	130.95^{c}	85.74^{c}	86.02^{c}	60.17^{d}
SEM±	2.07	6.03	5.74	6.84	5.83
CD at 5%	6.14	17.91	17.04	20.32	17.32

Note: Rec. NPK- 25:60:25 Kg ha^{-1}, Rec. FYM- 10t ha^{-1}, Phorate 10G @ 1Kg a.i ha^{-1}, Herbicide-Lasso 50 EC@2.5 l ha^{-1}, Fungicide seed treatment (Thiram + Bavistin - each 2g kg^{-1} of seeds), Rhizobium seed treatment common to all plots.

Table-2 *Effect of organic manures and fertilizers on soil microbial biomass-N ($\mu g\ g^{-1}$ soil)*

Treatments	Before sowing	45 DAS		At harvest	
		Rhizosphere	Non Rhizosphere	Rhizosphere	Non Rhizosphere
T_1. 5t of FYM	1.27^{c}	11.10^{d}	6.30^{bc}	10.38^{bc}	4.84^{bc}
T_2. 10t of FYM	2.87^{b}	18.83^{c}	8.73^{b}	14.03^{b}	6.03^{b}
T_3. 10t of FYM (Partially decomposed)	1.60^{c}	11.98^{d}	6.70^{bc}	11.03^{bc}	5.77^{b}
T_4. 10t of FYM + Mulching (Glyricidia 2 t ha^{-1})	2.94^{b}	19.45^{bc}	8.92^{b}	14.54^{b}	6.37^{b}
T_5. 20t of FYM	6.40^{a}	29.40^{a}	17.40^{a}	29.05^{a}	10.87^{a}
T_6. 17.5t of FYM + 25% rec. NPK	6.01^{a}	27.10^{a}	16.67^{a}	26.67^{a}	10.00^{a}
T_7. 15t of FYM + 50% rec. NPK	5.54^{a}	25.67^{a}	15.48^{a}	24.84^{a}	9.97^{a}
T_8. 12.5t of FYM + 75% rec. NPK	5.43^{a}	24.61^{ab}	14.80^{a}	23.91^{a}	9.20^{a}
T_9. Rec. NPK + rec. FYM + Phorate + Herbicide + Fungicide	5.40^{a}	24.33^{ab}	14.68^{a}	23.89^{a}	9.10^{a}
T_{10}. Rec. NPK	0.93^{c}	9.47^{d}	4.67^{c}	6.83^{c}	3.60^{c}
SEM±	0.36	1.73	0.93	1.74	0.62
CD at 5%	1.06	5.13	2.75	5.17	1.84

Note: Rec. NPK- 25:60:25 Kg ha^{-1}, Rec. FYM- 10t ha^{-1}, Phorate 10G @ 1Kg a.i ha^{-1}, Herbicide-Lasso 50 EC@2.5 l ha^{-1}, Fungicide seed treatment (Thiram + Bavistin - each 2g kg^{-1} of seeds), Rhizobium seed treatment common to all plots.

Table-3 *Effect of organic manures and fertilizers on soil microbial biomass-P ($\mu g\ g^{-1}$ soil)*

Treatments	Before sowing	45 DAS		At harvest	
		Rhizosphere	Non Rhizosphere	Rhizosphere	Non Rhizosphere
T_1. 5t of FYM	6.23^{f}	20.10^{d}	12.13^{e}	9.27^{e}	6.10^{e}
T_2. 10t of FYM	7.67^{e}	26.60^{abc}	15.54^{d}	11.87^{d}	7.30^{d}
T_3. 10t of FYM (Partially decomposed)	6.23^{f}	20.20^{d}	12.43^{e}	9.53^{e}	6.27^{e}
T_4. 10t of FYM + Mulching (Glyricidia 2 t ha^{-1})	7.90^{de}	24.89^{c}	15.76^{cd}	11.77^{d}	7.76^{cd}
T_5. 20t of FYM	10.06^{a}	28.71^{a}	18.67^{a}	15.43^{a}	10.59^{a}
T_6. 17.5t of FYM + 25% rec. NPK	9.20^{b}	27.67^{ab}	17.20^{b}	14.63^{ab}	9.13^{b}
T_7. 15t of FYM + 50% rec. NPK	8.90^{bc}	26.13^{bc}	17.10^{bc}	13.84^{bc}	8.69^{bc}
T_8. 12.5t of FYM + 75% rec. NPK	8.71^{bcd}	25.14^{c}	16.72^{bcd}	13.13^{bcd}	8.27^{bcd}
T_9. Rec. NPK + rec. FYM + Phorate + Herbicide + Fungicide	8.04^{cde}	25.01^{c}	16.04^{bcd}	12.77^{cd}	7.54^{d}
T_{10}. Rec. NPK	4.37^{g}	17.23^{e}	9.70^{f}	7.40^{f}	4.37^{f}
SEM±	0.29	0.71	0.44	0.51	0.35
CD at 5%	0.86	2.11	1.31	1.51	1.03

Note: Rec. NPK- 25:60:25 Kg ha^{-1}, Rec. FYM- 10t ha^{-1}, Phorate 10G @ 1Kg a.i ha-1, Herbicide-Lasso 50 EC@2.5 l ha^{-1}, Fungicide seed treatment (Thiram + Bavistin - each 2g kg^{-1} of seeds), Rhizobium seed treatment common to all plots.

The soil microbial biomass-P in the rhizosphere and non-rhizosphere soils at harvest was found to be significantly higher due to the application of 20t of FYM ha-1 (15.43 µg g^{-1} soil and 10.59 µg g^{-1} soils respectively) compared to all other treatments. However, it was on par with the application of 10t of FYM + mulching (Glyricidia 2 t ha^{-1}) (11.77 CFU X 105 g^{-1} soil and 7.76 CFU X 105 g^{-1} soil) and 10t of FYM (11.87 µg g^{-1} soil and 7.30 µg g^{-1} soil) respectively. The least soil microbial biomass-P was found to be due to rec. NPK (7.40 µg g^{-1} soil and 4.37 µg g^{-1} soils). The present study revealed that the microbial biomass-P was highest in manure treated plots. Similar work conducted by [14] in a 12-year field experiment to investigate the effect of different tillage methods and fertilization systems on microbial biomass C, N and P of a gray fluvo-aguic soil in rice-based cropping system. It was found that the microbial biomass-P was significantly greater in soils amended with manure along with mineral fertilizers than those of the treatments only with mineral fertilizers and the control. However, in the present study higher microbial biomass-P was recorded only in soils amended with manures.

Application of research: Application of organic manures in long time will help to maintain soil fertility and sustainability

Research Category: Organic Manures and Fertilizers

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