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Soil Biological properties as affected by Conservation and weed Management practices in Rice-Wheat System

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ABSTRACT
Tillage in traditional rice-wheat system affects the health of soil microbes significantly either by use of chemicals or intensive tillage for control of weeds. It also has direct/indirect impact on the crop performance. However, to mobilize the nutrients with help of soil microbes, conservational practices should be followed with proper management of weeds. Thus, the presentinvestigationwas carried out at two consecutive years during2015-16 to 2016-17 at N.E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) with 5 establishmentsmethods and 3 weed management practices under strip plot design, replicated thrice. Zero-till practice with retention of residues improved the soil health under weedy situation. Thus, the present investigation resulted conservational agriculture practice had significant effect on soil enzymatic activity.
Key words: *Acidphosphatase, dehydrogenase, Sesbania, soil urease, zero till*

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INTRODUCTION
Human efforts to produce ever-greater amounts of food leave their mark on our environment. Persistent use of conventional farming practices have magnified soil erosion losses and the soil resource base has been steadily degraded (1). Crop residues retention in soil surface also plays a significant role in building soil organic matter, microbial healthand enzymatic activity besides improving the soil physical environment (2) that leads to improved soil quality, health and overall enhancement of resources-use efficiency. Soil enzymes catalyse various reactions for biological assessment of soil processes like dehydrogenase, phosphatase, and urease. But these are much impaired by conventional traditional tillage practices (3). High use of herbicide for weed control also leads to damage the life process of soil microbes in top 0–15 cm soil depth, which ultimately affects the soil health (4). Thus, to improve the soil health and enzymatic activity, an investigation testing conservational practices with proper management of weeds was carried.

MATERIALS AND METHODS
Thestudy was undertaken at N.E. Borlaug Crop Research Centre of Govind Ballabh Pant University of Agriculture & Technology, Pantnagar (Uttarakhand) during 2015-16 to 2016-

17 on rice-wheat cropping system. The experiment was consisted of 5 establishment methods of rice and wheat in vertical strip *viz.,* conventional transplanted rice-conventional till wheat (TPR-CTW), TPR-CTW followed by *Sesbania* as green manure, direct seeded rice-conventional till wheat (DSR-CTW) fb *Sesbania* incorporation, zero-till direct seeded rice-zero till wheat(ZTR-ZTW) fb *Sesbania* as brown manure and ZTR-ZTW with retention of residues of previous wheat crop along with *Sesbania* as brown manure and 3 weed control measures in horizontal strip *viz.,*unweeded control, recommended herbicide *i.e.* bispyribac-sodium 20 g/ha (rice) and clodinafop propargyl 15% + metsulfuron-methyl 1%60+4 g a.i./ha (wheat) and integrated weed management *i.e.* herbicide application fb 1 hand weeding at 45 DAS/DAT in strip plot design replicated three times in clay loam soil. Brown manure *Sesbania* was used after knocking down by2,4-D at 30 days after sowing and residue of previous sown crop was retained as per the treatments. Herbicide was applied as post emergence with knap sack sprayer fitted with flat fan boom nozzle[5].
The soil after the sampling was collected and stored at 4°C for enzymatic studies*viz.,*soil dehydrogenase[6], phosphatase [7]and urease activity [8]. The data was analysed statistically by statistical package CPCS-1, designed and developed by Punjab Agricultural University, Ludhiana [9].

RESULTS AND DISCUSSION

The soil dehydrogenase, acid and alkaline phosphatase and urease activity after rice and wheat harvest owing to different establishment methods was influenced significantly during both the years (Table 1 and 2).
Zero till rice and wheat with retention of residues followed by *Sesbania* brown manuring (ZTR+R-ZTW+R-ZTS)recorded significantly higher soil dehydrogenase, acid and alkaline phosphatase activity, during both the years of study. Lower soil dehydrogenase, acid and alkaline phosphatase activity was recorded under TPR-CTW.There was close conformity of the results with [10]. Detrimental effect of puddling was also reported on soil microbes [11]. Optimum yield and good soil health was reported with zero tillage with 20% residue retention [12, 13].

Table 1. Establishment methods and weed management effects on soil biological properties after rice harvest (*kharif* 2015 and 2016)

Treatment	Dehydrogenase (µg TPF/hr/g soil)		Acid Phosphatase (µg p-nitrophenol/ hr/g soil)		Alkaline Phosphatase (µg p-nitrophenol/ hr/g soil)		Urease (mg urea/hr/g soil)	
	2015	2016	2015	2016	2015	2016	2015	2016
Establishment Methods								
TPR-CTW	15.8	15.9	54.3	52.6	128.3	134.3	63.9	64.4
TPR-ZTW-ZTS	21.6	21.6	83.8	79.4	150.2	155.2	65.9	66.3
DSR-CTW-ZTS	20.7	21.4	71.3	64.9	115.7	132.7	61.0	63.1
ZTR-ZTW-ZTS	30.5	28.9	84.2	79.5	157.1	159.7	60.5	62.7
ZTR+R-ZTW+R-ZTS	36.2	38.1	110.9	99.2	165.1	168.9	58.3	59.3
SEm±	**0.11**	**0.54**	**0.56**	**0.64**	**1.17**	**0.64**	**0.57**	**0.56**
LSD (P=0.05)	**0.5**	**2.3**	**2.4**	**2.7**	**4.9**	**2.7**	**2.4**	**2.4**
Weed Management								
Bispyribac-Na 20 g/ha PoE	24.0	24.2	77.4	71.7	139.8	144.2	61.6	62.8
IWM (bispyribac-Na 20 g/ha PoE fb 1 HW at 45 DAS/DAT)	22.2	22.6	61.8	57.4	113.3	127.5	58.7	60.1
Weedy check	28.7	28.8	103.5	96.2	176.7	178.7	65.5	66.5
SEm±	**0.06**	**0.45**	**0.98**	**0.82**	**1.26**	**1.39**	**0.45**	**0.66**
LSD (P=0.05)	**0.2**	**1.4**	**3.0**	**2.5**	**3.8**	**4.2**	**1.4**	**2.0**

However, the urease activity of the soil was recorded significantly higher in transplanted rice followed by zero till wheat along with introduction of *Sesbania* as green manure (TPR-ZTW-ZTS) after rice harvest, whereas after wheat harvest, higher urease activity was recorded significantly in direct seeded rice followed by conventional wheat with incorporation of *Sesbania* (DSR-CTW-ZTS), which was at par with TPR-CTW, during both the years of study. Lower urease activity was recorded under zero till rice and wheat with

residues retention and *Sesbania* brown manuring (ZTR+R-ZTW+R-ZTS).It might be due to increased soil mulch under no till, which increased water infiltration through the soil profile, leading to nitrate loss [14].

Variations in the dehydrogenase, acid and alkaline phosphatase and urease activity of soil was also found significant during 2015-16 and 2016-17 (Table 1 and 2). Weedy check recorded significantly highest enzymatic activity of soil during both the years of study. This might be due to high underground biomass under weedy condition that act as carbon source for the growth and activity of micro-organisms [15, 16]. However, lower was recorded under IWM practice(bispyribac-Na 20 g/ha in rice and clodinafop + MSM 64 g/ha in wheat fb 1 HW at 45 DAS/DAT).The results are in close agreement with the findings as reported less substrate availability for microbes due to herbicidal effect and thus the biological activity of soil microbes got declined [17].

Table 2. Establishment methods and weed management effects on soil biological properties after wheat harvest (*rabi* 2015-16 and 2016-17)

Treatment	Dehydrogenase (µg TPF/hr/g soil)		Acid Phosphatase (µg p-nitrophenol/g soil/hr)		Alkaline Phosphatase (µg p-nitrophenol/g soil/hr)		Urease (mg urea/g soil/hr)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
Establishment Methods								
TPR-CTW	14.5	14.4	51.5	51.3	120.4	120.0	62.6	62.3
TPR-ZTW-ZTS	18.7	19.9	77.9	77.4	135.8	135.5	59.8	59.0
DSR-CTW-ZTS	20.1	18.6	66.4	65.1	102.8	102.5	63.9	63.2
ZTR-ZTW-ZTS	28.0	27.8	80.3	79.8	142.2	141.7	59.5	59.1
ZTR+R-ZTW+R-ZTS	33.9	33.9	105.0	103.4	150.3	149.8	56.8	56.7
SEm±	**0.18**	**0.19**	**0.38**	**0.47**	**0.48**	**0.41**	**0.19**	**0.42**
LSD (P=0.05)	**0.8**	**0.8**	**1.6**	**2.0**	**2.0**	**1.7**	**0.8**	**1.8**
Weed Management								
Ready mix clodinafop + MSM 64 g/ha PoE	22.0	21.7	72.5	71.3	128.8	128.5	60.2	59.7
IWM (clodinafop + MSM 64 g/ha PoE fb 1 HW at 45 DAS)	20.3	20.2	57.6	57.2	106.9	106.4	57.1	56.8
Weedy check	26.8	26.7	98.6	97.7	155.3	154.8	64.2	63.7
SEm±	**0.23**	**0.17**	**0.33**	**0.48**	**0.32**	**0.43**	**0.40**	**0.58**
LSD (P=0.05)	**0.7**	**0.5**	**1.0**	**1.5**	**1.0**	**1.3**	**1.2**	**1.8**

CONCLUSION

Zero-till practice with retention of residues improved the soil health under weedy situation. Thus, the present investigation resulted conservational agriculture practice had significant effect on soil enzymatic activity.

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