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Impact on soil microbial communities under different cropping system of Prayagraj district, Eastern Uttar Pradesh, India

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Abstract
Cropping system is an effective agricultural practice which play crucial role in increasing soil microbial diversity, soil health and fertility. Keeping these views study was undertaken in Prayagraj district eastern Uttar Pradesh to investigate the impact on soil microbial communities affected by major cropping system. The major cropping system includes wheat-wheat, mustard-mustard, Rice-Wheat and Rice-Mustard. Soil samples were collected from eight tehsil of Prayagraj district randomly from depth 0-15 cm and 15-30 cm depth. The results conclude that Rice-wheat cropping system contains higher soil microbial population than other cropping system.

Keywords: cropping system, microbial diversity, colony forming unit, soil health.

Introduction
Soil is usually considered as the greatest heritage of mankind and a valuable natural resource and plays many key roles in terrestrial ecosystem (Hillel 1991) [8]. It is the soul of life and health for the well-being of humankind and animals. It is also a major source of most of our food production (Stevenson 1994; Greenland 1994) [13, 6].
The soil microbial diversity is the most important functional component of the soil biota (Tate, 2000) [14]. Microorganisms in the soil have an important role in the decomposition of organic matter, carbon and nitrogen cycling, and the creation and stabilisation of soil structure (Garbeva *et al*. 2004; Loranger-Merciris *et al*. 2006) [4, 9]. The microbial diversity identified as key indicator for maintain soil health and quality of microbial diversity (Bending *et al*. 2004) [1].
Growth of microbial populations and their action on soils are dependent on the interaction between plant species and soil (Grayston *et al*. 1998) [5]. Bacterial and fungal community composition results from the interaction between soil type, plant species and its rhizosphere localization Marschner *et al*. (2001) [10].
Microbial biomass can be increased by using appropriate agricultural practices like crop rotation (Hansen JP *et al*. 2013) [7]. Crop rotation can have huge impact on soil health, these includes improving soil structural stability, increasing crop water use efficiency, nutrient use efficiency and level of soil organic matter, better weed control etc. (Carter *et al*. 2002, Carter *et al*. 2003) [3, 2].
Therefore, the present study was undertaken with the objective of assessment of soil microbial count under different cropping system.

Materials and Methods
Study site
The field experiments were carried out at Prayagraj district, Uttar Pradesh. It covers an area of 5246 km^2. The soil samples were collected from all eight tehsils of Prayagraj districts. From each Tehsils four villages were randomly selected for the soil sampling. Soil samples were randomly collected from soil depth 0-15 cm and 15-30 cm two different cropping system *i.e*., wheat-wheat, mustard-mustard, rice-wheat and rice-mustard in the year 2017-18.

Soil sampling and analysis
Biological analysis of soil was done during grand growth of the crops. The soil was returned to the laboratory after sample and air-dried at room temperature. The soil weight was reduced and sieved through 2 mm mesh and then used for biological analysis. The count of microorganisms (bacteria and fungi) was carried out by using serial dilution pour plate method (Wollum, 1982) [15].

Microbial counts

Total bacterial and fungal count was done by using specific media *i.e.*, Nutrient Agar Media and Rose Bengal media. One gram of the rhizosphere soil was placed in 9 ml of sterilized distilled water under aseptic conditions. Serial dilution of 10^2, 10^3, 10^4, 10^5, 10^6 were prepared. One ml of aliquot from specific dilution was added over cooled and solidified nutrient media in Petri plates. The plates were rotated for uniform distribution. For 2-3 days, the plates were incubated at temperatures relevant to each microorganism. An electronic colony counter was used to count the colonies that grew on the media. For each sample, three replications were taken. The colony forming unit per gramme of soil (cfu/g soil) was used to calculate the microbial count.

Culture media

The media selected were among the most frequently cited in the literature as Nutrient Agar Medium for bacterial growth and Rose Bangal Media for fungal growth.

Statistical analysis

Analysis of variance F4 way classification was used and their after for comparing two objects together the value of critical difference was also analyzed.

Results and Discussion

The table 3.1 shows that fungal population in soil significantly varied under different cropping system. Highest fungal population was recorded under rice-wheat cropping system 21×10^6 cfu g^{-1} soil in 0-15 cm depth and 11×10^6 cfu g^{-1} soil in 15-30 cm depth of village Kaserua in Phulpur tehsil.

Similarly, lowest fungal population was recorded under mustard-mustard cropping system 4×10^6 cfu g^{-1} soil in 0-15 cm depth and 1×10^6 cfu g^{-1} soil in 15-30 cm depth of village Andhawa in Handiya tehsil.

The table 3.2 shows that bacterial population in soil significantly varied under different cropping system. Highest fungal population was recorded under rice-wheat cropping system 27×10^7 cfu g^{-1} soil in 0-15 cm depth and 17×10^7 cfu g^{-1} soil in 15-30 cm depth of village Kaserua in Phulpur tehsil.

Similarly, lowest bacterial population was recorded under mustard-mustard cropping system 7×10^7 cfu g^{-1} soil in 0-15 cm depth and 3×10^7 cfu g^{-1} soil in 15-30 cm depth of village Andhawa in Handiya tehsil. The population of bacteria was recorded maximum than fungal population. Similar order was also observed by Radhakrishnan *et al.*, (2016) and Nayak (2017) [12, 11].

Table 1: Fungal population of different cropping system at 0-15 cm and 15-30cm depth at grand growth of crops in the year 2017-18

Fungus ($\times10^6$ cfu g-1 soil)											
Tehsils	**Cropping system**	**(0-15 cm) depth**				**Mean**	**(15-30 cm) depth**				**Mean**
		V1	**V2**	**V3**	**V4**		**V1**	**V2**	**V3**	**V4**	
Meja	Wheat/Wheat	9	11	13	7	10	4	7	6	5	6
	Mustard/Mustard	6	10	7	11	9	4	6	4	7	5
	Rice/ wheat	13	15	13	8	12	7	8	7	3	6
	Rice/Mustard	10	14	10	13	12	5	7	5	8	6
Saroan	Wheat/Wheat	8	14	9	6	9	3	8	6	2	5
	Mustard/Mustard	6	11	5	10	8	3	6	2	4	4
	Rice/ wheat	10	16	11	9	12	4	9	7	4	6
	Rice/Mustard	8	8	6	12	9	5	6	3	6	5
Karchana	Wheat/Wheat	6	9	11	7	8	2	3	7	3	4
	Mustard/Mustard	5	7	12	5	7	3	4	5	2	4
	Rice/ wheat	9	11	14	10	11	5	8	9	5	7
	Rice/Mustard	7	9	13	7	9	4	5	7	3	5
Handiya	Wheat/Wheat	7	5	11	8	8	5	3	6	4	5
	Mustard/Mustard	6	5	7	4	6	3	2	3	1	2
	Rice/ wheat	9	7	14	10	10	6	5	8	5	6
	Rice/Mustard	7	7	10	6	8	5	4	6	3	5
karoan	Wheat/Wheat	13	9	7	5	9	9	5	4	3	5
	Mustard/Mustard	7	6	8	10	8	5	4	4	6	5
	Rice/ wheat	16	11	9	8	11	10	8	5	5	7
	Rice/Mustard	10	8	11	13	11	7	5	6	7	6
Bara	Wheat/Wheat	7	7	8	10	8	5	4	5	6	5
	Mustard/Mustard	6	5	7	9	7	3	4	4	5	4
	Rice/ wheat	10	9	10	12	10	7	5	5	7	6
	Rice/Mustard	8	7	9	11	9	4	5	5	6	5
Phulpur	Wheat/Wheat	10	10	18	11	12	8	7	10	7	8
	Mustard/Mustard	9	9	15	10	11	6	5	9	6	7
	Rice/ wheat	13	15	21	16	16	9	8	11	9	9
	Rice/Mustard	10	11	18	14	13	7	7	10	9	8
Sadar	Wheat/Wheat	8	9	7	12	9	6	5	4	7	6
	Mustard/Mustard	8	9	6	10	8	4	5	3	6	5
	Rice/ wheat	10	11	10	15	12	7	6	6	10	7
	Rice/Mustard	11	10	10	13	11	6	5	4	8	6
	Due to depth	Due to cropping system				Due to tehsil	Due to village				
Result	S	S				S	S				
SE(d)	0.24	0.34				0.49	0.34				
CD at 5%	0.48	0.69			0.97		0.69				

Table 2: Bacterial population of different cropping system at 0-15 cm and 15-30cm depth at grand growth of crops in the year 2017-18

Bacteria ($\times 10^7$ cfu g-1 soil)											
Tehsils	**Cropping system**	**(0-15 cm) Depth**				**Mean**	**(15-30 cm) Depth**				**Mean**
		V1	**V2**	**V3**	**V4**		**V1**	**V2**	**V3**	**V4**	
Meja	Wheat/Wheat	11	14	11	9	11.3	6	9	5	6	6.5
	Mustard/Mustard	8	12	9	14	10.8	5	7	4	5	5.3
	Rice/ wheat	15	17	16	10	14.5	9	10	8	8	8.8
	Rice/Mustard	13	16	14	15	14.5	7	9	7	9	8.0
Saroan	Wheat/Wheat	10	17	12	9	12.0	4	11	7	6	7.0
	Mustard/Mustard	9	14	8	13	11.0	3	8	4	6	5.3
	Rice/ wheat	14	18	12	11	13.8	7	10	9	5	7.8
	Rice/Mustard	11	9	9	15	11.0	7	7	4	8	6.5
Karchana	Wheat/Wheat	8	11	14	10	10.8	3	6	8	5	5.5
	Mustard/Mustard	9	10	15	8	10.5	3	5	7	4	4.8
	Rice/ wheat	12	15	17	13	14.3	5	9	9	7	7.5
	Rice/Mustard	10	11	15	9	11.3	5	7	8	5	6.3
Handiya	Wheat/Wheat	10	9	15	12	11.5	6	4	8	6	6.0
	Mustard/Mustard	8	7	8	7	7.5	4	3	4	3	3.5
	Rice/ wheat	11	9	16	13	12.3	6	5	10	8	7.3
	Rice/Mustard	9	10	13	8	10.0	6	6	7	4	5.8
Karoan	Wheat/Wheat	15	11	9	7	10.5	11	6	6	3	6.5
	Mustard/Mustard	10	9	11	7	9.3	7	5	4	5	5.3
	Rice/ wheat	18	13	11	10	13.0	11	9	7	7	8.5
	Rice/Mustard	13	10	13	15	12.8	8	6	9	9	8.0
Bara	Wheat/Wheat	10	9	11	12	10.5	7	5	7	6	6.3
	Mustard/Mustard	8	7	9	10	8.5	5	5	6	6	5.5
	Rice/ wheat	14	12	13	15	13.5	9	7	8	9	8.3
	Rice/Mustard	10	9	11	14	11.0	6	7	7	9	7.3
Phulpur	Wheat/Wheat	14	12	21	15	15.5	10	8	15	9	10.5
	Mustard/Mustard	11	10	18	11	12.5	7	6	11	7	7.8
	Rice/ wheat	17	17	27	19	20.0	12	10	17	10	12.3
	Rice/Mustard	13	14	20	15	15.5	8	9	13	11	10.3
Sadar	Wheat/Wheat	11	12	9	16	12.0	7	7	6	10	7.5
	Mustard/Mustard	10	10	9	12	10.3	5	6	5	9	6.3
	Rice/ wheat	15	14	12	19	15.0	9	7	9	12	9.3
	Rice/Mustard	13	13	12	15	13.3	7	6	6	10	7.3
	Due to depth	Due to cropping system				Due to tehsil			Due to village		
Result	S	S				S			S		
SE(d)	0.27	0.38				0.54			0.38		
CD at 5%	0.53	0.75				1.07			0.75		

Conclusion

We conclude from the study that different cropping systems have significant impact on soil microbial population. Soils under different cropping systems showed best results than monoculture crops. The study indicates that rice-wheat cropping system shows higher microbial population than all other cropping systems and lowest in mustard-mustard cropping system. Therefore, present study shows the different cropping systems have a potential to enhance soil microbial population and maintain soil health.

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