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Effect of crop-residue incorporation and nitrogen on succeeding wheat (*Triticum aestivum*)

K.P. VERMA

Regional Research Substation, Chandrashekhar Azad University of Agriculture and Technology, Saini, Kaushambi, Uttar Pradesh 212 217

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ABSTRACT

A field experiment was conducted during 1997–98 to 1999–2000 to work out the effect of residue incorporation of rice (*Oryza sativa* L.), soybean [*Glycine max* (L.) Merr.] and groundnut (*Arachis hypogaea* L.) and nitrogen requirement of succeeding wheat (*Triticum aestivum* L. emend. Fiori & Paol.) crop. An increasing trend was recorded in wheat yield and organic carbon content in soil with the incorporation of crop residue. Incorporation of groundnut residue showed higher rate of increase in grain yield of wheat than soybean and rice. Improvement in grain yield of wheat was observed with application of higher dose (150 kg/ha) of nitrogen. In general, positive improvement in soil-fertility status was recorded with residue incorporation. The crop sequence of wheat followed by rice produced highest net return and benefit : cost ratio. Similar trend was also noticed with removal of residue and application of higher dose of nitrogen.

Key words : Crop residue incorporation, Nitrogen levels, Succeeding crop, Soil-fertility status

Inorganic fertilizers have played a highly significant role in intensive cropping system which brought about manifold increase in crop production. However, with the increased usage of inorganic fertilizer alone in an unbalanced manner, problems such as diminishing soil health and multiple nutrients deficiency appeared. With the results the importance of residue waste from crop production was realized not only in refurbishing soil productivity but also increasing the efficiency of inorganic fertilizers. Hence an experiment was conducted to work out the effect of crop residue and nitrogen levels on succeeding wheat crop in central plain zone of Uttar Pradesh.

MATERIALS AND METHODS

The experiment was carried out at Regional Research Substation Saini, Kaushambi, from crop season 1997–98 to 1999–2000 on a permanent lay out in split-plot design replicated thrice. The soil was

sandy loam (Typic ustocrept), having pH 8.1, EC 0.25 dS/m and was also low in organic carbon (0.30%), available P_2O_5 19.5 kg/ha and available K_2O 170 kg/ha. The treatment consisted 3 rainy-season crops, i.e., rice, soybean and groundnut, 2 residue management (residue removed and residue incorporated) in main plot and 3 nitrogen levels (90, 120 and 150 kg/ha) for succeeding wheat crop in subplot. Fertilizer 60 kg P_2O_5 and 40 kg K_2O/ha was applied to each treatment in wheat, whereas recommended package of practices was followed to raise rainy-season crops. Rice variety 'Sarjoo 52', 'Soybean variety 'Gaurav' and groundnut variety. 'Chitra' were used in rainy season during each year. While wheat var. 'HUW 234' during 1997–98 and 'PBW 343' during 1998–99 and 1999–2000 respectively. Chopped crop residue was incorporated in respective treatment 2 weeks before planting of wheat crop. The yield data of crop residue and grain yield of crops in sequence were recorded every year. The soil samples were analysed for organic carbon, available P and K by standard method after completion of 3 years experimentation.

RESULTS AND DISCUSSION

Yield of rainy-season crop

Yield of any rainy-season crop (rice, soybean, groundnut) was not influenced by the residue and nitrogen management to succeeding wheat crop in sequential cropping. However, higher dose of notrogen application in wheat showed positive improvement on residue yield (Table 1) preceding rainy-season crops.

Wheat yield

Effect of preceding crop : Any rainy-season crop did not show significant effect on grain yield of wheat crop during 1997–98. It might be due to not much improvement in soil status during first year by different preceding crops. Grain yield of wheat after groundnut was found significantly higher than wheat yield recorded after rice during 1998–99 and 1999–2000. Quayyum and Maniruzzaman (1996) also noted that legumes in rotation improve soil

Table 1. Yield of preceding rainy-season crops as affected by residue and nitrogen management to succeeding wheat crop in sequence (pooled data of 1997–2000)

Treatment	Grain yield of rainy-season crop (q/ha)		
	Rice	Soybean	Groundnut
Residue management			
Removed	48.77 (165)	15.22 (9.1)	15.95(101)
Incorporated	49.13(166)	15.52 (10.1)	16.38 (104)
Nitrogen (kg/ha)			
N_{90}	48.56(164)	15.08 (9.7)	15.73 (100)
N_{120}	48.89(165)	15.30 (10.0)	16.27 (103)
N_{150}	49.42(167)	15.73 (10.2)	16.50(105)

Figures in parentheses indicate fresh yield (q/ha) of crop residue

Table 2. Grain yield of succeeding wheat crop and wheat grain-yield equivalent (q/ha) as affected by residue and nitrogen management to wheat crop in sequence cropping

Treatment	1997–98	1998–99	1999–2000	Mean
Rainy-season crop				
Groundnut	30.60 (62.73)	46.77 (80.30)	54.25 (75.72)	43.88 (76.25)
Soybean	29.68 (52.71)	45.04 (67.08)	53.42 (76.57)	42.70 (65.27)
Rice	29.67 (70.02)	43.35 (82.29)	51.45 (92.18)	41.48 (81.50)
CD (P=0.05)	NS (1.97)	1.50 (3.40)	1.77 (2.13)	1.81 (3.45)
Residue management				
Residue removed	29.50 (61.23)	44.37 (75.57)	51.85 (83.27)	41.90 (73.36)
Residue incorporated	30.47 (62.05)	45.73 (77.54)	54.24 (86.37)	43.48 (75.32)
CD (P=0.05)	NS (NS)	1.23 (NS)	1.45 (1.74)	1.38 (1.54)
Nitrogen (kg/ha)				
N_{90}	27.20 (58.91)	39.21 (70.28)	49.25 (80.16)	38.5 (69.78)
N_{120}	30.69 (61.92)	45.92 (77.62)	53.58 (85.60)	43.13 (75.05)
N_{150}	32.08 (64.09)	50.04 (81.78)	56.29 (88.70)	46.13 (78.19)
CD (P=0.05)	1.89 (1.61)	1.61 (1.81)	2.47 (2.57)	2.15 (2.97)

Figures in parentheses indicate wheat grain-yield equivalent

fertility and thereby increase the productivity of subsequent non-legume crop.

Effect of crop-residue management: Different crop residue incorporated did not influence the grain yield of succeeding wheat crop during first year (Table 2). But wheat yield significantly increased with incorporation of crop residue during next 2 succeeding years. Narang *et al.* (1999) also reported similar results. Although interactions were not significant, incorporation of the groundnut residue (haulm) showed higher wheat yield than soybean or rice. It might be due to very low residue load produced by soybean (Table 1), whereas rice residue contained lesser amount of nutrients which were released in the soil after decomposition. Dhillan and Dhillan (1991) also reported that incorporation of groundnut residue (2.36% N) before sowing of wheat at Ludhiana had significant effect on wheat yield.

Effect of nitrogen : Wheat grain yield was significantly higher with 150 kg N/ha than 120 and 90 kg N/ha during 1998–99 and 1999–2000. Though the trend of high yield was maintained at 150 kg N/ha, difference between 120 kg and 150 kg N/ha was not significant during 1997–98. It might be due to late sowing of wheat crop as well as genetic make-up of wheat variety sown during 1997–98. Singh *et al.* (1997) observed the similar results for late-sown wheat. A general trend in grain yield of wheat improvement was thus observed with application of higher dose of N (150 kg N/ha). But yield increased over 90 kg N/ha with application of 120 kg N/ha was more (349, 671, 433 kg/ha) in comparison to 150 kg N/ha over 120 kg N/ha (131, 412, 271 kg/ha) during 1997–98, 1998–99 and 1999–2000 respectively.

An interaction of N levels and residue management of different crops was

however, not significant in any of the years, but a higher mean yield was obtained when groundnut residue incorporated at 150 kg N/ha, followed by soybean residue incorporated at 150 kg N/ha.

Wheat grain-yield equivalent

The maximum wheat grain yield equivalent was recorded under wheat–rice sequence, whereas lowest with wheat–soybean sequence. Incorporation of crop residue gave significantly higher wheat grain-yield equivalent than residue removal during the third year only. Application of 150 kg N/ha in wheat gave significantly higher wheat grain-yield equivalent than 120 kg and 90 kg N/ha during all the years.

Economic returns

On the basis of 3 years pooled data (Table 3) wheat–rice crop sequence gave the highest monetary returns and wheat–soybean crop sequence the lowest net returns. The highest net returns were achieved when residue of rainy-season crop was removed and utilized as fodder. Application of 150 kg N/ha in wheat crop produced maximum net profit over 120 and 90 kg N/ha. Similar trend was also observed in relation to benefit : cost ratio.

Soil status

In general, there was a positive improvement in fertility status (Table 4) of soil due to residue incorporation. More positive effect on soil-fertility status was recorded with legumes crop (groundnut and soybean) than rice-residue incorporation at the end of 3-year experimentation. The result also supports the findings of Bhat *et al.* (1991) and Prasad and Power (1991).

No doubt, with the regular incorporation of crop residue for 3 years, the net returns over residue removed were not high, but the soil fertility improved considerably (Table 4). Therefore, the fertility can be improved

Table 3. Economic returns and benefit : cost ratio as influenced by residue and nitrogen management for succeeding wheat crop in a sequence (pooled data of 1997–2000)

Treatment	Total gross return (Rs/ha/annum)	Net returns (Rs/ha/annum)	Benefit: cost ratio
Rainy-season crop			
Groundnut	46,062	14,199	1.45:1
Soybean	39,127	12,787	1.48:1
Rice	50,185	18,090	1.57:1
Residue management			
Residue removed	44,509	15,328	1.52:1
Residue incorporated	45,740	14,723	1.48:1
Nitrogen (kg/ha)			
N_{90}	42,291	12,502	1.42:1
N_{120}	45,568	15,469	1.51:1
N_{150}	47,515	17,105	1.57:1

Table 4. Effect of crop-residue management and nitrogen levels on nutrient status (0–15 cm) at end of 3 succeeding wheat crops harvested

Treatment	pH	Organic carbon (%)	Available (kg/ha)	
			P	K
Initial	8.1	0.30	19.5	170
Rainy-season crop				
Groundnut	8.05	0.34	19.6	175
Soybean	8.10	0.32	19.9	172
Rice	8.05	0.31	18.8	170
Residue management				
Removed	8.07	0.29	18.5	168
Incorporated	8.08	0.35	20.3	177
Nitrogen (kg/ha)				
N_{90}	8.07	0.30	19.0	174
N_{120}	8.06	0.32	19.8	173
N_{150}	8.08	0.34	19.5	171

further through continuous incorporation of crop residue. In near future when combine harvesting will become inevitable in farming community it would be more economical and feasible to incorporate crop residue in soil to improve soil fertility, reduced doses of chemical fertilizers, will lead sustainability of food production.

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