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Effect of Rice Residue Management Techniques and Herbicides on Nutrient Uptake by *Phalaris minor* Retz. and Wheat (*Triticum aestivum* L.)

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ABSTRACT

A field experiment was conducted at experimental farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana (Punjab) during **rabi** seasons of 2004-05 and 2005-06 to study the effect of rice residue management techniques and weed control treatments on the growth and development of *Phalaris minor* and wheat. The studies revealed that surface placement of rice residues at 6 and 7 t/ha significantly reduced the dry matter accumulation and nutrient uptake by *P. minor* as compared to incorporation and no rice residue treatments. Grain yield and nutrient uptake by wheat were statistically similar in all rice residue management techniques. Post-emergence application of clodinafop 60 g/ha, sulfosulfuron 25 g/ha and mesosulfuron+iodosulfuron 14.4 g/ha significantly reduced the dry matter accumulation and nutrient uptake by *P. minor* as compared to control (unweeded). Consequently, all the herbicidal treatments recorded significantly higher grain yield and nutrient uptake by wheat as compared to control treatment.

Key words : Straw management, weed control, nutrient uptake

INTRODUCTION

Introduction of semi dwarf genotypes of wheat and extensive area under the intensive cropping system coupled with better irrigation and fertilizer application has provided congenial growing conditions for *Phalaris minor* particularly in rice-wheat cropping system where it has emerged as major weed of wheat causing yield reduction to the level of 30-80% (Brar and Walia, 1993; Singh *et al.,* 1999). Dependence on only one herbicide, isoproturon, for very long period for the control of *P. minor* in wheat has resulted in problem of resistance to this herbicide (Malik and Singh, 1995; Walia *et al*., 1997). The management of this weed has now become a major concern to sustain wheat productivity. Alternative herbicides, namely, sulfosulfuron, clodinafop and mesosulfuron+iodosulfuron are available, but there is a risk of development of cross-resistance. Efforts have been made to develop integrated approach to reduce *P. minor* population pressure through placement of rice residues or with the application of herbicides in order to sustain the productivity of wheat crop. Also the uptake of nutrients by the crop is governed by the nutrient supply system of soil through native and applied sources and their loss through leaching and removal by weeds. The faster growth of weeds causes rapid depletion of nutrients from soil. In this regard, placement of rice residue and herbicides could be a better solution in preventing weeds from removing nutrients from soil through restricting their growth for the better nutrient uptake by the crop. Keeping these points in view, an experiment was conducted to study the effect of rice residue management techniques and herbicidal treatments on the growth and development of wheat and weeds.

MATERIALS AND METHODS

The field experiment was conducted during **rabi** seasons of 2004-05 and 2005-06 at the experimental farm of Department of Agronomy, PAU, Ludhiana. The soil of the experimental field was loamy sand in texture, normal in soil reaction (7.3) and electrical conductivity (0.26 dS/m), medium in organic carbon (4.2 g/kg), available phosphorus (18.6 kg/ha) and potassium (150 kg/ha) and low in available nitrogen (230 kg/ha). The experiment was laid out in split plot design with five rice residue management treatments in the main plots and four herbicidal treatments in the sub-plots with three replications. Among the main plots; no rice residue, surface placement of rice residues at 5, 6 and 7 t/ha and rice residue 5 t/ha (incorporation) were kept. In sub-plots, clodinafop 60 g/ha, sulfosulfuron 25 g/ha, mesosulfuron + iodosulfuron

14.4 g/ha and control (unweeded) were applied.

In case of incorporation treatment, plots were ploughed twice with disc harrow and once with cultivator followed by planking to facilitate incorporation of residues. Wheat variety PBW 343 was sown on October 30, 2004 and November 3, 2005 with tractor drawn zero till drill in no rice residue and surface placed residue treatments and with ordinary seed drill in the residue incorporation treatment using a seed rate of 100 kg/ha. Light planking was given after sowing to cover the seeds properly with soil. Rice residues were spread uniformly after wheat sowing on the same day as per the treatments. Crop was raised with recommended package of practices. Nitrogen (125 kg/ha) and phosphorus (P_2O_5 60 kg/ha) were applied through urea and diammonium phosphate (DAP), respectively. Half the dose of nitrogen and whole of phosphorus was applied at the time of sowing, while the remaining half dose of N was applied as broadcast after first irrigation. Herbicides were applied 35 DAS with knapsack sprayer fitted with flat fan nozzle. Algrip 20 WP (metsulfuron) was sprayed at 5 g/ha a week after clodinafop and sulfosulfuron treatments to control broadleaf weeds.

Samples for grain and straw of wheat and dry matter accumulation by weeds were taken at the time of harvest from each plot. These were oven-dried, then-ground with electric grinder and chemically analysed for nitrogen, phosphorus and potassium contents. To determine nitrogen content 0.5 g plant material was digested in concentrated H_2SO_4 and selenium dioxide and N was determined by using autoanalyser.

To determine total phosphorus and potassium, the weed (*Phalaris minor*) and wheat samples were digested in triple acid mixture (HNO_3, $HClO_4$ and H_2SO_4) in ratio of 9 : 3 : 1 as outlined by Piper (1966). Total phosphorus in grains, straw and weeds was determined by the Vanadomolybdate phosphoric yellow colour method in nitric acid system as described by Jackson (1967) and intensity of colour was measured by Spectronic-20 colorimeter at a wavelength of 470 mμ. Total potassium content of grains, straw and weeds was determined with the help of a flame photometer. The N, P and K uptake by wheat (grains and straw) and weeds was calculated by multiplying per cent nutrient content in the tissue with their respective dry matter values and expressed as kg/ha.

RESULTS AND DISCUSSION

Effect on Weeds

Dry matter accumulation by *P. minor* was found to be significantly lower in surface placement of rice straw @ 6 and 7 t/ha treatment as compared to straw removal and incorporation treatments during both the years (Table 1). Placement of rice residues on the soil

Table 1. Influence of rice residue management techniques and weed control treatments on dry matter accumulation by *P. minor*, grain and straw yield of wheat

Treatments	Dry matter accumulation by *P. minor* (g/m^2)*		Grain yield of wheat (kg/ha)		Straw yield of wheat (kg/ha)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques						
No rice residue	9.70 (93.1)	11.23 (125.1)	4631	4399	6862	6629
Rice residue 5 t/ha (surface)	8.16 (65.6)	10.07 (100.4)	4802	4582	6927	6789
Rice residue 6 t/ha (surface)	7.05 (48.7)	8.31 (68.1)	4995	4757	7104	7094
Rice residue 7 t/ha (surface)	6.43 (40.3)	7.81 (60.0)	4901	4622	6932	6854
Rice residue 5 t/ha (incorporation)	9.19 (83.5)	10.78 (115.2)	4756	4537	6909	6755
LSD (P= 0.05)	2.07	2.55	NS	NS	NS	NS
Weed control treatments						
Clodinafop 60 g/ha	5.13 (26.3)	10.93 (119.5)	5278	4758	7449	7089
Sulfosulfuron 25 g/ha	5.07 (25.7)	4.10 (15.8)	5392	5312	7461	7530
Meso + iodo 14.4 g/ha	3.47 (11.0)	3.57 (11.7)	5186	5115	7103	7201
Control	18.81 (352.8)	19.96 (397.4)	3711	3133	5774	5476
LSD (P= 0.05)	1.73	2.03	302	224	665	904

*Data are transformed to $\sqrt{x+1}$. Values in parentheses are original values.
NS–Not Significant.

surface creates improper growing conditions which do not allow the weed seeds to germinate and as a result reduced dry weight of *P. minor* is observed under residue placement treatments (Rahman *et al.,* 2005).

Application of mesosulfuron + iodosulfuron 14.4 g/ha during the first year recorded least dry matter accumulation by *P. minor* which was statistically at par with sulfosulfuron 25 g/ha and clodinafop 60 g/ha (Table 1) but these herbicidal treatments were significantly better than control (unweeded) treatment. During the second year, among the herbicidal treatments clodinafop 60 g/ha failed to control *P. minor* efficiently due to aberrant weather conditions and therefore more dry matter accumulation by *P. minor* was recorded as compared to mesosulfuron + iodosulfuron 14.4 g/ha and sulfosulfuron 25 g/ha which were statistically at par with each other. However, all the herbicidal treatments were significantly better in controlling *P. minor* than control (unweeded) treatment.

Nitrogen, phosphorus and potassium contents in *P. minor* were neither significantly influenced by rice residue management techniques nor by weed control treatments during both the years (Table 2). Regarding N, P and K uptake by *P. minor*, residue removal and incorporation (5 t/ha) treatments, during both the years, recorded significantly higher uptake than surface placement of 5, 6 and 7 t/ha rice straw. In case of K during first year surface placement of rice straw 5 t/ha was statistically at par with incorporation (5 t/ha) treatment (Table 2). Further, surface placement of rice residues 5 t/ha recorded significantly higher N, P and K uptake by *P. minor* than surface placement of 6 and 7 t/ha treatments. In the second crop season in case of N surface placement of 5 t/ha treatment was statistically at par with surface placement of 6 t/ha. The differences in N, P and K uptake by *P. minor* were significant and were mainly due to the variable dry weight accumulation by *P. minor* in different treatments. Higher N, P and K uptake by *P. minor* in residue incorporation and no rice residue treatments was due to higher dry weight of *P. minor* in these treatments as compared to other treatments. All the three herbicidal treatments recorded significantly less N, P and K uptake by *P. minor* than unweeded (control) during both the years. The effect was more pronounced in mesosulfuron+iodosulfuron 14.4 g/ha treated crop as compared to sulfosulfuron 25 g/ha and clodinafop 60 g/ha treatments.

Effect on Crop

Grain and straw yield of wheat crop was not significantly influenced with rice residue management techniques during both the years of investigations (Table 1). Application of sulfosulfuron 25 g/ha recorded the highest grain yield which was statistically at par with clodinafop 60 g/ha and mesosulfuron+iodosulfuron 14.4 g/ha during both the years (Table 1). These treatments were significantly better than control (unweeded) treatment due to less intensity of weeds in herbicide applied plots. The higher grain yield with the application of herbicides could be ascribed to reduction in weed intensity which ultimately helped the crop to utilize nutrients, moisture, light and space more efficiently and hence increased the grain yield.

Regarding straw yield of wheat, sulfosulfuron 25 g/ha, clodinafop 60 g/ha and mesosulfuron+ iodosulfuron 14.4 g/ha were statistically at par (Table 1) and these were significantly better than control (unweeded) crop during both the years, which produced the least straw yield due to suppression of crop by weeds and hence less dry matter accumulation by crop. Although the least dry matter of weeds was observed under mesosulfuron+iodosulfuron 14.4 g/ha than other herbicides but straw yield was less due to suppression of crop due to some phytotoxic effect of the herbicide especially during initial stages.

Wheat grain contained higher phosphorus content than wheat straw, whereas potassium content was higher in wheat straw as compared to wheat grains. Results indicated that neither the rice residue management techniques nor the weed control treatments influenced the nutrient content (N, P and K) of grains and straw significantly (Table 3). However, the herbicidal treatments recorded slightly higher nutrient content in grains as well as straw than control (unweeded).

Rice residue management techniques did not influence the N, P and K uptake by grain and straw significantly during both the years (Table 4). N, P and K uptake by wheat crop was significantly influenced by different weed control treatments during both the years. During the first year, N, P and K uptake by wheat crop (grain+straw) was higher with the application of sulfosulfuron 25 g/ha which was statistically at par with clodinafop 60 g/ha and mesosulfuron+iodosulfuron 14.4 g/ha treatments (Table 4). All the three herbicidal treatments recorded significantly more N, P and K uptake

Table 2. Influence of rice residue management techniques and weed control treatments on N, P and K content and uptake by *P. minor*

Treatments	Nutrient content (%)						Nutrient uptake (kg/ha)					
	N		P		K		N		P		K	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques												
No rice residue	1.14	1.15	0.28	0.27	1.13	1.08	10.63	14.44	2.57	3.41	10.31	13.52
Rice residue 5 t/ha (surface)	1.22	1.08	0.30	0.27	1.18	1.06	8.00	10.83	1.99	2.76	7.76	10.69
Rice residue 6 t/ha (surface)	1.22	1.36	0.33	0.34	1.23	1.24	5.92	9.24	1.59	2.31	5.97	8.42
Rice residue 7 t/ha (surface)	1.26	1.25	0.37	0.36	1.29	1.23	5.55	7.47	1.49	2.13	5.20	7.40
Rice residue 5 t/ha (incorporation)	1.16	1.14	0.30	0.28	1.05	1.10	9.69	13.12	2.49	3.20	8.98	12.69
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	1.63	1.89	0.31	0.37	1.65	1.84
Weed control treatments												
Clodinafop 60 g/ha	1.28	1.05	0.30	0.30	1.34	1.09	3.62	10.16	1.46	2.57	4.29	8.98
Sulfosulfuron 25 g/ha	1.15	1.34	0.30	0.30	1.16	1.20	2.65	2.92	1.25	0.69	2.53	3.24
Meso + iodo 14.4 g/ha	1.32	1.39	0.30	0.31	1.28	1.28	1.62	2.39	0.90	0.59	1.56	2.31
Control	1.10	1.01	0.20	0.30	0.99	1.05	37.69	43.62	8.30	9.82	33.89	41.64
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	1.26	1.39	0.23	0.26	1.33	1.45

NS–Not Significant.

Table 3. Influence of rice residue management techniques and weed control treatments on N, P and K content of wheat

Treatments	Nutrient content (%)											
	N				P				K			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques												
No rice residue	1.85	1.81	0.43	0.44	0.30	0.30	0.20	0.20	0.49	0.48	0.98	1.03
Rice residue 5 t/ha (surface)	1.85	1.86	0.48	0.50	0.31	0.31	0.21	0.21	0.52	0.52	1.04	1.09
Rice residue 6 t/ha (surface)	1.86	1.85	0.50	0.50	0.31	0.31	0.22	0.21	0.54	0.54	1.04	1.08
Rice residue 7 t/ha (surface)	1.88	1.87	0.50	0.51	0.31	0.31	0.22	0.21	0.53	0.53	1.06	1.10
Rice residue 5 t/ha (incorporation)	1.82	1.79	0.46	0.45	0.31	0.30	0.21	0.20	0.52	0.50	1.02	1.07
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed control treatments												
Clodinafop 60 g/ha	1.87	1.82	0.48	0.46	0.31	0.30	0.22	0.20	0.51	0.51	1.07	1.06
Sulfosulfuron 25 g/ha	1.84	1.85	0.48	0.50	0.31	0.31	0.23	0.21	0.52	0.51	1.08	1.09
Meso + iodo 14.4 g/ha	1.88	1.87	0.49	0.51	0.31	0.31	0.23	0.22	0.52	0.52	1.09	1.11
Control	1.83	1.79	0.46	0.44	0.30	0.29	0.20	0.18	0.50	0.50	0.88	1.03
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS–Not Significant.

Table 4. Influence of rice residue management techniques and weed control treatments on N, P and K uptake by wheat

Treatments	Nutrient uptake (kg/ha)											
	N				P				K			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques												
No rice residue	85.82	79.69	29.61	29.23	14.00	13.05	4.94	4.90	22.89	20.99	67.15	68.41
Rice residue 5 t/ha (surface)	88.88	85.31	33.25	33.80	14.85	13.99	5.47	5.50	25.10	23.61	72.00	73.98
Rice residue 6 t/ha (surface)	93.01	88.00	35.45	35.74	15.53	14.56	5.82	5.85	26.85	25.52	74.16	76.27
Rice residue 7 t/ha (surface)	92.04	86.43	34.81	34.66	15.27	14.16	5.61	5.64	25.98	24.68	73.21	75.59
Rice residue 5 t/ha (incorporation)	86.56	81.31	31.51	30.42	14.54	13.70	5.25	5.27	24.77	22.53	70.52	72.23
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed control treatments												
Clodinafop 60 g/ha	96.89	86.59	35.52	32.61	16.42	14.46	5.81	5.53	27.08	24.36	79.92	75.25
Sulfosulfuron 25 g/ha	97.71	98.27	35.81	37.65	16.85	16.38	5.89	6.17	27.71	27.30	80.80	82.34
Meso + iodo 14.4 g/ha	95.94	95.65	35.01	36.73	16.27	15.78	5.75	5.98	26.76	26.29	77.39	79.81
Control	66.79	56.08	25.41	24.09	10.95	8.96	4.22	4.05	18.93	15.92	47.79	55.78
LSD (P= 0.05)	4.86	5.19	1.87	2.06	0.99	1.07	0.31	0.36	1.43	1.49	4.01	4.14

NS–Not Significant.

than control (unweeded) treatment. During second year, clodinafop 60 g/ha failed to control *P. minor* effectively as a result nutrient uptake by *P. minor* was more and by wheat crop was less in this treatment. Higher dry matter production by wheat under herbicidal treatments increased the N, P and K uptake by the herbicide treated crop despite non-significant differences in N, P and K content of grains and straw. Higher N, P and K uptake by wheat crop under herbicidal treatments as compared to control (unweeded) treatment was also reported by Pandey *et al.* (2001).

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