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Short Term Effect of Crop Residue and Different Nitrogen Levels on Grain yield of Wheat under Rice-Wheat System

Narayan Khatri*, Dev Raj Chalise, Nabin Rawal

Scientist, National Wheat Research Program, Bhairahawa, Nepal

Abstract— *Crop residues are very important source of plant nutrients and recycling of crop residues with inorganic fertilizer increases the yield of rice and wheat in rice-wheat system. The objective of the study was to determine the production and productivity of wheat as affected by management of crop residues and different nitrogen levels. The field experiments were carried out in 2014 and 2015 at National Wheat Research Program, Bhairahawa, Nepal and the field was laid out in split plot design: two crop residue levels (with and without residues) as whole plot and seven nitrogen levels (0, 25, 50, 75,100, 125, 150 kg/ha) as sub-plot which were replicated three times. Significant difference was observed with crop residues incorporation in biological yield with the value of 5538 kg/ha as compared to without residue incorporation (4167 kg/ha) in 2014. Similar result was observed in 2015 as highest significant biological yield of 6629 kg/ha was recorded from residue incorporation plot. On the other hand, application of nitrogen @ 150 kg/ha resulted to significantly highest grain yield of 2593 and 3073 kg/ha in both years (2014 and 2015) respectively. The overall conclusion is that an improved crop residue management with appropriate dose of chemical fertilizer increases the grain yield of wheat in short term basis.*

Keywords— Crop residue, Nitrogen level and Yield.

I. INTRODUCTION

Crop residues are parts of crops left in the field after crops have been harvested and threshed. Crop residues are important natural resources and recycling of crop residues has the advantage of converting the surplus farm wastes into useful materials for meeting nutrient requirement of crops. it also maintains the soil physical and chemical condition (Powel et al 1997) and improves the overall ecological balance of the crop production system. As cereal crops, rice and wheat both are exhaustive feeders, and the double cropping system is heavily depleting the soil of its nutrient content. The combined use of rice or wheat straw and inorganic fertilizer can increase the yield of rice and wheat in rice-wheat systems (Mahapatra et. al. 1991). A rice-wheat sequence that yields 7 tons per ha of rice and 4 tons per ha of wheat removes more than 300 kg N, 30 kg P, and 300 kg K per ha from the soil (Singh and Singh, 2001). Another estimate shows that a 10 t ha^{-1} crop yield removes 730 kg NPK from the soil where the crop reisdue is often not returned to the soils (Gupta *et al.,* 2002). If this residue is not returned this may cause mining of soil for major nutrients leading to net negative balance and multi- nutrient deficiencies in crops. This is one of the reasons for the yield decline in the rice-wheat system. Thus, there are urgent needs to manage the residues of these crops for sustainability and stability of the system. Crop residues are very important source of plant nutrients. Literatures suggest that about 25% of nitrogen (N) and phosphorus (P), 50% of sulphur (S), and 75% of potassium (K) uptake by cereal crops are retained in crop residues, making them valuable nutrient sources (Singh and Singh, 2001). Unlike huge potential of crop residues in replenishing soil fertility, their importance has not been recognized by the farmers.

II. MATERIALS AND METHODS

The experiment was conducted in winter season of 2014 and 2015 at National Wheat Research Program, (NWRP), Bhairahawa and the field was laid out in split plot design: two crop residue levels (with and without residues) as whole plot and seven nitrogen levels (0, 25, 50, 75,100, 125, 150 kg/ha) as sub-plot which were replicated three times. The crop, Vijay variety was sown on December 3rd in 2014 and November 26 in 2015 at the spacing of 25 cm between rows with continuous seeding. The plot size was 5 × 3 m giving a net plot area of 15 m^2. Urea, single super phosphate, murate of potash and borax were the source of fertilizers used for supplying nitrogen, phosphorus, potash and boron respectively. Full dose of phosphorus, potassium and boron fertilizers was applied at the time of land preparation. Whole Crop residues were retained in the field

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as natural residues after rice harvesting. The recommended dose of 50 kg P_2O_5/ha, 50 kg K_2O/ha and 2 kg borax were applied as basal in all plots at the time of seed sowing. Half dose of N was used at the time of seed sowing as basal dose. The remaining half dose of N was side-dressed at 20 DAS and 40 DAS. The monthly mean maximum, minimum temperature and rainfall of both years were presented in table 1. Data were analyzed through GENSTAT statistical package and treatment means were compared using least significant difference (LSD) test at $P \leq 0.05$.

Table.1: Mean maximum, minimum temperature and rainfall values during the crop growing season, 2014/15 and 2015/16

Month	Maximum mean temperature (C°)		Minimum mean temperature (C°)		Rainfall (mm)	
	2014/15	2015/16	2014/15	2015/16	2014/15	2015/16
October	31.39	33.4	20.37	20.7	156	25.5
November	29.15	30.0	15.30	16.0	0	0.0
December	20.70	24.5	11.45	10.5	17.6	0.4
January	19.13	21.6	10.01	8.7	326	4.5
February	25.36	26.9	12.15	11.5	0	0.0
March	29.65	32.2	15.47	15.5	122.9	19.6

Source: National Wheat Research Program, Bhairahaw, Nepal.

III. RESULTS AND DISCUSSION

Effect of crop residues and nitrogen levels on growth and yield attributes of wheat, 2014

Significant difference was observed with crop residues incorporation in biological yield whereas no significant effects were observed in other yield attributing parameters maturity days, plant height, spike length, spikes per m^2, grains per spike, thousand grain weight and grain yield (Table 2). Result shows no incorporation of crop residues gave significantly higher biological yield (5538 kg/ha). Incorporation of crop residues gave higher maturity days (109.23), more grains per spike (24.57) and higher thousand grain weight (51.58gm) whereas taller plant height (93.93 cm), greater spike length (10.46 cm), more spikes per m^2 (221.4) and higher grain yield (2235 kg/ha) were observed in the plots with no crop residues incorporation.

Table.2: Effect of crop residues and nitrogen levels on growth and yield attributes of wheat at NWRP, Bhairahawa, 2014

Treatments	Maturity Days	Plant Height (cm)	Spike length (cm)	Spikes/m^2	Number of grains/spike	Thousand grain weight (gm)	Grain yield (kg/ha)	Biological yield (kg/ha)
Crop residues (A)								
Without crop residues	109.09	93.93	10.46	221.4	23.90	50.79	2235	5538
With crop residues	109.23	91.73	9.80	210.5	24.57	51.58	1946	4167
F-test of A	NS	NS	NS	NS	NS	NS	NS	*
LSD 0.05	0.35	6.7	1.63	27.37	3.111	6.10	336.6	826.9
Nitrogen levels (kg/ha) (B)								
0	108.16	88.40	9.53	175.7	20.45	50.60	1361	3050
25	108.0	92.40	10.33	176.8	22.60	51.57	1785	4150
50	108.33	92.20	9.27	214.8	23.55	51.50	1990	5017
75	109.33	95.0	10.57	221.0	25.15	49.97	2044	5033
100	109.66	95.13	10.37	218.7	25.92	53.40	2326	5317
125	110.0	95.17	10.50	230.2	25.53	51.93	2534	5567
150	110.66	91.53	10.33	274.7	26.47	49.33	2593	5833
F-test of B	***	NS	NS	***	**	NS	***	***

LSD 0.05	0.52	4.77	1.22	37.09	3.16	4.63	496.6	1132.2
Interaction								
F-test of A × B	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	0.4	4.3	10.1	14.4	11	7.6	19.9	19.6

Results (Table 2) revealed significant ($P<0.05$) differences among different nitrogen levels on maturity days, spike per $m^{2,}$ grains per spike, grain yield and biological yield but was non-significant on plant height, spike length and thousand grain weight. Highest maturity days (110.66) was observed in application of nitrogen @150 kg/ha to the crop. Plots amended with nitrogen @125kg/ha gave greater plant height (95.17 cm) which was ad par with the application of 25 (92.40), 50 (92.20), 75 (95), 100 (95.13) and 150 (91.53) kg N/ha. Similarly, greater spike length (10.33 cm) was observed with N @125 kg/ha treated plots, whereas more spike per m^2 (274.7) was with 150 kg N/ha amended plots. Nitrogen application @150 kg/ha produced more number of grains per spike (26.47) which was at par with the application of N @ 50 (23.55), 75 (25.15), 100 (25.92) and 125 (25.53) kg N/ha. Higher thousand grain weight (53.40 gm) was produced with the application of 100 kg N/ha followed by 125 kg N/ha (51.93 gm). N application @ of 150 kg/ha yielded highest grain yield of 2593 kg/ha. Highest biological yield was observed in the plot with application of nitrogen @150 kg/ha (5833 kg/ha) which was ad par with N-application of 50 (5017 kg/ha), 75 (5033 kg/ha), 100 (5317 kg/ha) and 125 (5567 kg/ha) kg/ha. No significant differences were observed in the interaction between crop residues and nitrogen levels.

Significant difference was observed with crop residues incorporation in plant height, spike length, thousand grain weight and biological yield whereas no significant effects were observed in other yield attributing parameters maturity days, spikes per m^2, grains per spike and grain yield. Results showed that incorporation of crop residues gave significantly highest plant height (101 cm), spike length (8.9 cm), thousand grain weight (43.94 gm) and biological yield (6629 kg/ha).

Table.3: Effect of crop residues and nitrogen levels on growth and yield attributes of wheat at NWRP, Bhairahawa, 2015

Treatments	Maturity Days	Plant Height (cm)	Spike length (cm)	Spikes/m^2	Number of grains/spike	Thousand grain weight (gm)	Grain yield (kg/ha)	Biological yield (kg/ha)
Crop residues (A)								
Without crop residues	115	98	8.6	270.6	31.25	42.93	2376	4871
With crop residues	116	101	8.9	261.6	32.74	43.94	2410	6629
F-test of A	NS	*	*	NS	NS	*	NS	*
LSD 0.05	2.48	1.8	0.16	67.5	3.18	0.85	767.5	1172.7
Nitrogen levels (kg/ha) (B)								
0	115	92	7.9	196.3	29.30	43.63	1387	3433
25	115	98	8.1	213.8	31.00	44.07	1868	4567
50	115	100	8.9	239.3	34.33	45.27	2120	5200
75	115	100	8.9	272.7	32.62	44.60	2707	6150
100	115	102	9.2	294.2	32.22	44.37	2698	6700
125	115	103	9.1	302.8	31.78	41.83	2897	6850
150	114	104	9.5	343.5	32.72	40.30	3073	7350
F-test of B	NS	***	***	***	**	**	***	***
LSD 0.05	2.11	3.4	0.78	48.02	3.87	2.66	365.6	580.9
Interaction								
F-test of A × B	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	1.5	2.9	7.5	15.1	10.1	5.1	12.8	8.5

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Effect of crop residues and nitrogen levels on growth and yield attributes of wheat, 2015

Similarly, analysis of data revealed that significant differences among different nitrogen levels was recorded in the year 2015 on plant height, spike length, spike per $m^{2,}$ grains per spike, thousand grain weight, grain yield and biological yield but effect was found to be non significant on days to maturity (Table 3). Nitrogen application @150 kg/ha gave greater significant ($P<0.05$) plant height (104 cm) which was at par with the application of 50 (100 cm), 75 (100 cm), 100 (102 cm) and 125 (103 cm) kg N/ha. Similarly, greater spike length of 9.5 cm and maximum number of spikes per square meter (343.5) were recorded in the plots treated with N @150 kg/ha. N application @ of 150 kg/ha yielded highest significant ($p<0.05$) grain and biological mean yield of 3073 and 7350 kg/ha respectively. No significant differences were observed in the interaction between crop residues and nitrogen levels.

Similarly, figure 1 shows that the grain yield as affected by crop residues was found higher in second year as compared to first year. Lower yield in first year might be immobilization of soil N in presence of crop residues with wide C/N ratio, but in later year, straw incorporation did not affect wheat yields adversely. Incorporation of rice straw into the soil after its harvest leads to slow down of the decomposition and soil nitrate is immobilized (Bacon et.al 1987), reducing the N uptake and yield of subsequent wheat crops by about 40% (Bacon et. al. 1987; Sidhu et. al 1989).

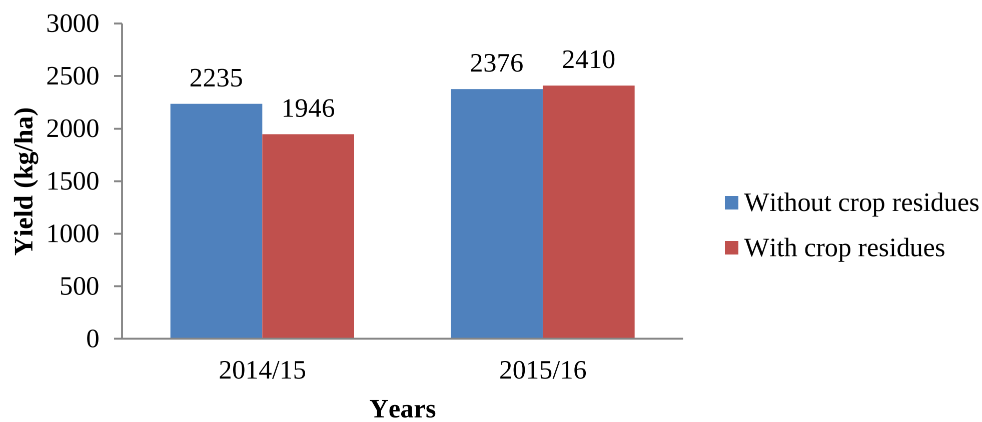

Fig.1: Comparison of mean grain yield of wheat as affected by crop residues, 2014/15 and 2015/16.

Grain yield was found highest with the application of Nitrogen @ 150 kg/ha in both years. While grain yield of wheat was obtained higher in second year as compared to first year in all levels of nitrogen (Figure 2).

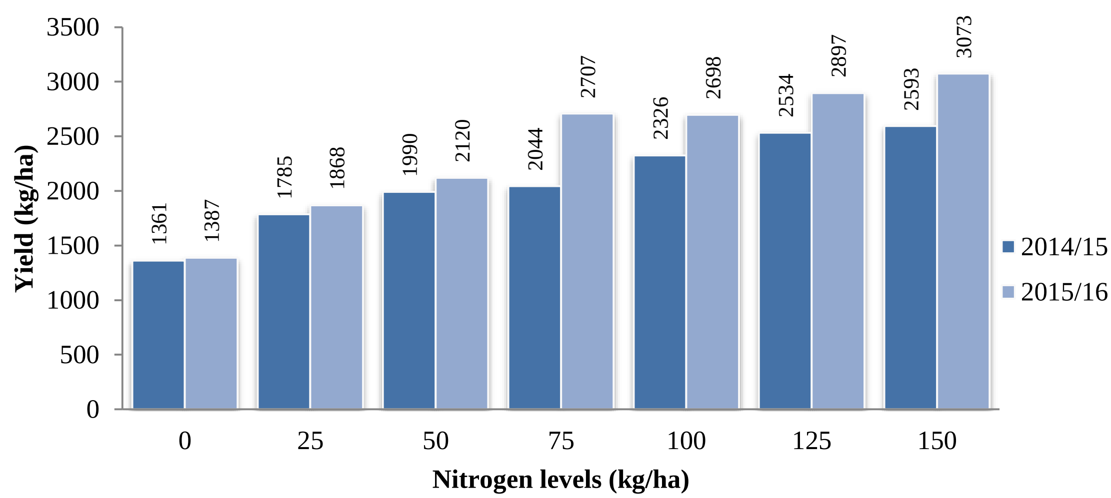

Fig.2: Comparison of mean grain yield of wheat as affected by nitrogen levels, 2014/15 and 2015/16.

IV. CONCLUSION

Highest biological yield of both season wheat was observed in the plots with no incorporation of crop residues. Non significant differences on different plant growth and yield parameters were observed owing to very less decomposition of residues in the first year wheat production. Nitrogen application @150 kg/ha seemed beneficial in producing higher grain yield of wheat.

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