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Weed Dynamics and Wheat (*Triticum aestivum* L.) Productivity as Influenced by Planting Techniques and Weed Control Practices

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ABSTRACT

An experiment was conducted at experimental farm of Department of Agronomy, Punjab Agricultural University, Ludhiana (India) during **rabi** seasons of 2004-05 and 2005-06 in a split plot design comprising five planting techniques in main plots (conventional tillage, zero till sowing without stubbles, zero till sowing in standing stubbles, zero till sowing after partial burning and bed planting) and five weed control treatments in sub-plots (clodinafop 60 g/ha, clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha, sulfosulfuron 25 g/ha, mesosulfuron+iodosulfuron 12 g/ha and unweeded control). Reduced dry matter of *Phalaris minor* Retz. and broadleaf weeds and higher wheat grain yield were recorded with zero till sowing in standing stubbles followed by zero till sowing after partial burning and bed planting. Clodinafop 60 g/ha alone controlled *P. minor* but did not control broadleaf weeds. Significantly reduced population of *P. minor* as well as broadleaf weeds and increased grain yield of wheat were observed with post-emergence application of clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha, sulfosulfuron 25 g/ha and mesosulfuron+iodosulfuron 12 g/ha than clodinafop 60 g/ha alone and control. Among the planting techniques, zero till sowing in standing stubbles and among the weeds control practices sulfosulfuron 25 g/ha recorded highest wheat yield.

Key words : Broadleaf weeds, *Phalaris minor*, planting techniques, weed control, wheat

INTRODUCTION

Wheat [*Triticum aestivum* (L.) emend. Fiori and Paol.] occupies prime position among the food crops of the world. Introduction of high yielding dwarf genotypes, improved fertilizer and irrigation facilities coupled with scientific research have led India to the prestigious position in the world in wheat production. Rice (*Oryza sativa* L.)-wheat is the major cropping system of India. The long duration varieties of rice adopted by the farmers leave less time for field preparation between rice harvest and wheat sowing. Several tillage operations are carried out to prepare field to plant wheat after the harvest of transplanted rice. Due to multiplicity of tillage operations and poor rice-stubble management techniques, the sowing of wheat gets delayed leading to decreased grain yield. Delay in wheat sowing beyond 25 November causes 35-40 kg/ha/day reduction in yield (Sharma *et al.*, 1984). Losses caused due to delay in sowing of wheat can be reduced by advancing wheat sowing with zero tillage technology.

In rice-wheat cropping system, wheat is infested by multifarious weed flora comprising both grassy as well as broadleaf weeds causing yield reduction of 15-40% depending upon type and intensity of their infestation (Jat *et al*., 2003). Due to development of resistance in *P. minor* against isoproturon (Malik and Singh, 1995; Walia *et al*., 1997; Singh *et al.*, 1999), the most commonly used herbicide and increasing infestation of broadleaf weeds particularly *Rumex dentatus* L. and *Malva neglecta* Wallr. the management of these weeds has now become a major concern so as to uphold wheat productivity. Many new herbicides viz., clodinafop, fenoxaprop and sulfosulfuron have been found quite promising against *P. minor* (Brar *et al*., 2003; Walia *et al*., 2005). However, these recommendations have been made for weed control in conventional till flat sown situations. The burnt rice straw in the form of ash, organic carbon has been shown to be highly absorptive of herbicides (Walia *et al*., 1999). Moreover, the standing stubbles of rice can also be responsible for intercepting applied herbicides to wheat crop. So, the behaviour of herbicides may vary in standing stubble, partial burning, zero tillage and bed planting techniques. Hence, in the light of such complexities, the present investigation was carried out to study the performance of different herbicides for the control of *P. minor* and broadleaf weeds in wheat under varying planting techniques in rice-wheat rotation.

MATERIALS AND METHODS

A field experiment was conducted during the

rabi seasons of 2004-05 and 2005-06 at the experimental farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana. The soil of the experimental field was loamy sand in texture (sand, silt and clay 76.8, 9.3 and 13.8%, respectively), 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 a split plot design with five wheat planting techniques (conventional tillage, zero till sowing without stubbles, zero till sowing in standing stubbles, zero till sowing after partial burning and bed planting) in main plots and five weed control treatments (clodinafop 60 g/ha, clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha, sulfosulfuron 25 g/ha, mesosulfuron+ iodosulfuron 12 g/ha (formulated herbicide and unweeded control) in sub-plots. The treatments were replicated thrice.

In case of conventional tillage and bed planting, field was ploughed to facilitate the preparation of fine seed bed. Wheat was directly sown in zero tillage treatments without any preparatory tillage after rice harvest. In case of bed planting treatment, beds were prepared with bed planter, which were 67.5 cm wide (37.5 cm bed top and 30 cm furrow). The sowing of wheat was done on 30 October 2004 and 3 November 2005 with tractor drawn zero till/ordinary drill as per treatment using seed rate of 100 kg/ha. Sowing of bed planting treatment was done with tractor drawn bed planter (2 rows/bed) using 75 kg seed/ha. Herbicides (clodinafop, sulfosulfuron and mesosulfuron+ iodosulfuron) were applied as post-emergence (after first irrigation) 35 days after sowing (DAS). 2, 4-D was applied one week after clodinafop application. Spraying was done with the help of knapsack sprayer fitted with flat-fan nozzle. Wheat was raised with recommended package of practices. Crop was harvested on 7 April 2005 and 12 April 2006 during the first and second year, respectively.

Data on population, dry matter accumulation and leaf area index (LAI) of weeds were recorded at 120 DAS. Weed control efficiency was calculated based on dry matter accumulation at 120 DAS. Weed control efficiency for planting techniques was calculated assuming conventional tillage as control treatment. Data on growth parameters, yield attributes and yield of wheat were recorded at harvest to draw valuable conclusions.

RESULTS AND DISCUSSION

Effect on Weeds

The weed flora of the experimental field consisted of both grassy (*Phalaris minor*) and broadleaf weeds like *Rumex dentatus* L., *Anagallis arvensis* L., *Trigonella polycerata* L., *Melilotus alba* L. *Lepidium sativa* L., *Malva neglecta* Wallr. and *Medicago denticulata* Willd.

The population, dry matter accumulation and leaf area index (LAI) of *P. minor* as well as broadleaf weeds were significantly reduced in zero till sowing in standing stubbles, bed planting and zero till sowing after partial burning treatments than zero tillage without stubbles and conventional tillage treatments during both the years (Table 1). Highest weed control efficiency for *P. minor* and broadleaf weeds was recorded under zero till sowing in standing stubbles followed by bed planting, zero till sowing after partial burning and zero till sowing without stubbles during both the years (Table 1). Zero till sowing without stubbles showed negative weed control efficiency during both the years, indicating that there may be problem of broadleaf weeds in zero tillage practice as compared to conventional tillage practice. Zero till sowing in standing stubbles and after partial burning reduced the infestation of both categories of weeds as compared to conventional tillage as rice straw acted as mulch, due to less soil disturbance and loss of viability due to high temperature generated during burning. Mishra *et al*. (2005) also reported lower population and dry matter of weeds under zero tillage as compared to conventional tillage. In case of bed planting drying of bed top reduced the germination of weeds and as a result reduced the population and dry weight of weeds (Yadav *et al*., 2002).

All the herbicidal treatments were statistically at par with each other for population, dry matter accumulation and LAI of *P. minor* during the first year and were significantly superior over unweeded control as all the herbicides proved very effective against *P. minor* (Table 1). During the second year, sulfosulfuron 25 g/ha and mesosulfuron+iodosulfuron 12 g/ha recorded significantly lower population, dry matter and LAI of *P. minor* than clodinafop 60 g/ha alone and clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha treatments. Chandi (2004) also reported more population, dry matter and LAI of *P. minor* under unweeded control than in herbicide applied treatments.

Table 1. Effect of planting techniques and weed control treatments on dry matter, leaf area index and control efficiency of weeds in wheat

Treatments	Population/m² at 120 DAS*				Dry matter (g/m²) 120 DAS*				LAI at 120 DAS*				Weed control efficiency (%)			
	P. minor		Broadleaf weeds		*P. minor*		Broadleaf weeds		*P. minor*		Broadleaf weeds		*P. minor*		Broadleaf weeds	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Planting techniques																
Conventional tillage	7.82	9.51	6.94	7.19	9.32	11.94	13.42	14.08	1.44	1.59	2.02	2.03	-	-	-	-
	(60.2)	(89.5)	(47.1)	(50.7)	(85.9)	(141.6)	(179.0)	(197.3)	(1.08)	(1.52)	(3.06)	(3.13)				
Zero till sowing	7.11	8.49	7.17	7.21	8.81	11.33	13.84	14.32	1.38	1.54	2.07	2.05	17.61	10.73	-7.01	-0.59
(without stubbles)	(49.6)	(79.9)	(50.4)	(51.0)	(76.6)	(127.4)	(190.5)	(204.1)	(0.89)	(1.36)	(3.28)	(3.21)				
Zero till sowing	5.21	6.95	5.17	5.32	6.84	9.25	10.14	10.72	1.21	1.34	1.63	1.65	56.48	47.26	45.44	46.15
(in standing stubbles)	(26.2)	(47.2)	(25.7)	(27.3)	(45.8)	(84.5)	(101.7)	(113.9)	(0.47)	(0.80)	(1.67)	(1.72)				
Zero till sowing after partial	5.66	7.49	5.56	5.62	7.25	9.72	10.82	11.45	1.25	1.39	1.72	1.73	48.50	38.44	36.52	39.64
burning (Farmers' practice)	(31.0)	(55.1)	(29.9)	(30.6)	(51.6)	(93.4)	(116.0)	(130.2)	(0.56)	(0.94)	(1.94)	(2.00)				
Bed planting	5.43	7.20	5.27	5.44	7.01	9.42	10.33	10.94	1.23	1.37	1.66	1.67	52.82	43.24	43.10	43.59
	(28.4)	(50.8)	(26.8)	(28.6)	(48.1)	(87.7)	(105.7)	(118.8)	(0.51)	(0.86)	(1.74)	(1.80)				
LSD (P=0.05)	1.41	1.47	1.36	1.47	1.41	1.58	2.19	2.22	0.124	0.129	0.24	0.26	-	-	-	-
Weed control treatments																
Clodinafop 60 g/ha	4.35	7.24	8.84	8.98	5.46	9.35	17.25	17.61	1.15	1.37	2.45	2.45	86.67	71.71	7.99	10.96
	(17.9)	(51.4)	(77.2)	(79.6)	(28.8)	(86.4)	(296.5)	(309.0)	(0.32)	(0.87)	(5.02)	(5.01)				
Clodinafop 60 g/ha	4.42	7.52	2.80	2.77	5.54	9.62	5.37	5.23	1.15	1.39	1.20	1.19	86.15	69.40	91.78	92.54
fb 2, 4-D 0.5 kg/ha	(18.6)	(55.6)	(6.9)	(6.67)	(29.6)	(91.5)	(27.9)	(26.3)	(0.33)	(0.95)	(0.45)	(0.42)				
Sulfosulfuron 25 g/ha	4.28	5.05	2.95	3.19	5.36	6.50	5.67	5.67	1.14	1.19	1.22	1.26	87.12	86.52	90.82	89.72
	(17.3)	(24.5)	(7.7)	(9.19)	(27.7)	(41.2)	(22.9)	(31.2)	(0.31)	(0.42)	(0.50)	(0.58)				
Mesosulfuron+	2.87	3.21	2.26	2.09	3.55	4.07	4.19	3.76	1.06	1.08	1.13	1.10	94.64	94.88	95.11	96.20
iodosulfuron 12 g/ha	(7.2)	(9.3)	(4.1)	(3.4)	(11.6)	(15.6)	(16.6)	(13.1)	(0.13)	(0.16)	(0.27)	(0.21)				
Control (unweeded)	11.63	13.52	9.21	9.51	4.54	17.34	17.94	19.51	1.85	2.02	2.54	2.58	-	-	-	-
	(134.3)	(181.7)	(83.9)	(89.4)	(210.3)	(299.8)	(320.9)	(379.6)	(2.42)	(3.09)	(5.45)	(5.63)				
LSD (P=0.05)	2.26	2.46	1.94	2.11	2.21	2.49	2.33	3.26	0.093	0.108	0.22	0.23	-	-	-	-

Interactions : Non-significant.
*Data are transformed to $\sqrt{x+1}$. Values in the parentheses are original.
fb–followed by.

Table 2. Effect of planting techniques and weed control treatments on growth, yield attributing characters and yields of wheat

Treatments	Dry matter accumulation (t/ha)		LAI at 120 DAS		Grains/ ear		Test weight (g)		Grain yield (kg/ha)		Straw yield (kg/ha)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Planting techniques												
Conventional tillage	10.53	9.65	3.11	2.98	46.65	45.44	39.39	38.88	4454	4156	6670	6148
Zero till sowing (without stubbles)	10.71	10.04	3.14	3.02	47.26	46.11	40.73	39.72	4518	4238	6761	6325
Zero till sowing (in standing stubbles)	11.82	11.09	3.41	3.22	50.61	49.45	44.17	42.56	4885	4637	7148	6759
Zero till sowing after partial burning (Farmers' practice)	11.61	11.33	3.37	3.18	49.91	48.58	42.86	41.17	4806	4586	7016	6921
Bed planting	11.04	10.48	3.24	3.12	48.70	47.83	43.33	41.99	4634	4383	6767	6346
LSD (P= 0.05)	0.87	0.89	0.18	0.15	2.34	2.46	2.09	NS	282	338	NS	581
Weed control treatments												
Clodinafop 60 g/ha	11.15	10.30	3.11	3.00	47.16	45.10	41.48	40.08	4607	4331	6935	6489
Clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha	12.30	11.22	3.51	3.21	50.92	48.11	42.91	41.54	5312	4783	7477	6624
Sulfosulfuron 25 g/ha	12.42	12.29	3.57	3.45	51.31	51.26	43.39	42.12	5373	5238	7550	7384
Mesosulfuron+iodosulfuron 12 g/ha	11.99	11.77	3.48	3.37	50.02	50.57	43.06	41.97	5091	5023	7125	7181
Control (unweeded)	7.86	7.01	2.59	2.51	43.72	42.37	39.64	38.62	2914	2624	5275	4751
LSD (P= 0.05)	0.51	0.53	0.14	0.13	1.78	1.83	1.38	1.26	287	236	456	463

Interactions : Non-significant.
fb–followed by.

Clodinafop 60 g/ha alone did not control broadleaf weeds, while all other herbicidal treatments were statistically at par with each other regarding population, dry matter accumulation and LAI of broadleaf weeds (Table 1). The highest weed control efficiency of 94.64 and 94.88% during first and second year, respectively, for *P. minor* was recorded with mesosulfuron+iodosulfuron 12 g/ha followed by sulfosulfuron 25 g/ha (87.12 and 86.52%), clodinafop 60 g/ha alone (86.67 and 71.71%) and clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha (86.15 and 69.40%). Regarding broadleaf weeds, the highest weed control efficiency (95.11 and 96.20%) was recorded with mesosulfuron+ iodosulfuron 12 g/ha followed by clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha (91.78 and 92.54%), sulfosulfuron 25 g/ha (90.82 and 89.72%) and clodinafop 60 g/ha alone (7.99 and 10.96%) during first and second year, respectively.

Effect on Crop

Zero till sowing in standing stubbles and after partial burning treatments were statistically at par with bed planting and recorded significantly higher dry matter, LAI, grains/ear, test weight (1000-grain weight) and grain yield of wheat than zero tillage without stubbles and conventional tillage treatments during both the years (Table 2). Higher growth parameters, yield attributes and grain yield under zero till sowing in standing stubbles, zero till sowing after partial burning and bed planting treatments were due to less weed infestation (Table 1) and favourable conditions for crop growth. Bacon and Cooper (1985) also recorded higher yield with zero till sowing in standing stubbles.

Zero till sowing in standing stubbles and after partial burning treatments produced significantly more straw yield than conventional tillage treatment (Table 2). Zero till sowing in standing stubbles, bed planting and zero tillage without stubbles treatments were statistically at par with each other.

Highest crop dry matter accumulation, LAI, highest grains/ear and test weight were recorded with sulfosulfuron 25 g/ha which were statistically at par with clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha and mesosulfuron+iodosulfuron 12 g/ha and these treatments recorded significantly more dry matter, LAI, highest grains/ear and test weight than clodinafop 60 g/ha alone as well as unweeded control treatment during first year (Table 2). Further, clodinafop 60 g/ha alone recorded significantly higher dry matter, LAI of crop, highest grains/ear and test weight than unweeded control.

Application of sulfosulfuron 25 g/ha recorded highest grain and straw yield of wheat during both the years. It was statistically at par with clodinafop 60 g/ha fb 2, 4-D 0.5 kg/ha and mesosulfuron+ iodosulfuron 12 g/ha and these three treatments were significantly better than clodinafop 60 g/ha alone and unweeded control treatments (Table 2). Among the different herbicides, clodinafop 60 g/ha recorded lower grain and straw due to infestation with broadleaf weeds, low dry matter production by crop and lower yield attributes as compared to other herbicidal treatments. During the second year, clodinafop treated plots recorded lower wheat grain yield than first year because during 2005-06, it failed to control the *P. minor* efficiently (Table 1) which reduced the yield of crop.

Among different planting techniques, zero till sowing in standing stubbles, partial burning and bed planting techniques significantly reduced the growth and development of *P. minor* as well as broadleaf weeds than conventional tillage and zero tillage treatments. Zero till sowing in standing stubbles and partial burning recorded significantly higher growth parameters, yield attributes and grain yield of wheat as compared to conventional tillage and zero tillage techniques. Mesosulfuron+iodosulfuron, sulfosulfuron and clodinafop fb 2, 4-D were quite effective against *P. minor* and broadleaf weeds and thus recorded more grain yield of wheat as compared to clodinafop alone and unweeded control treatment. As there was no interaction effect between planting techniques and weed control treatments, all the herbicides were equally effective in all the planting techniques.

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