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Assessment of Different Micro Organisms Metabolic Activity in the Rhizosphere of Main Kharif Crop under Conventional and Conservation Agriculture System

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Conventional tillage practices may adversely affect long-term soil productivity due to erosion and loss of organic matter in soils. Sustainable soil management can be practiced through conservation tillage (including no-tillage), high crop residue return, and crop rotation. Microorganisms in the soil strongly influence soil processes fulfill key roles in the decomposition of organic matter, Therefore, the constituents of soil microorganisms, such as microbial and microbial community diversity, have often been identified as sensitive indicators of biological indices for maintaining soil health and quality. Conservational agriculture system showed significantly higher total bacterial count in rhizospheric soil of main kharif crop viz. paddy, maize and soybean over conventional agriculture system. Conservational agriculture system proved to be superior over conventional agriculture system. Microbial activity as bacteria, actinomycetes fungi and there metabolic activity microbial biomass carbon, nitrogen, phosphorus were highest at reproductive stage in both conventional and conservational agriculture system in soybean crop.

Introduction

Microorganisms in the soil strongly influence soil processes (Garbeva *et al.,* 2004), fulfil key roles in the decomposition of organic matter, the cycling of carbon and nitrogen and the formation and stabilization of soil structure (Loranger-Merciris *et al.,* 2006). Therefore, the constituents of soil microorganisms, such as microbial and microbial community diversity, have often been identified as sensitive indicators of biological indices for maintaining soil health and quality (Bending *et al.,* 2004). Unsustainable agricultural practices have resulted in extreme soil erosion (Cai *et al.,* 2006; Jiang *et al.,* 2007), which can lead to physical and chemical degradation (Lal *et al.,* 2000). In response to the decline in regional soil quality in the Loess plateau, there has been a gradual shift from conventional tillage towards conservation tillage practices such as zero tillage farming, crop residue retention and crop rotation. These production practices, have resulted in positive effects on crop yield and soil physical and chemical properties (Peixoto *et al.,* 2006), also strongly influence the size, composition, diversity and function of soil microbial communities (Steenwerth *et al.,* 2002; Salles *et al.,* 2006), resulting in significantly altered soil processes. Zero tillage has increased soil organic carbon in the surface layer (Melero *et al.,* 2009), including increases of up to 100% in microbial biomass C (MB-C) in as little as five years (Franchini *et al.,* 2007), and significantly improved soil microbial activity and diversity as well. Conservation tillage is defined as a tillage system in which at least 30% of crop residues are left in the field and is an important conservation practice to reduce soil erosion. The advantages of conservation tillage practices over conventional tillage include reducing cultivation cost; allowing crop residues to act as an insulator and reducing soil temperature fluctuation; building up soil organic matter; conserving soil moisture. Conventional tillage can lead to soil microbial communities dominated by aerobic microorganisms, while conservation tillage practices increase microbial population and activity as well as microbial biomass.

Materials and Methods

Two field sites were selected for the study were to the research field of Department of Soil Science and Agricultural Chemistry, JNKVV Jabalpur under AICRP on STCR and The Bourlog Institute of South Asia situated at village Khamaria Jabalpur. The initial fertility status of soil before sowing of each crop, composite soil samples from 0-15 cm and 15-30 cm depth was randomly collected from the experimental field. All the possible technical precautions as prescribed for standard soil sampling method have been followed. The soil samples thus obtained from 0-15 cm and 15-30 cm were subjected to various chemical and biological analysis to assess the two field sites for analysis of soil biochemical properties and microbial population counts before sowing of the crop maximum vegetative growth and after harvest of each crop under conventional and conservational agriculture system. The experimental data were collected subjected to statistical analysis to test the significance of treatments and statistical analysis was done following method using Factorial CRD.

Results and Discussion

The findings obtained during the investigation are discussed with possible reasons for superiority of the system supported with the findings by research workers in India and abroad on various characters under study. Attempts have been made in the following description to evaluate and explain the effect of different treatments on various parameters of paddy, maize and soybean crop recorded in the investigation. The data collected for each parameter was compiled, statistically analyzed and being presented in tables 1–6.

It is evident from data presented in table 1. Is that in paddy crop (C_1) at initial stage (St_1) under conservational agriculture system MBC count was 74.13 percent higher than conventional agriculture system. At reproductive stage (St_2) 27.10 percent and at harvest the MBC was 1.35 percent higher in conservational agriculture system. In maize crop (C_2) at initial stage (St_1) MBC was 52.5 percent in reproductive stage (St_2) 25.79 percent and at harvest 9.88 percent higher in conservational agriculture system. In soybean crop (C_3) at initial stage (St_1) MBC was 66.15 percent, and at reproductive stage 19.93 percent higher and at harvest (St_3) 36.31 percent higher than conventional agriculture system. MBC was high in sub surface soil (D_1) 0-15 cm than (D_2) 15-30 cm in both the system (S_1 and S_2) respectively.

The data presented in table 2 shows the interaction effect of stage with crop, crop with system and depth on the MBC content. Paddy, maize and soybean had maximum biomass carbon of 138.0, 106.51 and 89.7 respectively and significantly higher at reproductive stage. When compared to crop and system of agriculture the MBC was maximum at initial stage (St_1) having 134.44 and 164.79 in the paddy, maize rhizosphere soil had 100.9 and 152.32 mg/kg while it was 122.73 and 92.69 at harvest stage (St_3) in the soybean rhizosphere soil under conventional and conservational system of agriculture.

When compared with crop and depth it was observed that paddy crop at 0-15 cm and 15-30 cm had 194.05 and 105.18 respectively followed by maize rhizosphere soil content was 161.97 and 91.26 and lowest of 148.22 and 67.2 MBC content in depth 15-30 cm was recorded under convention and conservational system having 122.73 and 92.69 mg/kg respectively in soybean rhizosphere soil. It is evident from data that in paddy crop (C_1) at initial stage (St_1) under conservational agriculture system MBN count is 24.30 percent higher than conventional agriculture system. In reproductive stage (St_2) 27.10 percent and at harvest the MBN is 43.10 percent higher in conservational agriculture system. In maize crop (C_2) at initial stage (St_1) MBN is 17.7 percent in reproductive stage (St_2) 2.85 percent and at harvest 36.86 percent higher in conservational agriculture system. In soybean crop (C_3) at initial stage (St_1) MBN is 35.21 percent and at reproductive stage 45.17 percent higher than conventional agriculture system. MBN is high in sub surface soil (D_1) 0-15 cm than (D_2) 15-30 cm in both the system (S_1 and S_2) respectively.

Table.1 Impact of conventional and conservational agricultural system in Microbial biomass carbon (mg/kg) of rhizospheric soil

Depth	Crop	Stage	S1 Conventional (mg/kg)	S2 Conservational (mg/kg)
0-15 cm (D_1)	Paddy(C_1)	Initial(St_1)	115.83	201.70
		Reproductive(St_2)	107.40	244.83
		Harvest(St_3)	153.23	155.30
	Maize(C_2)	Initial(St_1)	45.90	287.33
		Reproductive(St_2)	181.73	228.60
		Harvest(St_3)	76.11	152.13
	Soybean(C_3)	Initial(St_1)	92.14	153.43
		Reproductive(St_2)	244.74	293.53
		Harvest(St_3)	123.33	168.12
15-30 cm (D_2)	Paddy(C_1)	Initial(St_1)	77.63	108.10
		Reproductive(St_2)	106.00	184.10
		Harvest(St_3)	113.03	124.23
	Maize(C_2)	Initial(St_1)	121.83	152.53
		Reproductive(St_2)	121.90	107.20
		Harvest(St_3)	60.93	62.13
	Soybean(C_3)	Initial(St_1)	76.80	62.40
		Reproductive(St_2)	78.93	63.00
		Harvest(St_3)	31.63	46.43
SEm±	0.51			
CD(p=0.05)	1.53			

Table.2 Interaction between crops (C) stages (St), depth (D), crop and System(S) and crop on microbial biomass carbon (mg/kg)

Crop x Stage				**Crop x Depth**		**Crop x System**	
Crop	**Initial (St_1)**	**Reproductive (St_2)**	**Harvest (St_3)**	**0-15cm (D_1)**	**15-30cm (D_2)**	**Conv.**	**Cons.**
Paddy(C_1)	83.88	138.06	77.30	194.05	105.18	134.44	164.79
Maize(C_2)	83.10	106.57	63.55	161.97	91.26	100.91	152.32
Soybean(C_3)	64.13	89.70	61.59	148.22	67.2	122.73	92.69
Mean	77.04	111.44	67.48	168.08	87.88	119.36	136.60
SEm±			0.25		0.21		0.21
CD(p=0.05)			0.75		0.63		0.63

Table.3 Impact of conventional and conservational agricultural system in Microbial biomass nitrogen (mg/kg) of rhizospheric soil

Depth	**Crop**	**Stage**	**S1 Conventional (mg/kg)**	**S2 Conservational (mg/kg)**
0-15 cm (D_1)	Paddy(C_1)	Initial(St_1)	32.73	26.33
		Reproductive(St_2)	42.73	36.67
		Harvest(St_3)	33.53	23.43
	Maize(C_2)	Initial(St_1)	31.87	11.50
		Reproductive(St_2)	32.47	31.57
		Harvest(St_3)	36.27	26.50
	Soybean(C_3)	Initial(St_1)	28.80	21.30
		Reproductive(St_2)	53.37	53.13
		Harvest(St_3)	32.73	32.03
15-30cm (D_2)	Paddy(C_1)	Initial(St_1)	16.67	16.27
		Reproductive(St_2)	22.93	12.73
		Harvest(St_3)	18.33	11.13
	Maize(C_2))	Initial(St_1)	21.33	15.17
		Reproductive(St_2)	21.87	20.07
		Harvest(St_3)	17.33	14.73
	Soybean(C_3)	Initial(St_1)	22.30	11.10
		Reproductive(St_2)	32.37	25.47
		Harvest(St_3)	30.53	11.83
SEm±	0.72			
CD(p=0.05)	2.16			

Table.4 Effect of interaction between crop (C), stages (St), depth (D), crop and System(S) and crop on microbial biomass nitrogen in (mg/kg)

Crop x Stage				Crop x Depth		Crop x System	
Crop	**Initial (St_1)**	**Reproductive (St_2)**	**Harvest (St_3)**	**0-15cm (D_1)**	**15-30cm (D_2)**	**Conv.**	**Cons.**
Paddy(C_1)	15.33	19.18	14.41	32.57	16.34	24.92	23.99
Maize(C_2)	13.31	17.66	15.81	28.36	18.41	26.74	20.03
Soybean(C_3)	13.92	27.39	17.86	36.89	22.27	31.24	27.92
Mean	14.19	21.41	16.02	32.61	19.01	27.64	23.98
SEm±			0.36		0.29		0.29
CD(p=0.05)			1.08		0.87		0.87

Table.5 Impact of conventional and conservational agricultural system in Microbial biomass phosphorus (mg/kg) of rhizospheric soil

Depth	**Crop**	**Stage**	**S1 (Conventional) (mg/kg)**	**S2 (Conservational) (mg/kg)**
0-15 cm (D_1)	Paddy(C_1)	Initial(St_1)	5.17	6.63
		Reproductive(St_2)	5.13	7.37
		Harvest(St_3)	5.30	6.63
	Maize(C_2)	Initial(St_1)	2.80	5.10
		Reproductive(St_2)	5.20	7.30
		Harvest(St_3)	3.20	5.20
	Soybean(C_3)	Initial(St_1)	8.20	8.30
		Reproductive(St_2)	5.10	8.40
		Harvest(St_3)	6.27	6.20
15-30 cm (D_2)	Paddy(C_1)	Initial(St_1)	7.40	9.20
		Reproductive(St_2)	4.40	5.33
		Harvest(St_3)	2.30	2.20
	Maize(C_2)	Initial(St_1)	2.30	4.13
		Reproductive(St_2)	5.10	4.40
		Harvest(St_3)	2.30	2.83
	Soybean(C_3)	Initial(St_1)	5.30	6.20
		Reproductive(St_2)	2.40	5.43
		Harvest(St_3)	3.70	3.73
SEm±	0.071			
CD (P=0.05)	0.213			

Table.6 Effect of interaction between crop (C), stages (St), depth (D), crop and System(S) and crop on microbial biomass phosphorus in (mg/kg)

	Crop x Stage			Crop x Depth		Crop x System	
Crop	**Initial (St_1)**	**Reproductive (St_2)**	**Harvest (St_3)**	**0-15cm (D_1)**	**15-30cm (D_2)**	**Conv.**	**Cons.**
Paddy(C_1)	5.07	3.71	2.74	7.71	3.81	6.62	4.89
Maize(C_2)	2.39	3.67	2.26	4.8	3.51	4.17	4.14
Soybean(C_3)	5.00	4.39	3.32	8.24	4.46	5.49	7.21
Mean	4.15	3.92	2.77	6.92	3.93	5.43	5.42
SEm±			0.036		0.029		0.029
CD(p=0.05)			0.108		0.087		0.087

The interaction between crop, stage, depth and systems have been worked out and presented in table 4, indicating that all the three crops had maximum MBN at reproductive stage having 19.18,17.66 and 27.39 mg/kg of microbial biomass nitrogen recorded in the soil of paddy, maize and soybean rhizosphere respectively, having 31.24 and 27.92 mg/kg in conventional and conservational system under two depth 0-15 and 15-30 cm having 36.89 and 22.27 mg/kg of soybean growing soil have been recorded respectively.

It is evident from the data that in paddy crop (C_1) at initial stage (St_1) under conservational agriculture system. The MBP is 28.23 percent higher than conventional agriculture system. At reproductive stage (St_2) 43.16 percent and at harvest the MBP was 25.03 percent higher in conservational agriculture system.

In maize crop (C_2) at initial stage (St_1) MBP was 82.14 percent in reproductive stage (St_2) 40.38 percent and at harvest 62.50 percent higher in conservational agriculture system. In soybean crop (C_3) at initial stage (St_1) MBP it was 1.21 percent, and at reproductive stage 1.12 percent higher than conventional agriculture system. MBP was observed to be high in sub surface soil (D_1) 0-15 cm than (D_2) 15-30 cm in both the system (S_1 and S_2) respectively. The data presented in table 6, shows the interaction between crop and stages of growth varied as paddy and soybean has maximum biomass phosphorus in the initial stage while maize gave highest biomass phosphorus in reproductive stage of growth having 5.07, 3.67 and 5.0 mg/kg under paddy maize and soybean crops. Crop and depth of soil sample had also affected the biomass having recorded to be high in depth 0-15 and 15-30 cm having 7.71 and 3.81 but observed to be increased to 8.24 and 4.46 in 0-15 and 15-30 cm depth with paddy and soybean crop respectively. The crops raised under the conventional system and conservational system the MBP was recorded to be 6.62 at initial stage and 7.21 mg/kg in paddy and soybean having maximum MBP at harvest stage under conventional and conservational system respectively. The best interaction obtained was with crop soybean having 8.24 mg/kg at depth 0-15 cm having maximum of 8.24 mg/kg and minimum of 4.46 mg/kg under 15-30 cm while it was 5.49, 7.21 mg/kg in conventional and conservational system of cultivation.

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