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Influence of puddling levels, organic manures and N-levels applied to rice (*Oryza sativa*) on succeeding wheat (*Triticum aestivum*)

Kuldip Singh Dhiman, K. Bassi and D. Badiyala
Department of Agronomy
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.

Abstract

A field experiment was conducted during Kharif and Rabi season of 2004-05 and 2005-06 to study the direct effect of organic manures and nitrogen levels under different puddling levels on rice crop and its carryover effect on succeeding wheat crop. The experiment was laid out in split- plot design with two puddling levels (conventional and reduced) and three organic manure treatments (Control, *Sesbania* green manure and FYM @ 10 t ha^{-1}) and four nitrogen levels (0, 30, 60 and 90 kg N ha^{-1}). The results revealed that grain yield of rice was not influenced significantly with puddling levels. Amongst organic manure treatments, *Sesbania* green manuring (in-situ) produced significantly highest grain as well as straw yields of rice over FYM application. Nitrogen application @ 60 kg N ha^{-1} produced significantly higher grain as well as straw yield of rice over control during both the years. The differences between 90 kg N ha^{-1} and 60 kg N ha^{-1} were not significant. Total number of tillers, dry matter accumulation and grain yield as well as straw yield of wheat was significantly higher when raised after reduced puddling treatment to rice as compared to conventional puddling treatment during both the years. The residual effect of FYM application on all the growth parameters, grain yield of wheat and straw yield was superior to *Sesbania* green manuring. No residual effect of N applied to rice was observed on wheat.

Key words: Puddling, organic manuring, nitrogen levels, rice, residual effect, wheat.

Introduction

The rice-wheat is the most extensive and traditional cropping system in India, which is the main stay of cereal food production in the country. Puddling is the most common method of land preparation for lowland rice cultivation. Puddling increases the dispersion of soil particles, which lateron settle on soil surface creating a thin surface layer, seal pores and hence maintain submerged conditions. Mishra *et al.*(2003) also found that the average rate of water loss was reduced significantly under puddle conditions. Puddled soils on drying become hard and compact. This type of soil conditions are unfavourable for subsequent crop and is considered to be the important factor responsible for the poor yield of wheat following rice. Under such conditions, use of the organic amendment to enhance the soil structure in post rice soils is an option to improve yield of succeeding wheat crop. Organics are known to improve the soil productivity under rice-wheat cropping system by way of improving physical conditions and nutrient status of the soil. Keeping these points in view, the present investigation was undertaken with different tillage methods and organic manures in combination with nitrogen levels applied to rice crop and the residual effect of these treatments was studied on succeeding wheat crop.

Material and Methods

The field experiment was conducted at Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur during the Kharif and Rabi seasons of 2004-05 and 2005-06. The soil was silty clay loam, having 0.80 per cent organic carbon, 299 kg ha^{-1} available nitrogen, 18 kg ha^{-1} available phosphorus and 211 kg ha^{-1} available potassium with pH 5.8. The experiment was laid out in split plot design with two puddling levels, viz., conventional puddling (ploughing 15-18 cm deep and 4 runs with wooden puddler followed by planking) and reduced puddling (shallow ploughing 5-7 cm and two runs with wooden puddler followed by planking) and three organic manure treatments, viz., control; *Sesbania* green manure (in-situ); FYM @ 10 t ha^{-1} as main plot treatments and four nitrogen levels *viz.*, 0, 30, 60 and 90 kg ha^{-1} as sub plot treatments with three replications.

Net plot area during Kharif season was 7.68 m^2. Transplanting of rice seedlings was done on 22nd July and 16th July during first and second year, respectively. Two to three seedlings of rice (cv. HPR-957) were transplanted at a spacing of 15cm X 20 cm. Residual effect of these treatments was studied on succeeding wheat crop. Net plot during Rabi season was 10.92 m^2. Wheat (Cv. HPW-89) was sown on 25th November and 21st November during first and second year, respectively with recommended package of practices. The net plot area in each crop was harvested and sun dried for three to four days in the field and the total biomass yield was recorded.

Results and Discussion

Rice yield was not influenced significantly even when the number of tillage operations was reduced from four puddlings to two puddlings treatment (Table 1). Straw yield of rice was decreased significantly in reduced puddling treatment over conventional puddling treatment during 2004. Incorporation of *Sesbania* green manure in the system significantly increased the grain as well as straw yield of rice over FYM and control during both the years. Grain and straw yield was significantly increased with increasing nitrogen levels from 0 to 60 kg N ha^{-1}. Effect of 90 kg N ha^{-1} over 60 kg N ha^{-1} was not significant.

Table 1. Effect of different treatments on grain yield, straw yield and harvest index of rice

Treatments	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Harvest index	
	2004	2005	2004	2005	2004	2005
Tillage method						
Conventional	33.21	31.10	64.09	52.71	0.34	0.37
Reduced	32.45	30.48	59.73	52.56	0.36	0.37
CD (P=0.05)	NS	NS	3.55	NS	NS	NS
Organic manure						
Control	25.87	24.36	47.90	42.92	0.36	0.37
Sesbania	38.10	35.81	71.14	59.30	0.35	0.38
FYM	34.53	32.21	66.70	55.67	0.34	0.37
CD (P=0.05)	1.28	2.07	4.35	3.28	NS	NS
Nitrogen Level (kg ha^{-1})						
0	23.39	21.61	41.71	34.07	0.36	0.39
30	34.19	32.33	63.20	53.74	0.35	0.38
60	37.04	34.67	70.23	60.18	0.35	0.37
90	36.71	34.56	72.50	62.55	0.34	0.36
CD (P=0.05)	1.90	1.78	4.62	3.11	NS	0.012

The residual effect of puddling levels and organic manures was significant on growth, development and yield of wheat crop (Table 2). The number of tillers and dry matter accumulation was recorded significantly higher in reduced puddling treatment at all the stages of observation during both the years of experimentation as compared to conventional puddling treatment. Adverse effects of excessive puddling on succeeding wheat crop have also been reported by Bajpai and Tripathi (2000). On the other hand negative effect of intensive puddling on soil bulk density and penetration resistance have also been reported by Bajpai and Tripathi (2000) and Kukal and Aggarwal (2003). Increased aeration in soil due to low bulk density in reduced puddling might have increased the root growth and number of tillers in wheat crop. Amongst organic manure treatments, FYM application remaining at par with *Sesbania* green manure produced significantly more number of tillers and dry matter than control plots in wheat crop indicating residual effect of organic manures. The differences in dry matter production due to FYM and *Sesbania* green manure treatment were also significant at harvest during 2005-06. Beneficial effect of organic manures on growth parameters may be attributed to higher availability of nitrogen and other major nutrients to plants (Vivek *et al.*, 1998).

Table 2. Residual effect of different treatments applied to rice crop on growth characteristics of wheat at harvest

Treatments	Plant height		Number of tillers m^{-2}		Dry matter (gm^{-2})	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Tillage method						
Conventional	100.0	90.2	266.6	230.9	994.1	800.6
Reduced	103.2	91.9	287.7	247.2	1089.8	857.9
CD (P=0.05)	NS	NS	13.42	12.49	52.34	39.08
Organic manure						
Control	95.5	86.8	257.3	223.8	967.2	755.8
Sesbania	105.3	91.1	280.3	242.8	1050.6	836.6
FYM	104.1	95.3	293.5	250.5	1108.0	895.4
CD (P=0.05)	6.58	3.43	16.44	13.90	64.10	47.86
Nitrogen Level (kg ha^{-1})						
0	101.4	90.5	270.9	237.0	1041.2	814.3
30	100.2	90.8	276.2	237.0	1047.8	821.8
60	102.5	90.6	281.7	240.0	1036.2	830.2
90	102.4	92.5	279.9	242.4	1042.6	850.7
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Yield attributes *viz.*, effective tillers, number of grains per spike, and 1000-grain weight in wheat were higher in reduced puddling treatment (Table 3). Similarly, wheat grain and straw yields were significantly higher when sown after reduced puddling treatment as compared to when sown after conventional puddling treatment to rice. Organic manuring to the preceding rice crop also increased the yield attributes of wheat crop significantly over control plots. Wheat grain and straw yields during both the years were significantly higher in organic manure as compare to control plots. Significant residual effect of various organics in rice was observed on succeeding wheat crop by Singh *et al.* (2001). Residual effect of FYM application was better as indicated by significantly highest grain yield of wheat during 2004-05 as compare to when raised after *Sesbania* green manuring. The differences for yield and yield attributes of wheat due to N-levels were found to be non-significant during both the years.

Table 3. Residual effect of different treatments applied to rice on yield attributes and yield of wheat

Treatments	Effective tillers m^{-2}		Number of grains per spike		1000-grain weight (g)		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Harvest index	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Tillage Method												
Conventional	253.4	217.4	40.2	37.2	43.35	43.50	34.89	28.13	64.52	51.93	0.35	0.35
Reduced	276.6	237.0	43.0	39.7	45.08	43.70	38.85	30.69	70.13	55.10	0.36	0.36
CD (P=0.05)	14.77	14.98	1.84	1.87	1.52	NS	2.30	2.11	3.94	2.88	NS	NS
Organic manure												
Control	240.1	209.6	39.0	36.0	43.06	42.43	33.55	26.49	63.17	49.09	0.35	0.35
Sesbania	265.2	231.4	41.8	39.8	44.24	44.27	36.98	29.99	68.08	53.67	0.35	0.36
FYM	289.8	240.6	44.1	39.6	45.37	44.10	40.08	31.75	70.73	57.79	0.36	0.35
CD (P=0.05)	18.09	18.35	2.24	2.29	1.87	0.81	2.81	2.57	4.83	3.53	NS	NS
Nitrogen Level (kg ha^{-1})												
0	258.1	224.7	41.3	38.1	44.31	43.50	36.53	29.46	67.60	51.98	0.35	0.36
30	264.0	224.5	41.3	39.4	44.44	43.82	36.42	28.54	68.37	53.64	0.35	0.35
60	270.0	228.4	42.6	37.7	43.92	43.78	37.56	28.95	66.06	54.07	0.36	0.35
90	268.0	231.2	41.3	38.6	44.20	43.30	36.98	30.69	67.28	54.38	0.35	0.36
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

The present investigation showed that number of puddling operations before rice transplanting can be decreased in silty clay loam soil to increase wheat yield without affecting the rice yields. *Sesbania* green manuring was found superior than FYM in increasing rice grain yield while residual effect of FYM showed more benefits to wheat.

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