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Rice Residue Position and Load in Conjunction with Weed Control Treatments-Interference with Growth and Development of *Phalaris minor* Retz. and Wheat (*Triticum aestivum* L.)

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ABSTRACT

There is lack of information on the effects of rice residue position and load on the growth and development of *Phalaris minor* Retz. and the efficacy of different herbicides in wheat under different rice residue management situations. The studies revealed that surface application of rice residues @ 6 and 7 t/ha significantly reduced the growth and development of *P. minor* and recorded higher weed control efficiency as compared to incorporation and no rice residue treatments. Application of rice residues @ 6 and 7 t/ha also significantly reduced the emergence of wheat seedlings as compared to rice residue incorporation and no rice residue treatments. Wheat growth parameters, yield attributes, grain and biological yield were statistically at par in all the rice residue management techniques. Application of clodinafop 60 g/ha, sulfosulfuron 25 g/ha and mesosulfuron + iodosulfuron 14.4 g/ha significantly reduced the growth and development of *P. minor* and registered higher weed control efficiency as compared to unweeded control. Consequently, all the herbicidal treatments recorded significantly higher wheat growth parameters, yield attributes, grain and biological yield as compared to unweeded control treatment.

Key words : Herbicide, *Phalaris minor,* residue management, weed control, wheat

INTRODUCTION

Rice (*Oryza sativa* L.)-wheat (*Triticum aestivum* L.) is the major cropping system of India covering 10.0 million hectares under this cropping system, where it covers 75% of the total rice area and 63% of total wheat area (Prasad and Nagarajan, 2004). *Phalaris minor* Retz. (little seed canary grass) is the predominant weed of wheat in this cropping system. Due to continuous use of isoproturon, *P. minor* has developed resistance to this herbicide (Walia *et al*., 1997) and the problem will be further aggravated with the development of multiple and cross resistance to other herbicides. Hence, there is a need to develop an integrated approach for the management of *P. minor*.

After the harvest of paddy crop, enormous quantity of rice residues becomes surplus in the fields as it is a low profile fodder for the animals. This offers a serious problem during the sowing of succeeding wheat crop. These residues are either burnt *in-situ*, removed out of field, left in the field in the form of surface mulch or incorporated in the field by the farmers. Mostly farmers resort to the burning practice as it is straightforward and swift alternative. This practice leads to huge losses of plant nutrients, organic matter, creates environmental pollution and fire hazards, etc. The physical removal of combine harvested crop residue is no longer feasible because of increased labour cost. In order to improve soil health and crop productivity, there is a need for retaining rice residues *in-situ* by surface mulching or by incorporating it in soil. However, incorporation of residues is not admired amongst the farmers because of many problems such as additional tillage requirement for proper seed bed preparation, problem of seed placement, erratic plant population, nutrient immobilization, increased number of pests, incidence of plant pathogens, production of phytotoxins, etc. But these residues can be used for improving soil health and productivity in the long run (Dhiman *et al.,* 2000).

Besides, residue management system has a marked influence on the germination environment of seeds by altering the temperature and moisture of the top soil, weed seed distribution in the profile and the amount of crop residues on the surface of soil (Froud-William, 1988). Many authors have reported differential effect on weed population with different rice residue management techniques. The recommendations regarding chemical control of weeds in wheat are for residue removed situations only. The performance of herbicides may vary under no residues, residue incorporation and surface mulching situations. The reported effects of rice residue management techniques in conjunction with weed control treatments are inconsistence. Keeping these factors in view, the present investigation was undertaken with the aim to know the influence of rice residue management techniques and different herbicides on growth and development of *P. minor* and wheat, and to study the efficacy of different herbicides under different rice residue management techniques.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab (India). 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 techniques in main plots and four weed control treatments in sub-plots. The treatments were replicated three times. The main plots (rice residue management techniques) were no rice residue, rice residues @ 5.0 t/ha (surface), rice residues @ 6.0 t/ha (surface), rice residues @ 7.0 t/ha (surface) and rice residues @ 5.0 t/ha (incorporation). Sub-plots (weed control treatments) comprised post-emergence application 35 days after sowing (DAS) of clodinafop 60 g/ha, sulfosulfuron 25 g/ha, mesosulfuron + iodosulfuron 14.4 g/ha (formulated herbicide) and unweeded control.

After harvesting paddy crop, field was ploughed twice with disc harrow and once with cultivator followed by planking in case of residue incorporation treatment. Other plots were kept as such. The sowing of wheat was done on October 30, 2004 and November 3, 2005 with tractor drawn zero till drill in zero tillage treatments and with ordinary drill in incorporation treatment using seed rate of 100 kg/ha. Light planking was given after sowing to cover the seeds properly with soil. Chopped rice residues were spread uniformly after wheat sowing on the same day as per the treatments. N (125 kg/ha) and 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 (24 DAS).

Post-emergence application of clodinafop, sulfosulfuron and mesosulfuron+iodosulfuron was made 35 DAS (after first irrigation) at their respective doses. A general spray of Algrip 20 WP (metsulfuron) was applied at 25 g/ha a week after treatmental sprays to control broad leaf weeds. Spraying was done with the help of knapsack sprayer fitted with flat fan nozzle. The wheat crop was harvested on 7 April, 2005 and 12 April, 2006 during the first and second year, respectively. Emergence count of wheat was recorded 15 DAS from main plots only as herbicides in sub plots were applied 35 DAS, whereas data on weeds, growth parameters and yield attributes were taken at 120 DAS; however, wheat grain and biological yields were recorded at harvest to draw valid conclusions.

RESULTS AND DISCUSSION

Effect on Weeds

Surface application of rice residues @ 6 and 7 t/ha significantly reduced population, dry matter accumulation and leaf area index (LAI) of *P. minor* as compared to straw removal and incorporation treatments during both the years (Table 1). Assuming the no rice residue treatment as standard check the highest weed control efficiency was registered with surface application of rice residues @ 7 t/ha followed by rice residues @ 6 t/ha, rice residues @ 5 t/ha and rice residues @ 5 t/ha (incorporation) treatments. Application of rice residues on the soil surface creates improper growing conditions which do not allow the weed seeds to germinate and as a result reduced population, dry weight and LAI of *P. minor* were observed under surface application of rice residue treatments (Rahman *et al.,* 2005).

Application of mesosulfuron + iodosulfuron 14.4 g/ha during both the years recorded least population, dry matter accumulation and LAI of *P. minor* which was statistically at par with sulfosulfuron 25 g/ha and clodinafop 60 g/ha (Table 1) and these herbicidal treatments were significantly better than unweeded control treatment. Among the weed control treatments, higher weed control efficiency was recorded with the treatment of mesosulfuron + iodosulfuron 14.4 g/ha followed by sulfosulfuron 25 g/ha and clodinafop 60 g/ha treatments (Table 1). The interaction effects were

Table 1. Influence of rice residue management techniques and weed control treatments on population, dry matter, LAI and weed control efficiency of *Phalaris minor* at 120 DAS

Treatments	Population (No./m^2)		Dry matter (g/m^2)		Leaf area index (LAI)		Weed control efficiency (%)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques								
No rice residue	5.84 (33.1)	6.59 (42.4)	9.70 (93.1)	11.23 (125.1)	1.51 (1.27)	1.63 (1.67)	-	-
Rice residue 5 t/ha (surface)	4.68 (20.9)	6.00 (35.0)	8.16 (65.6)	10.07 (100.4)	1.51 (1.27)	1.63 (1.67)	29.54	19.74
Rice residue 6 t/ha (surface)	3.91(14.3)	4.48 (19.1)	7.05 (48.7)	8.31 (68.1)	1.29 (0.66)	1.39 (0.93)	47.69	45.56
Rice residue 7 t/ha (surface)	3.34(10.2)	4.27 (17.2)	6.43 (40.3)	7.81 (60.0)	1.26 (0.59)	1.34 (0.80)	56.71	52.04
Rice residue 5 t/ha (incorporation)	5.71(31.6)	6.31 (38.8)	9.19 (83.5)	10.88 (117.4)	1.49 (1.22)	1.60 (1.56)	10.31	6.16
LSD (P= 0.05)	1.77	1.81	2.07	2.55	0.197	0.204		
Weed control treatments								
Clodinafop 60 g/ha	3.53 (11.5)	6.90 (46.6)	5.13 (26.3)	10.93 (118.5)	1.20 (0.43)	1.44 (1.08)	92.55	70.18
Sulfosulfuron 25 g/ha	3.15 (8.9)	2.97 (7.8)	5.07 (25.7)	4.10 (15.8)	1.18 (0.04)	1.22 (0.48)	92.72	96.02
Meso+iodo 14.4 g/ha	2.06 (3.2)	2.13 (3.5)	3.47 (11.0)	3.57 (11.7)	1.10 (0.21)	1.11 (0.23)	96.88	97.06
Control (unweeded)	10.04 (99.8)	10.21 (103.2)	18.81(352.8)	19.96 (397.4)	1.90 (2.62)	2.02 (3.07)	-	-
LSD (P=0.05)	1.53	1.59	1.73	2.03	0.107	0.123		

Interaction : All interactions NS.

Data are transformed to $\sqrt{x+1}$. Values in parentheses are original values.

non-significant as all the tried herbicides were equally effective against *P. minor* under different rice residue management techniques. Walia *et al*. (2005) also reported effective control of *P. minor* with the application of sulfosulfuron, mesosulfuron+iodosulfuron and clodinafop as compared to unweeded control.

Effect on Crop

Emergence of crop seedlings during both the years was significantly reduced under surface application of rice residues @ 6 and 7 t/ha as compared to incorporation and residue removal treatments (Table 2). Better germination under no rice residue and incorporation treatments might be attributed to better physical conditions of soil which provided the congenial growing environment for crop (Kumar *et al.,* 2005). Wheat growth parameters (tiller count, plant height and leaf area index), yield attributes (ear length, number of grains/ear and test weight), grain and biological yield were not significantly influenced with rice residue management techniques during both the years of investigation (Table 3). However, numerically rice residues @ 6 t/ha treatment recorded highest wheat growth parameters, yield attributes, grain and biological yield which was followed by rice residues @ 7 t/ha, rice residues @ 5 t/ha, rice residues @ 5.0 t/ha (incorporation) and no rice residue treatments. Surface application of rice residues reduced weed infestation (Table 1) and thus provided favourable environment for crop growth as compared to no rice residue and incorporation treatments. Lower grain yield under surface application of rice residues @ 7 t/ha than rice residues @ 6 t/ha treatments was due to reduced crop germination (Table 2) despite higher control of *P. minor*.

Plant height of wheat was significantly higher under unweeded control treatment than mesosulfuron+ iodosulfuron 14.4 g/ha but was statistically at par with clodinafop 60 g/ha (Table 2) during both the years. Less plant height with the application of herbicides might be due to some suppression effect of herbicides on crop plants and also due to non-competitive conditions, whereas under unweeded control treatment plants were taller due to overcrowding (competition) of plants. Application of sulfosulfuron 25 g/ha, clodinafop 60 g/ha and mesosulfuron+iodosulfuron 14.4 g/ha produced significantly higher wheat leaf area index (LAI) and tiller count than unweeded control crop (Table 2). Herbicide treated crop recorded higher wheat LAI and tiller count as there was less competition with weeds. Chandi (2004) also recorded better growth of wheat under herbicide applied crop as compared to unweeded control.

Sulfosulfuron 25 g/ha, clodinafop 60 g/ha and mesosulfuron+iodosulfuron 14.4 g/ha were statistically at

Table 2. Influence of rice residue management techniques and weed control treatments on emergence and growth parameters of wheat

Treatments	Emergence count (No./m^2)*		Effective tillers (No./m^2)		Plant height (cm)		LAI	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Rice residue management techniques								
No rice residue	198	204	503	488	85.6	83.7	3.11	2.95
Rice residue 5 t/ha (surface)	190	193	523	506	84.9	82.6	3.28	3.12
Rice residue 6 t/ha (surface)	180	181	546	526	83.3	81.8	3.42	3.25
Rice residue 7 t/ha (surface)	168	170	536	512	82.5	81.0	3.36	3.19
Rice residue 5 t/ha (incorporation)	194	195	513	500	85.7	83.7	3.18	3.02
LSD (P= 0.05)	12.0	13.7	NS	NS	NS	NS	NS	NS
Weed control treatments								
Clodinafop 60 g/ha			561	499	84.5	83.2	3.39	3.27
Sulfosulfuron 25 g/ ha			571	569	84.0	82.4	3.44	3.34
Meso + iodo14.4 g/ha			549	553	82.9	80.4	3.32	3.16
Control (unweeded)			417	404	86.1	84.3	2.94	2.79
LSD (P= 0.05)			29.1	32.2	2.2	2.1	0.15	0.21

Interaction : All interactions NS.
*Data were analysed using RBD as emergence count was taken before the application of herbicides.
NS : Not Significant.

Table 3. Influence of rice residue management techniques and weed control treatments on yield attributes and yield of wheat

Treatments	Ear length (cm)		Grains/ear		1000-grain weight		Grain yield (q/ha)		Biological yield (q/ha)	
	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	8.69	8.56	47.19	45.33	39.04	39.58	46.31	43.99	114.9	110.3
Rice residue 5 t/ha (surface)	8.82	8.64	48.27	46.56	40.74	41.95	48.02	45.82	117.3	113.7
Rice residue 6 t/ha (surface)	8.86	8.70	50.05	48.06	42.38	43.84	49.95	47.57	121.0	118.5
Rice residue 7 t/ha (surface)	8.85	8.68	49.45	47.49	43.35	44.84	49.01	46.22	118.3	114.8
Rice residue 5 t/ha (incorporation)	8.72	8.61	47.99	46.38	39.97	41.35	47.56	45.37	116.7	112.9
LSD (P= 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Weed control treatments										
Clodinafop 60 g/ha	8.87	8.66	51.45	47.49	41.79	42.00	52.78	47.58	126.3	117.5
Sulfosulfuron 25 g/ha	8.92	8.80	52.21	51.30	42.17	43.23	53.92	53.12	127.5	128.9
Meso + iodo14.4 g/ha	8.85	8.74	50.51	49.77	42.08	43.18	51.86	51.15	121.9	123.7
Control (unweeded)	8.51	8.35	40.19	38.56	38.34	40.84	37.11	31.33	94.9	86.1
LSD (P= 0.05)	0.21	0.19	4.09	3.91	2.93	NS	3.02	2.24	8.9	9.7

Interaction : All interactions NS.
NS : Not Significant.

par with each other and produced significantly more ear length and number of grains/ear than unweeded control crop (Table 3). Test weight of wheat crop was significantly higher under all the three herbicidal treatments (Table 3) as compared to unweeded control during first year, however, differences were not up to the level of significance during second year. Herbicide treated crop faced less competition from weeds and had a better growing environment thus produced more ear length and grains/ear than unweeded control. Kaur (2005) also reported more ear length and grains/ear of wheat with herbicidal treatments as compared to control treatment.

All the tried herbicides viz., sulfosulfuron 25 g/ha, clodinafop 60 g/ha and mesosulfuron + iodosulfuron 14.4 g/ha were equally effective under all the rice residue management techniques and recorded significantly higher wheat grain and biological yield than unweeded control which recorded the least grain and biological yield during both the years (Table 3). The higher grain and biological yield with the application of herbicides could be ascribed to reduction in weed intensity (Table 1) which ultimately helped the crop to utilize nutrients, moisture, light and space more efficiently. Higher wheat yield with the application of sulfosulfuron 25 g/ha, mesosulfuron+ iodosulfuron 14.4 g/ha and clodinafop 60 g/ha than unweeded control was also reported by Walia *et al.* (2005).

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