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Production potential of wheat (*Triticum aestivum*) crop as influenced by residual organics, direct and residual fertility levels under rice (*Oryza sativa*)–wheat cropping system

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ABSTRACT

A field experiment was conducted during the winter seasons of 1995–96 and 1996–97 at Pusa, Bihar, to study the effect of residual organics, residual fertility and fertility levels on the yield of wheat (*Triticum aestivum* L. emend. Fiori & Paol.) crop under rice (*Oryza sativa* L.)–wheat cropping system. Fertilizers applied to rice crop did not show any significant effect on the succeeding wheat crop. Among the organic manures applied to rice crop, biogas-slurry and rice straw incorporation resulted in significant residual effect. Biogas-slurry recorded significantly higher grain yield of wheat (39.90 and 40.04 q/ha) than rice-straw incorporation (36.94 and 39.00 q/ha), green-manure (32.57 and 33.83 q/ha) and no organic manure (31.20 and 32.24 q/ha) during 1995–96 and 1996–97 respectively. Significantly higher grain yield was obtained with the application of recommended fertilizer level (120, 60 and 40 kg N, P, and K/ha) to wheat in both the years.

Key words : Rice–wheat cropping system, Wheat crop, Residual organics, Residual fertility, Fertility levels, Yield attributes, Yield, Nutrient content, Nutrient uptake

Rice–wheat cropping is the most eminent system in the northern India. Because of the only use of chemical fertilizers in the rice–wheat system, the yield potential of this cropping system is declining. Deterioration in physico-chemical properties of soil have been reported by several workers in this system. It is, therefore, desirable to improve the physico-biochemical properties of the soil through integration or organic and inorganic sources of nutrient for sustainable production of the system (Singh *et al.*, 1994). The present study was therefore undertaken to find out the effect of integrated nutrient supply on the production

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of wheat under rice–wheat cropping system.

MATERIALS AND METHODS

The field experiment was conducted at the Research farm of the RAU, Pusa, Bihar, during winter seasons of 1995–96 and 1996–97. The soil of field was silt-clay loam belonging to textural class (calciorthent soil), having organic carbon 0.56% with pH 8.5, available N 242.63 kg/ha, available P 24.62 kg/ha and available K 114.60 kg/ha. The experiment was laid out in factorial randomized block design with 3 replications. Wheat crop was grown after harvesting of rice crop. In the rice crop, 4 organic manures (no organic manure, biogas-slurry @ 10 tonnes/ha, *Sesbania aculeata* @ 14 tonnes/ha green biomass and rice straw @ 5 tonnes/ha + treatment with 2% urea solution) and 3 fertility levels (50,30 and 20; 75, 45 and 30; and 100,60 and 40 kg N, P and K/ha) were applied. After harvesting of rice crop, each plot was divided again into 3 equal plots and 3 fertility levels (60, 30 and 20; 90, 45 and 30; and 120, 60 and 40 kg N, P and K/ha) were applied randomly in the wheat crop. 'UP 262' variety of wheat was used for the purpose. A seed rate of 125 kg/ha was used with a row spacing of 23 cm in both the years. Half dose of N, full dose of P_2O_5 and K_2O were applied basal and remaining N was top-dressed in 2 equal splits, one-fourth after first irrigation and one-fourth at panicle-initiation stage. Recommended irrigation and weeding were done at appropriate stages.

RESULTS AND DISCUSSION

Yield attributes

Residual effect of biogas-slurry showed significant influence on the production of effective tillers/m^2 in both the years compared with all other organic manures. Residual effect of rice-straw incorporation also significantly surpassed to no organic manure and *Sesbania* green-manure application. No organic manure and green-manure treatments were inferior and at par to each other. No significant residual effect of *Sesbania* green-manure was recorded in wheat crop. Residual fertility did not show any significant bearing on effective tillers production of wheat. The effective tillers/m^2 increased with increasing fertilizer levels in wheat crop. Application of 120, 60 and 40 kg N, P and K/ha (100% NPK dose) recorded significantly higher number of productive tillers/m^2 (Table 1).

The other yield attributes, viz. ear length, fertile spikelets, grains/ear, grain weight/ear and 1,000 grain weight, of wheat increased significantly with residual biogas-slurry and rice-straw incorporation. The residual fertility level did not influence all these attributes of wheat. Application of 100% NPK recorded significantly higher yield attributes.

Grain yield of wheat

The integrated use of biogas-slurry with different fertilizer levels applied to rice crop showed significant residual effect on the yield of wheat, followed by rice-straw incorporation treatments and was superior to no organic manure and *Sesbania* green-manure treatments. Green-manure did not show any significant influence on the wheat yield. The biogas-slurry recorded higher grain yield which was significantly superior to others, i.e. rice straw treatment, green-manure and no organic manure. The treatments *Sesbania* green-manure and no

Table 1. Effect of different organic manures and inorganic fertilizers on the yield attributes of wheat under rice–wheat system

Treatment	Effective tillers/m²		Ear length (cm)		Fertile spikelets/ear		Unfertile spikelets/ear		Grains/ ear		Grain weight/ear (g)		1,000-grain weight (g)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Residual organic manures														
No organic manure	288.80	290.40	9.20	9.50	17.90	18.36	2.50	2.30	31.35	32.00	1.26	1.30	38.62	39.00
Sesbania aculeata	290.80	295.60	9.30	9.60	17.94	18.45	2.54	2.34	31.40	32.73	1.28	1.32	38.70	39.00
Biogas-slurry	325.60	329.00	10.60	10.80	19.20	19.86	1.75	1.68	34.90	35.53	1.48	1.56	41.00	41.40
Rice straw	306.00	311.00	9.37	9.80	18.57	18.80	1.90	1.70	33.77	34.44	1.35	1.44	39.70	40.20
CD (P = 0.05)	6.50	11.80	0.38	0.37	0.36	0.43	0.20	0.08	1.12	1.12	0.06	0.06	1.30	1.26
Residual fertility (N, P, K kg/ha)														
50 : 30 : 40	304.90	308.90	9.50	9.82	18.36	18.80	2.17	2.00	32.84	33.42	1.35	1.44	39.30	39.70
75 : 45 : 30	306.30	310.60	9.54	9.77	17.40	18.80	2.16	1.98	32.90	33.52	1.36	1.44	39.40	39.76
100 : 60 : 40	307.80	302.30	9.56	9.82	18.40	18.84	2.19	1.96	32.98	33.30	1.36	1.46	39.50	39.94
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels (N, P, K kg/ha)														
60 : 30 : 20	278.30	281.50	8.60	8.92	16.10	16.60	2.83	2.64	29.98	30.80	1.16	1.18	37.32	37.80
90 : 45 : 30	310.20	312.80	9.48	9.82	18.76	19.22	2.35	2.03	34.70	35.30	1.35	1.40	38.47	39.74
120 : 60 : 40	335.60	337.20	10.30	10.60	20.31	20.73	1.44	1.27	36.10	36.73	1.46	1.53	39.63	41.14
CD (P=0.05)	6.60	7.90	0.22	0.41	0.36	0.44	0.11	0.18	0.81	0.80	0.06	0.05	0.90	0.95

organic manure were statistically at par each other. There was no significant difference on the grain yield of wheat due to different fertility levels applied to prior rice crop (Table 2). Hegde and Dwivedi (1992) and Kumar (1994) also noticed no significant response of residual green-manure and inorganic fertilizer on the succeeding wheat crop.

The yield of wheat was influenced by the incorporation of crop residue when applied to the preceding rainy-season crop (Singh *et al.*, 1996). Prasad and Sinha (1995) observed inferior residual effect of crop residue than FYM on wheat but was significantly superior to 100% NPK applied as inorganics.

Application of different levels of fertilizers significantly influenced the grain yield of wheat. Significantly higher grain yield was obtained under recommended 100% NPK, followed by 75% NPK and 50% NPK levels. All the fertility levels showed significant differences among themselves. Gangwar and Sharma (1996) also suggested recommended dose of fertilizer even with organic manures in wheat crop under rice–wheat system.

The yield of straw also recorded similar trends in grain yield of wheat in both the years. In the present investigation, the harvest index of wheat was not significantly affected by the residual organic manures, residual fertility levels and fertility levels

Table 2. Effect of organic manures and inorganic fertilizers on yield and harvest index of wheat under rice–wheat system

Treatment	Grain yield (q/ha)		Straw yield (q/ha)		Harvest index (%)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Residual organic manures						
No organic manure	31.20	32.24	54.70	56.85	36.32	36.20
Sesbania aculeata	32.57	33.83	57.14	59.73	36.34	36.15
Biogas-slurry	39.90	42.04	63.90	66.26	38.50	38.80
Rice straw	36.96	39.00	61.43	64.17	37.50	37.80
CD (P = 0.05)	1.80	2.00	1.60	2.00	NS	NS
Residual fertility (NPK kg/ha)						
50 : 30 : 20	34.47	36.36	58.70	60.80	36.00	37.40
75 : 45 : 30	35.00	37.55	59.10	61.80	37.20	38.00
100 : 60 : 40	35.98	37.80	60.00	62.60	37.40	37.50
CD (P=0.05)	NS	NS	NS	NS	NS	NS
Fertility levels (NPK kg/ha)						
60 : 30 : 20	27.84	29.80	47.00	49.35	37.20	37.60
90 : 45 : 30	36.84	38.24	62.10	64.44	37.20	27.20
120 : 60 : 40	40.78	42.60	68.60	71.46	37.30	37.30
CD (P = 0.05)	1.90	1.37	3.10	1.84	NS	NS

Table 3. Effect of organic manures and inorganic fertilizers on nutrient content of wheat under rice–wheat system

Treatment	N content (%)				P content (%)				K content (%)			
	Grain		Straw		Grain		Straw		Grain		Straw	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Residual organic manures												
No organic manure	1.71	1.72	0.30	0.30	0.50	0.51	0.10	0.10	0.41	0.41	1.23	1.23
Sesbania aculeata	1.82	1.81	0.31	0.31	0.51	0.51	0.10	0.10	0.41	0.41	1.23	1.23
Biogas-slurry	2.12	2.16	0.37	0.37	0.54	0.55	0.12	0.12	0.45	0.45	1.54	1.54
Rice straw	2.10	2.10	0.37	0.38	0.55	0.54	0.12	0.12	0.45	0.46	1.54	1.54
CD (P=0.05)	0.03	0.09	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
Residual fertility (NPK kg/ha)												
50 : 30 : 20	1.93	1.93	0.33	0.33	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
75 : 45 : 30	1.93	1.95	0.33	0.33	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
100 : 60 : 40	1.95	1.95	0.34	0.34	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels (NPK kg/ha)												
60 : 30 : 20	1.82	1.81	0.32	0.32	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
90 : 45 : 30	1.92	1.94	0.33	0.33	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
120 : 60 : 40	2.10	2.10	0.35	0.35	0.52	0.53	0.12	0.12	0.43	0.43	1.39	1.39
CD (P=0.05)	0.02	0.01	0.01	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Effect of organic manures and inorganic fertilizer on the total nutrient uptake of wheat crop under rice–wheat system

Treatment	Protein content in grain (%)		Total N uptake (kg/ha)		Total P uptake (kg/ha)		Total K uptake (kg/ha)	
	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97	1995–96	1996–97
Residual organic manures								
No organic manure	10.70	10.70	68.84	72.22	21.70	21.90	78.00	81.70
Sesbania aculeata	11.50	11.60	74.66	78.98	21.69	21.95	83.54	85.60
Biogas-slurry	13.22	13.50	106.80	112.11	26.70	28.40	114.80	117.34
Rice straw	13.00	13.10	91.89	103.66	25.81	27.36	108.10	114.44
CD (P = 0.05)	0.15	0.30	2.30	3.20	2.00	1.05	3.05	1.60
Residual fertility (NPK kg/ha)								
50 : 30 : 20	12.10	12.10	84.94	90.59	23.90	24.90	95.17	98.55
75 : 45 : 30	12.10	12.20	84.97	91.68	23.96	25.00	94.57	99.57
100 : 60 : 40	12.10	12.20	85.67	92.84	24.00	25.27	95.60	99.84
CD (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels (NPK kg/ha)								
60 : 30 : 20	11.37	11.32	68.90	72.78	18.10	19.96	77.00	82.22
90 : 45 : 30	12.12	12.20	89.14	95.62	25.50	26.14	99.54	104.10
120 : 60 : 40	12.90	12.97	99.96	107.00	27.20	29.20	108.76	112.34
CD (P = 0.05)	0.12	0.12	4.60	2.85	1.28	0.77	1.26	1.08

applied to wheat crop.

Nutrient content

Residual biogas-slurry and rice-straw incorporation significantly influenced plant nutrient content in wheat crop. Nitrogen content in wheat was also influenced by the fertility levels, but P and K contents in grain and straw of wheat were not affected with the fertility levels applied to wheat crop. Residual fertility levels had no significant effect on the NPK content in wheat crop. The protein content of wheat was significantly influenced by the residual organic manures (biogas-slurry and rice straw) and fertility levels applied to wheat crop (Table 3).

The application of FYM, crop residue and higher dose of NPK increased the nitrogen content and protein in wheat crop as was reported also by Mazurek and Kus (1991).

Nutrient uptake

Application of organic materials in rice–wheat system contributed to significant increase in nutrient uptake of wheat at harvest (Sharma and Mittra, 1991). Higher NPK uptake by wheat crop was recorded with residual biogas-slurry and rice-straw incorporation in both the years, while residual fertility did not show any significant effect on the nutrient uptake. Higher uptake of NPK with organic materials indicated that mineralized nutrient from these sources could sufficiently meet the nutritional requirement of the crop.

Thus higher fertilizer dose favourably influenced the plant growth and developmental characters which ultimately resulted in higher yield. Due to the higher yield of grain and straw, the plants removed larger quantities of nutrients (NPK) at higher fertility level.

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