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Influence of Sustainable Agricultural Practices on Biological Properties of Vertisol Soil with Wheat Crop in Soybean-Wheat Cropping Sequence

K. Menaria* and R.K. Tenguria

Division of Microbiology, Department of Botany, Govt. MVM., Bhopal, India.

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The present study is one step towards sustainable agricultural practices. The results observed for biological properties like enumeration of microorganism (bacteria, fungi and actinomycetes), biomass in terms of organic carbon for both the crops but nodulation in case of soybean in vertisol soil indicated that these properties were significantly enhanced for both the crops on the application of different IPNM treatments. The best results were observed with T_6 treatment (25% NPK+FYM). The incorporation of different IPNM treatments has also showed that IPNM treatments have significantly leading to the improved biological properties of soil.

Key words: IPNM, Microorganism, Soybean, Wheat, Vertisol soil, Root nodules.

Taxonomically, soils of Madhya Pradesh are divided into four orders such as Inceptisols (27.65%), Entisols (12.97%), Vertisols (52.75%) and Mollisols (0.41%). This shows that soils of MP are rich of vertisol type. The vertisol /black cotton soil is originated from latin word verto which means turn (Murthy *et al*., 1982).

This order of mineral soils is characterized by high content of swelling type clays, which in dry seasons cause the soils to develop deep, wide cracks. The water holding capacity of this soil is high. The bulk density generally varies between 1.2 and 1.6 M gm^{-3}. The main constraints of this soil are low infiltration capacity and poor internal drainage, narrow workable soil water range, poor crop stand, evaporation from soil surface and shrinkage cracks. For these constraints the balanced and integrated use of plant nutrients as per soil value is the best strategy to maintain the soil health and crop productivity and yield. Therefore keeping these ideas in mind the present investigation was undertaken at Sehore district to represent the Central India.

* To whom all correspondence should be addressed.

MATERIAL AND METHODS

A field experiment was conducted during two consecutive years i.e.2003-04, 2004-05 in the Rabi season respectively in medium black soil (vertisol) on "Influence of Sustainable Agricultural Practices on Biological Properties of Vertisol Soil with Soybean-Wheat Crop in Soybean-Wheat Cropping Sequence". The treatments applied to soil were Control (T_1), 100% NPK (T_2), 75% NPK (T_3), 50% NPK (T_4), 50% NPK+FYM (T_5), 25% NPK +FYM (T_6), 100 % NPK+ FYM (IPNM) (T_7). The treatments were replicated thrice in a randomized block design (RBD). The soybean CV JS-335 and wheat CV GW-273 were used for experiments. To study the biological health of soil the enumeration of microorganism (bacteria, fungi and actinomycetes), biomass in terms of organic carbon was measured for both the crops but nodulation in case of soybean were studied. The Most Probable Number (MPN) counting method (Clark et al., 1977; Sundstrom and Klei, 1979) was followed to count number soil bacteria and Luria Bertine media (Shapton and Gould, 1969) was to culture the bacteria. Given value indicates that the MPN of bacteria per gm of soil. The "dilution plate counting" method was followed for counting of soil fungi. The soil samples were serially diluted and inoculated on sterile media petriplates. The Martin's medium (Streptomycine-rose Bengal agar) was used to develop fungal culture (Sunderajan, 2001). The dilution plate counting method was used for enumeration of actinomycetes. Jensen's agar medium was used to culture the actinomycetes (Kiprian *et al*., 2000). After sterilization media was poured into the petriplates at 45°C and mixed the inoculum with the medium. Allowed the media to cool in the inoculated petriplates to solidify and then pertiplates transferred to an incubator at 25-30°C in inverted position. Proper humidity in the incubator was maintained by keeping an open petriplate, containing water in the incubator. The petriplates were examined after 5 days of incubation upto 7 days. The number of colonies of actinomycetes was recorded. Biomass was measured in terms of organic carbon in q/ha. Organic carbon was determined by Walkley and Black method (1934). The number and dry weight of root nodules were recorded at 35 and 45 DAS. The plants were uprooted carefully to avoid unwanted shattering of root nodules. The nodules of soybean plant for each treatment were counted manually and then nodules were dried in oven to record the dry weight of nodule.

RESULTS AND DISCUSSION

Mean values of microflora status per gram of soil as influenced by different treatments under soybean-wheat cropping sequence experiments during two consecutive years (2003-04, 2004-05) were experimentally obtained and identified as bacteria, fungi and actinomycetes on the basis of their morphological structure. The treatment T_7 was found to be best for the he enumeration results of bacteria in soybean fields where the maximum number were recorded Likewise in wheat field the numbers of bacteria were observed minimum with T_1 and maximum with T_7 (Table 1 & Fig. 1).

The enumeration results of fungi in soybean field were observed minimum with T_1 and maximum with T_7. While the numbers of fungi in wheat field were observed minimum with T_1 and maximum numbers were observed with T_7(Table 1 & Fig. 1) . The enumeration results of actinomycetes in soybean field were found minimum for T_1 and maximum numbers were observed for T_7. The numbers of actinomycetes in wheat field were minimum with T_1 and maximum with T_7 (Table 1 & Fig. 1).The experimental findings on microflora status in the soil under soybean-wheat cropping sequence indicated that it was boosted up T_6 followed by T_5 treatments. Incorporation of NPK and FYM increased the microflora of soil over control significantly. The similar increase in the microbial population of the soil has also been observed by Ganjir & Singh (2002), Jain & Vyas (2003). The increase in the microflora status in the soil after harvest of soybean-wheat crop under cropping sequence could be visualized due to the increased microbial activities by the application of different IPNM treatments.

The addition of different IPNM treatments have also shown their efficiency to increase the organic carbon and organic matter significantly leading to the improved physical,

Table 1. Mean values of microflora status per gram of soil in soybean and wheat field as influenced by different treatments under soybean- wheat cropping sequence experiments (mean of two years 2003-04 and 2004-05).

S. No.	Treatments ha^{-1}	Bacteria		Fungi		Actinomycetes	
		Soybean field	Wheat field	Soybean field	Wheat field	Soybean field	Wheat field
T_1	Control	05×10^4	7×10^4	06×10^3	5×10^3	11×10^3	11×10^3
T_2	100% NPK	15×10^4	17×10^4	14×10^3	12×10^3	21×10^3	13×10^3
T_3	75% NPK	09×10^4	11×10^4	12×10^3	10×10^3	18×10^3	15×10^3
T_4	50% NPK	08×10^4	10×10^4	10×10^3	6×10^3	16×10^3	14×10^3
T_5	50% NPK+FYM	18×10^4	19×10^4	15×10^3	15×10^3	20×10^3	17×10^3
T_6	25% NPK +FYM	20×10^4	21×10^4	18×10^3	15×10^3	22×10^3	20×10^3
T_7	100 % NPK+ FYM	30×10^4	31×10^4	20×10^3	18×10^3	24×10^3	25×10^3

Table 2. Biological Properties of soil (Vertisol) at different stages of soybean as influenced by different treatments under soybean- wheat cropping sequence experiments (mean of two years 2003-04 and 2004-05)

S. No.	Treatments	Biomassq/ha (i.e. wt of O.C.) in soybean crop	Biomass q/ha (i.e. wt of O.C.) in wheat crop	Number of nodules/ plant	Nodules dry weight / plant (mg)
T_1	Control	101.30	104.30	45.70	70.5
T_2	100% NPK	129.80	112.80	54.40	94.10
T_3	75% NPK	123.00	121.00	49.10	89.50
T_4	50% NPK	117.00	131.50	46.10	88.60
T_5	50% NPK+FYM	139.50	146.50	57.80	100.70
T_6	25% NPK +FYM	133.50	123.30	50.10	92.70
T_7	100 % NPK+ FYM	141.80	171.30	59.60	104.10
	SEm	1.90	1.86	1.02	1.10
	CD 5%	5.75	4.76	3.07	3.40

chemical and biological properties of the soil which ultimately responsible for increased microflora status in the soil.

The results on biomass in terms of weight of organic carbon with soybean and wheat crop was calculated minimum for T_1 treatment while the maximum with $T_{7.}$ The results obtained on biomass of both the crops indicated that it was significantly boosted up by different IPNM treatments over that other treatment. The maximum and significant response was observed under T_7 and T_5 treatments. These treatments were noticed statistically at par with each other indicating the superiority of T_5 treatment in increasing the organic pool of the experimental soil. The lowest values were recorded under T_1(Table 2 & Fig. 2). Although these results are in close agreement with those observed by Lund ad Goksoyr (1980), Mahler and Wollum (1981), Ocio and Brooks (1990), Uhlirova and Santruckova (2003), Pascual *et al.* (2000), Rose *et al.* (2003), Hargreaves *et al.* (2003), Jain and Vyas (2003).

The soil is an ecosystem that contains a variety of microbial population. The number of activities of these various microbes is influenced by the chemical, physical and biological characteristics of the soil as well as the presence of growing plants. In the present study, the addition of different IPNM treatment significantly improved the physical, chemical biological properties of soil leading to the increased microbial activities and canopy developments, which ultimately accelerated the

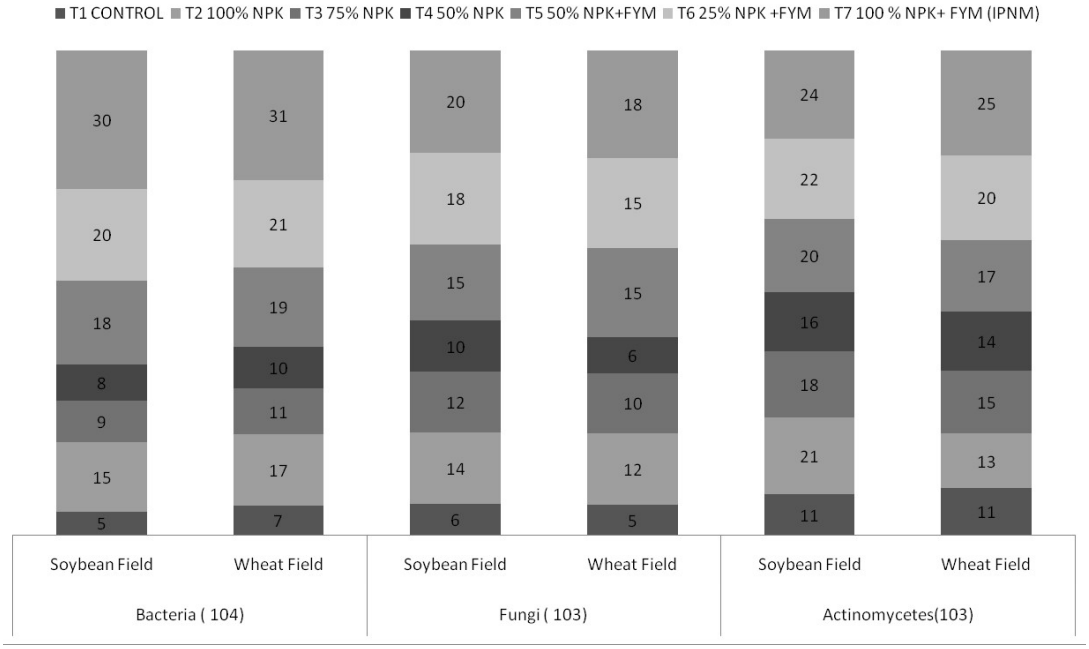

Fig. 1. Mean values of Microflora status per gram of soil in soybean and wheat field as influenced by different treatments under soybean-wheat cropping sequence experiments (mean of two years 2003-04, 2004-05

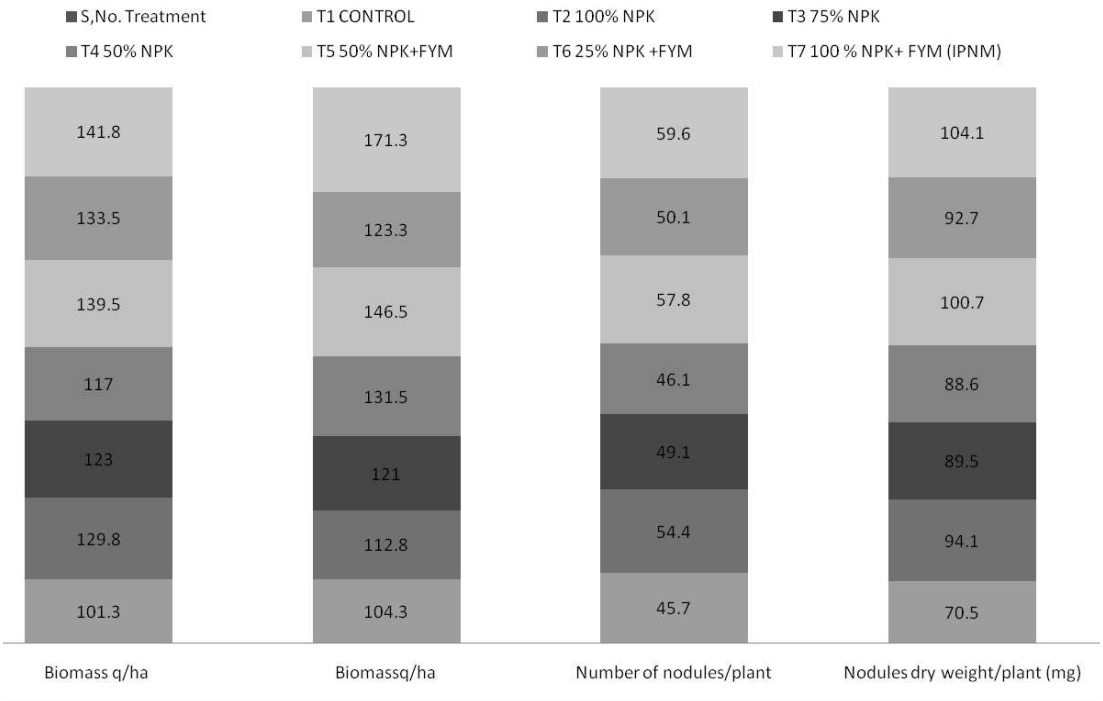

Fig. 2. Biological properties of vertisol soil at differents soybean as influenced by different treatments under soybean-wheat cropping sequence experiments (mean of two years 2003-04, 2004-05

amount of organic carbon and thus increased biomass.

Nodulation in soybean crop is another biological parameter to measure the rhizobial activity, which in turn reveals the availability of nitrogen. In the present study the data acquired on number of nodules per plant of soybean crop where the minimum value was observed for T_1 and the maximum was T_7(100% NPK+FYM).The data acquired on dry weight of nodules per plant of soybean crop were observed minimum nodule dry weight for T_1 while the maximum was in T_7 (100% NPK+FYM) (Table 2 & Fig. 2). The data shows for nodule number/ plant and their dry weight / plant of soybean crop, the significant superiority of T_5 treatment. Though, the maximum impact was observed under T_7 treatment but it was statistically at par with T_5 treatment. The lowest values were recorded under control (T_1) (Table 2 & Fig. 2).

Similar results have also been reported by Anderson (1964), Dev and Tilak (1976), Jain and Vyas (2003). The incorporation of different IPNM treatments significantly increased the biological properties leading to the increased available nutrient status in the soil. Such increased fertility status ultimately influenced the better development of the plant and it might profuse nodulation on account of increase in the rhizobial activity in the rhizosphere, which in turn resulted in the formation of active and higher number of root nodules.

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