Indian Journal of Agronomy **51** (4) : 247–250 (December 2006)

Effect of rice *(Oryza sativa)* residue and nitrogen on performance of wheat *(Triticum aestivum)* under rice-wheat cropping system

RAJEEV SINGH AND D.S. YADAV

Department of Agronomy, N.D. University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh 224 229

Received : May 2006

ABSTRACT

A field experiment was conduced during the winter *(rabi)* season of 2001-02 and 2002-03 to find out the effect of rice *(Oryza sativa* L.) residue and N levels on performance of wheat *(Triticum aestivum* L.emend. Fiori & Paol.) in rice-wheat cropping system. Highest mean grain yield of 33.6 q/ha was recorded on incorporation of residue, which was respectively 14.72 and 8.64 per cent more than when the residue was removed and retained. Residue incorporation also increased the organic carbon content in the soil by 0.37, 0.35 and 0.31 per cent in residue incorporated, retained and removed treatment respectively. It also increased the organic carbon content in the soil by 17.73 and 5.71 per cent in comparison with residue removed and retained treatment over a period of 2 years. Application of 150 kg N/ha increased the growth, yield attributes and yield of wheat. It increased the grain yield by 96.6, 65.0 and 37.3 per cent compared with N @ 0, 50 and 100 kg/ha. Available N in the soil also increased by 10 per cent during the 2 years.

Key words : Residue, Nitrogen, Rice, Wheat, Yield

Rice-wheat cropping system is being followed in 10.5 million ha in India (Yadav *et al.,* 2005). Over the years, there has been stagnation or decline in yield of rice *(Oryza sativa* L.) and wheat *(Triticum aestivum* L. emend. Fiori & Paol.) in rice-wheat cropping system (Yadav, 1998; Duxbury *et al.,* 2001). Declining soil fertility, especially soil-organic matter, is one of the important factors responsible for this (Olk *et al.,* 1996). Hence there is emphasis on building up soil-organic matter and one of the ways for this is to recycle the crop residues. Rice and wheat are generally harvested by a combine, which leaves significant quantities of residues or stubbles in the field. The effect of residue management in such fields has been found inevitable (Sindhu and Beri, 1989). Hence the present investigation was undertaken to find out the effect of removal, incorporation and retention of rice residue and N levels on the performance of wheat in a rice-wheat system under eastern Uttar Pradesh conditions.

MATERIALS AND METHODS

A field experiment on rice-wheat cropping system was carried out during 2001-02 and 2002-03 at Agronomy Research Farm of N.D. University of Agriculture and Technology, Kumarganj, Faizabad. The treatments comprised three practices of rice-residue management, viz. residue removed, residue incorporated and residue retained; and four levels of nitrogen, viz. 0, 50, 100 and150 kg/ha applied in wheat. Twelve treatment combinations with four replications were tested under strip-plot design. After rice harvest by combine, lay-out plan was carried out in the standing rice stubbles field. For the straw-removal treatment, stubbles were removed close to the soil surface, which weighed 3 tonnes/ha in both the years. For the residue-incorporated treatment, rice stubbles were incorporated with mouldboard plough and a light irrigation was applied. In the rice-residue retained plots, the crop was sown among the stubbles with a seed-drill. Recommended dose of fertilizers @ 60 kg P_2O_5 and 40 kg K_2O/ha was applied to each treatment in wheat, whereas other recommended packages of practices were followed in both wheat and rice. Wheat 'NW 1014' was sown during both the years in the same field and lay-out. The soil was silty loam, with pH 8.2; electrical conductivity (EC) 0.36 dS/m, low in organic carbon (0.30%) and available nitrogen (207 kg/ha); medium in available phosphorus (20 kg/ha) and rich in available potassium (303 kg/ha). The data on growth parameters, yield attributes and yield of wheat were recorded. The soil samples were analysed for organic carbon, available N, P, K, pH and bulk density by standard methods during both the years before sowing. Plot size was 10 m × 4.8 m. Samples of 0.5 m row length from three places in each plot were

drawn from the side rows, leaving three border rows from each side and 1 m border from both sides. Plant height of the 10 shoots from sampled plants was measured from each plot.

RESULT AND DISCUSSION

The growth parameters such as plant height and dry-matter production were significantly higher with rice-residue incorporation (Table 1). At harvest, rice-residue incorporation recorded the highest value (95 cm) of plant height, which was 6.6 and 5.4 cm more than the residue-retained and residue removed treatments respectively. Similarly, for dry-matter accumulation at harvest, rice-residue incorporation produced more dry matter of 208 g/m, which was 7.9 and 6.5 per cent higher than those obtained with rice-residue retained and rice-residue removed treatments respectively. Application of nitrogen significantly increased the growth parameters. N @ 150 kg/ha produced significantly taller plants, and dry-matter than all other treatments.

Rice-residue incorporation increased the yield attributes, viz. spikes/m, grains/spike, grain weight/spike and 1,000-grain weight (Table 1). Values of spikes/m were 7.94 and 6.78 per cent and number of grains/spike were 6.54 and 4.37 per cent higher with residue incorporation than with residue-retained and residue-removed treatments respectively. Similarly, grain weight/spike and 1,000-grain weight under residue-incorporation treatment were respectively 15.38 and 7.14% higher than residue-retained, and 7.93 and 9.48% higher than residue-removed treatments. These higher values might be due to increased leaf-area index (LAI) and better growth and development, where the plants got good opportunity for nutrient uptake which resulted in higher plant growth and development as well as yield attributes. Verma (2001) also reported similar findings.

Application of 150 kg N/ha produced 34.9, 27.3 and 5.1 per cent more spikes/m, and 27.8, 26.7 and 8.0 per cent more grains/spike than that of 0, 50 and100 kg N/ha respectively. Similarly, heaviest weight of grains was also recorded with the application of 150 kg N/ha. Higher level of N improved the fertility level of soil and created congenial condition for better growth and development of plants, and thus improved the yield attributes. These results are in conformity with those reported by Dwivedi and Thakur (2000).

Yield

Rice-residue incorporation gave significantly higher grain and straw yields over residue-removed and residue-retained treatments during both the years (Table 2). Rice-residue incorporation recorded 1.7 and 10 per cent more grain yield in 2001-02, and 12 and 7 per cent more in 2002-03 than residue-retained and residue-removed treatments respectively. Incorporation of rice residue showed significant increase in straw yield over residue-retained and residue-removed treatments, being, 11.25 and 7.31 per cent higher in 2001-02 and 9.03 and 6.38 per cent higher in 2002-03 respectively. The improvement in grain and straw yields of wheat may be due to addition of crop residue, which improved the status of soil-organic matter, leading to higher uptake of available nutrients from the soil. Crop residue on decomposition released nutrients slowly throughout the growth period, which resulted in better plant growth and higher grain and straw yields. Dwivedi and Thakur (2000) and Das *et al.* (2001) also reported increase in grain and straw yields of wheat with residue incorporation.

Application of 150 kg N/ha gave significantly higher grain and straw yields over that of 0, 50 and 100 kg N/ha during both the years. The highest grain yield of 45.18 and 38.88 q/ha was produced with 150 kg N/ha, showing an increase of 94, 63 and 15 per cent in 2001-02, and 111, 76 and 11 per cent in 2002-03 over 0, 50 and 100 kg N/ha

Table 1. Growth characters and yield-contributing characters of wheat as influenced by various treatments (pooled values of 2 years)

Treatment	Shoots/m at harvest	Plant height (cm) at harvest	Dry matter at harvest (g/m)	Spikes/m	Grains/spike	Grain weight/spike (g)	1,000-grain weight (g)
Rice-residue management							
Residue removed	58.0	89.6	211.0	56.0	34.3	1.4	35.3
Residue-incorporaed	61.6	95.0	224.8	59.8	35.8	1.5	38.1
Residue retained	57.0	88.4	208.3	55.4	33.6	1.3	34.8
CD (P=0.05)	3.23	6.74	9.82	3.12	2.01	0.12	2.81
Nitrogen (kg/ha)							
N_0	48.3	80.8	152.5	48.7	30.6	1.2	31.9
N_{50}	53.9	87.1	205.5	51.6	32.4	1.3	33.9
N_{100}	64.2	94.5	237.9	62.5	36.2	1.5	38.5
N_{150}	69.1	102.1	262.8	65.7	39.1	1.7	41.4
CD (P=0.05)	3.06	6.18	10.06	3.03	1.88	0.13	2.88

respectively. Application of 150 kg N/ha gave straw yield of 56.97 and 48.52 q/ha, registering an increase of 82, 55 ad 12 per cent in 2001-02, and 99, 61 and 8 per cent in 2002-03 compared with those of 0, 50 and 100 kg N/ha respectively. The increase in grain and straw yields due to increasing level of N might be due to the fact that nitrogen fertilization pushed up the removal of nutrients and water from the soil by the crop, which enhanced the photo-synthesis and translocation of assimilates from source to sink. Verma (2001) also reported the increase in grain and straw yields due to application of 150 kg N/ha.

N uptake and N-use efficiency

Nitrogen uptake by wheat and nitrogen-use efficiency were positively influenced by rice residue incorporation (Table 2). Incorporation of rice-residue led to higher nitrogen uptake, which showed an increase of 15 and 19 per cent more over rice-residue removed and rice-residue retained respectively. Nirogen-use efficiency was also higher with rice-residue incorporation and registered an increase of 12.6 and 2.3 per cent over rice-residue retained and rice-residue removed treatment respectively.

Application of 150 N/ha recorded maximum nitrogen uptake, which increased by 151.9 per cent over the control. However, nitrogen-use efficiency was higher with 100 kg N/ha, which was 102.5 per cent more over the control. It might be because nitrogen uptake is directly correlated with yield. Increased yield ultimately resulted in higher uptake. Nitrogen-use efficiency did not increase due to excessive nitrogen, which did not show further response. Dwivedi and Thakur (2000) also reported similar findings.

Physico-chemical properties of soil

Rice-residue incorporation and rice-residue retained treatments recorded significantly lower bulk density over rice-residues removed during both the years (Table 4). Incorporation of rice residue also recorded higher organic

Table 2. Yield, N uptake and N-use efficiency of wheat as influenced by various treatments

Treatment	Grain yield (q/ha)		Straw yield (q/ha)		N uptake* (kg/ha)	N-use efficiency* kg grains/ha N
	2001-02	2002-03	2001-02	2002-03		
Rice-residue management						
Residue removed	33.4	28.4	43.5	36.6	79.3	13.1
Residue-incorporated	36.8	30.4	46.7	38.9	91.6	13.4
Residue retained	31.4	27.1	41.9	35.7	76.9	11.9
CD (P=0.05)	2.0	1.8	2.8	2.3		
Nitrogen (kg/ha)						
N_0	23.4	18.3	31.4	24.9	46.8	-
N_{50}	27.7	22.1	36.9	30.1	65.4	8.0
N_{100}	39.4	34.9	50.9	45.1	100.0	16.2
N_{150}	45.2	38.9	56.9	48.5	117.9	14.1
CD (P=0.05)	3.0	2.5	2.8	2.6		

*Mean data of 2 years

Table 3. Physico-chemical properties of soil after wheat harvest as influenced by various treatments

Treatment	BD (g/cc)		Organic C (%)		EC (dS/m)		pH		Available N (kg/ha)	
	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03	01-02	02-03
Rice-residue management										
Residue removed	1.42	1.47	0.31	0.31	0.38	0.38	8.14	8.07	209	214
Residue-incorporated	1.33	1.36	0.36	0.37	0.38	0.39	7.74	7.70	212	218
Residue retained	1.38	1.39	0.34	0.35	0.37	0.40	7.90	7.94	215	220
CD (P=0.05)	0.07	0.07	0.02	0.02	NS	NS	0.24	0.33	NS	NS
Nirogen (kg/ha)										
N_0	1.37	1.40	0.34	0.34	0.39	0.38	7.95	7.64	200	205
N_{50}	1.36	1.40	0.34	0.35	0.37	0.39	7.90	7.83	211	217
N_{100}	1.37	1.40	0.34	0.34	0.38	0.40	7.87	7.85	216	222
N_{150}	1.38	1.41	0.33	0.35	0.38	0.39	7.86	7.87	220	226
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	17	12

BD=studied

carbon content, i.e. 16 and 8 per cent in 2001-02, and 19 and 6 per cent in 2002-03 over rice-residue removed and rice-residue retained treatments respectively. Values of pH was also higher under rice-residue incorporation in comparison with residue-removed and residue-retained treatments. Application of 150 kg N/ha increased the available N over the control by 10 per cent.

REFERENCES

Das, K., Medh N. and Guha, B. 2001. Recycling effect of crop residues with chemical fertilizers on physico-chemical properties of soil and rice *(O. sativa)* yield. *Indian Journal of Agronomy* **46**(4) : 648–653.

Duxbury, J. M., Abrol, I.P., Gupta, R.K. and Bronson, K. 2000. Analysis of long term soil fertility experiments with rice-wheat rotation in South Asia. (In) : *Long-term Soil Fertility Experiments in Rice-Wheat Cropping System.* Abrol, I.P., Bronson, K., Duxbury, J.M. and Gupta, R. K. (Eds). RWC Research Serial no. 6, New Delhi.

Dwivedi, D.K. and Thakur, S.S., 2000. Production potential of wheat *(T. aestivum)* crop as influenced by residue organics, direct and residual fertility levels under rice-wheat cropping system. *Indian Journal of Agronomy* **45**(4) : 641–647.

Olk, D.G., Cassman, K. G., Randall, E.W., Kindhesh, P., Sanger, L.J. and Anderson, J.M. 1996. Changes in the chemical properties of soil organic matter in tropical lowland soils. *Environmental Journal of Soil Science* **47 :** 293–303.

Sidhu, B.S. and Beri, V. 1989. Effect of crop residue management on the yields of different crops and on soil properties. *Biological Wastes* **27** : 15–27.

Verma, K.P. 2001. Effect of crop residue incorporation and nitrogen on succeeding wheat *(T. aestivum* L.) *Indian Journal of Agronomy* **46** (4) **:** 665–669.

Yadav, D.S., Shukla, R.P., Sushant and Birendra Kumar 2005. Effect of zero tillage and nitrogen level on wheat *(Triticum aestivum)* after rice *(Oryza sativa). Indian Journal of Agronomy* **50** (1) : 52–53.

Yadav, R.L. 1998. Factor productivity trends in a rice-wheat cropping system under long term use of chemicals. *Experimental Agriculture* **34:** 1–18.