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Soil Micro-flora as influenced by Nutrient Management Practices and Cropping System

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ABSTRACT: The field experiment was conducted during three seasons (*Kharif, Rabi* and Summer) in the two consecutive years 2021-22 to 2022-23 at Instructional Research Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. The experiment was laid out in split plot design with 24 treatment combinations of six different nutrient management practices and 4 cropping system. The allocation of various treatments to different plots was done randomly with three replications. Under main plot, NM_1 (100% organic), NM_2 (50% Organic NM + NF inputs Beejamrit + Ghanjeevamrit + Jeevamrit), NM_3 (50% Organic NM + 50% Inorganic NM), NM_4 (25% Organic NM + NF inputs Beejamrit + Ghanjeevamrit + Jeevamrit + 25% Inorganic NM), NM_5 (Farmer practices), NM_6 (100% Inorganic NM). CS_1 (Soybean-wheat), CS_2 (Soybean-berseem), CS_3 (Soybean-mustard-green gram), CS_4 (Soybean-lentil-sorghum) allotted under sub-plot. The results revealed that biological properties of soil were significantly enhanced by different nutrient management practices and cropping system during both the years of experimentation. The bacterial (46.81×10^5 cfu g^{-1} soil) and fungal population (42×10^3 cfu g^{-1} soil) was found maximum under 100% organic nutrient management followed by INM (25% + 25%). Whereas the actinomycetes population was maximum (14×10^2 cfu g^{-1} of soil) under INM (25% organic + 25% inorganic + NF inputs) followed by 50% organic + NF inputs with soybean-mustard-green gram cropping system.

Keywords: Soybean based cropping system, nutrient management, bacteria, fungi, and actinomycetes.

INTRODUCTION

Soybean (*Glycine max* L. (Merr.)) is one of the most important pulse crops. Soybean has become the premier oil seed crop in India, producing 10.11 Mt from 6.69 m ha area with productivity of 1511 kg/ha (DAC GOI, 2012). Soybean mainly grown in central part of the country Madhya Pradesh, Maharashtra and Rajasthan covering about 95% of the production.

Soybean based cropping systems are important for sustaining agricultural production and also maintain soil fertility with an ecological balance. This system also reduces the dependency on chemical fertilizers and help in monetary saving. Most of the farmers grow soybean without fertilizer application and realize the carry over effect of the legume crop on the succeeding wheat crop. Application of organic material along with inorganic fertilizers into the soils leads to increase in productivity of the cropping system enhance the use efficiency of fertilizer input and sustain the soil health for longer period (Jat *et al*., 2015; Tambe *et al*., 2019). The continuous use of high levels of chemical fertilizers is adversely affecting the sustainability of agricultural production and causing soil pollution.

Further, indiscriminate use of chemical fertilizer and pesticides in intensive production systems has deteriorated the soil fertility, productivity. It is well documented that organic manures are good complimentary sources of nutrients and improve the efficiency of the applied nutrients on one hand and also improve soil physical and biological properties on the other hand (Singh and Ryan 2015). Integrated nutrient management refers to the maintenance of soil fertility and plant nutrient supply at an optimum level for sustaining the benefit manner. The objective of Integrated nutrient management improves the available nutrient status of the soil with the incorporation of FYM alone or in combination with chemical fertilizer could be attributed to the slow decomposition of organic manure producing acids and enhancing soil biological activity. That is provide congenial soil physical conditions, conserve soil nitrogen and increase the availability of other nutrients.

METHODS AND MATERIALS

The field experiment was conducted during three seasons (*Kharif, Rabi* and Summer) in the two consecutive years 2021-22 to 2022-23 at Instructional Research Farm, Department of Agronomy, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India. The experiment was laid out in split plot design with 24 treatment combinations of six different nutrient management practices and 4 cropping system. The allocation of various treatments to different plots was done randomly with three replications. Nutrient management practices were taken as main plot and cropping system taken as sub plot. Main plot, NM_1 (100% organic), NM_2 (50% Organic NM + NF inputs Beejamrit + Ghanjeevamrit + Jeevamrit), NM_3 (50% Organic NM + 50% Inorganic NM), NM_4 (25% Organic NM + NF inputs Beejamrit + Ghanjeevamrit + Jeevamrit + 25% Inorganic NM), NM_5 (Farmer practices), NM_6 (100% Inorganic NM). Sub-plot CS_1 (Soybean-wheat), CS_2 (Soybean-berseem), CS_3 (Soybean-mustard-green gram), CS_4 (Soybean-lentil-sorghum). The microbial population were estimated by the standard method.

Soil of the experimental field soil was sandy in texture, slightly alkaline in reaction (pH 7.28) with medium OC content (0.68%), high EC (0.381 dSm^{-1}) and analyzing low in available Nitrogen (258 kg ha^{-1} N), Medium in available Phosphorus (13.5 kg ha^{-1} P) and medium available potassium (284 kg ha^{-1} K) starting the present experiment during *Kharif* 2021 (Table 2). The status of soil slightly varied under different treatments (cropping system) over the initial status after harvest of the *Rabi* and *Summer* crops during 2022-2023.

RESULTS AND DISCUSSION

A. Bacterial population

The data on bacterial population have been mentioned in Table 1 after the harvest of the crop. There was a significant variation in bacterial population among the different nutrient management practices and cropping system both the year and in pooled data.

On mean basis, it was observed that the 100% organic nutrient management showed maximum (46.81×10^5 cfu g^{-1} soil) total bacterial population which was followed by INM (45.69×10^5 cfu g^{-1} soil), 50% organic. Whereas, the minimum bacterial population (40.89×10^5 cfu g^{-1} soil) was found under farmer practices. Similar results were also found by Das *et al.* (2019). Under cropping system, the soybean-mustard-green gram cropping system recorded the maximum bacterial population (44.02×10^5 cfu g^{-1} soil) followed by soybean-berseem cropping system (43.92×10^5 cfu g^{-1} soil).

The minimum bacterial population was found under soybean-wheat cropping system during both the year. Improvement in microbial count under legume based cropping system has been observed by Davari and Sharma (2011).

The interaction effect between different nutrient management practices and cropping systems on bacterial population was found to be non-significant.

B. Fungal population

The data related to the fungi population have mentioned in Table 2. There was a significant variation among the different nutrient management practices and cropping system during both the year of experimentation.

It was found that the maximum fungi population was found in 100 % organic nutrient management (42×10^3 cfu g^{-1} soil) followed by INM (41.66×10^3 cfu g^{-1} soil) and lowest population fungi was registered under farmer practices (40.91×10^3 cfu g^{-1} soil). Similar results were also found by Das and Dkhar (2011).

On the other hand under different cropping systems the fungi population was highest in soybean-mustard-green gram cropping system (41.61×10^3 cfu g^{-1} soil) followed by soybean-berseem cropping system (41.33×10^3 cfu g^{-1} soil) and least population was found under soybean-wheat cropping system (41.27×10^3 cfu g^{-1} soil).

The interaction effect between different nutrient management practices and cropping systems on bacterial population was found to be non-significant.

C. Actinomycetes population

The growth of actinomycetes was slightly changed with the application of different nutrient management while with cropping system the population was not affected. The actinomycetes population showed significant variation with nutrient management but with cropping system it was non-significant during both the year and in pooled data.

The maximum population of actinomycetes (14×10^2 cfu g^{-1} of soil) was marked under INM (25% organic + 25% inorganic + NF inputs) which is followed by 50 % organic + NF inputs (12.58×10^2 cfu g^{-1} of soil). The minimum population of actinomycetes (10.75×10^2 cfu g^{-1} of soil) was found under farmer practices. Similar results were also found by Mallikarjun and and Maity (2018).

The soybean - mustard - green gram cropping system recorded the maximum population of actinomycetes (12.16×10^2 cfu g^{-1} of soil) followed by soybean - berseem cropping system (12.05×10^2 cfu g^{-1} of soil) and soybean-lentil-sorghum population. Whereas the minimum population (11.83×10^2 cfu g^{-1} of soil) was found under soybean - wheat cropping system.

The interaction effect between different nutrient management and cropping system found to be non-significant.

Table 1: Effect of nutrient management and cropping system on Bacteria population.

Nutrient management	Cropping system (10^5 cfu g^{-1} soil)				
	Initial status 42.25				
	CS1	**CS2**	**CS3**	**CS4**	**Mean**
100%org	46.57	46.99	47.11	46.57	46.81
50%org+NF inputs	45.56	45.82	45.95	45.44	45.69
INM (50%org+50%inorg)	42.79	42.86	42.94	42.87	42.86
INM (25%org+25%inorg) + NF inputs	44.22	44.42	44.66	44.38	44.42
Farmer practices	40.73	40.97	40.95	40.90	40.89
100%inorg	42.14	42.48	42.53	42.22	42.34
Mean	**43.67**	**43.92**	**44.02**	**43.73**	
				Interaction	
	Nutrient Management	**Cropping System**	**Factor B at same level of A**		**Factor A at same level of B**
SEm±	0.158	0.104	0.316		0.271
CD (p =0.05)	0.505	0.299	N/S		N/S

Where, CS1 is Soybean-wheat, CS2 is Soybean-berseem (F+S), CS3 is Soybean-mustard-green gram, CS4 is Soybean-lentil-sorghum (fodder)

Table 2: Effect of nutrient management and cropping system on fungal population.

Nutrient management	Cropping system (10^3 cfu g^{-1} soil)				
	Initial status 31.00				
	CS1	**CS2**	**CS3**	**CS4**	**Mean**
100%org	32.00	32.00	32.00	32.00	32.00
50%org+NF inputs	31.00	31.33	31.66	31.00	31.25
INM (50%org+50%inorg)	31.00	31.00	31.33	31.00	31.08
INM (25%org+25%inorg) + NF inputs	31.66	31.33	32.00	31.33	31.58
Farmer practices	30.66	31.00	31.00	31.00	30.91
100%inorg	31.00	31.00	31.66	31.00	31.16
Mean	31.22	31.27	31.61	31.22	
				Interaction	
	Nutrient Management	**Cropping system**	**Factor B at same level of A**		**Factor A at same level of B**
SEm±	0.059	0.085	0.118		0.189
CD (p =0.05)	0.188	0.244	N/S		N/S

Where, CS1 is Soybean-wheat, CS2 is Soybean-berseem (F+S), CS3 is Soybean-mustard-green gram, CS4 is Soybean-lentil-sorghum (fodder)

Table 3: Effect of nutrient management and cropping system on actinomycetes population.

Nutrient management	Cropping system (10^2 cfu g^{-1}soil)				
	Initial status 10.52				
	CS1	**CS2**	**CS3**	**CS4**	**Mean**
100%org	11.00	12.00	12.00	12.00	11.75
50%org+NF inputs	12.33	12.66	13.00	12.33	12.58
INM (50%org+50%inorg)	11.66	12.00	12.00	12.00	11.91
INM (25%org+25%inorg) + NF inputs	14.00	14.00	14.00	14.00	14.00
Farmer practices	11.00	10.66	11.00	10.33	10.75
100%inorg	11.00	11.00	11.00	11.00	11.00
Mean	11.83	12.05	12.16	11.94	
				Interaction	
	Nutrient management	**Cropping system**	**Factor B at same level of A**		**Factor A at same level of B**
SEm±	0.095	0.085	0.190		0.204
CD (p =0.05)	0.303	N/S	N/S		N/S

Where, CS1 is Soybean-wheat, CS2 is Soybean-berseem (F+S), CS3 is Soybean-mustard-green gram, CS4 is Soybean-lentil-sorghum (fodder)

CONCLUSIONS

Based on the results it can be concluded that the microbial population slightly changes from the initial status due to different nutrient management practices and cropping system. The bacterial and fungal population was maximum under 100% nutrient management while the actinomycetes population was maximum under INM (25% organic +25% inorganic) + NF inputs with soybean- mustard - green gram cropping system.

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Conflict of Interest. None.

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