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Potency of Trifluralin, Chlorsulfuron and their Tank Mixture against Isoproturon Resistant *Phalaris minor* Retz.

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Littleseed canary grass (*Phalaris minor* Retz.) is the major weed of wheat in the rice-wheat cropping systems of north-western India. Continuous use of isoproturon, faulty application methods and the monotonous cropping systems (rice and wheat) resulted in the development of resistance in *P. minor* against isoproturon in north-west India (Malik and Singh, 1995) and four alternate post-emergence herbicides (clodinafop-propargyl, fenoxaprop-p-ethyl, sulfosulfuron and tralkoxydim) were recommended for the control of resistant biotypes of *P. minor*. But cross-resistance in few biotypes of *P. minor* against fenoxaprop, diclofop-methyl and a lower level of cross-resistance with clodinafop and sulfosulfuron has also been reported which warrants the situation further for their proper application. From the reports available so far, it is expected that the possibilities of development of cross-resistance are less in dinitroanilines based compounds (Holts *et al.*, 1993). Hence, present investigation was conducted to evaluate the potency of trifluralin, chlorsulfuron and their tank mixture against both resistant (R) and susceptible (S) biotypes of *P. minor*.

Pot culture experiments at CCSHAU, Hisar were conducted during winter season of 2001. Experiments included six different doses of trifluralin, chlorsulfuron and trifluralin+chlorsulfuron in the ratio of 25 : 1. Two isoproturon R biotypes (Karnal and Kaithal) and one isoproturon S biotype (Charkhi) of *P. minor* were selected for the study. Twenty seeds/pot (30 cm height and 15 cm top radius filled with sandy loam soil) were sown. Each herbicide was used as pre-plant incorporation (PPI) before sowing of *P. minor*, pre-emergence (Just after sowing of seeds but not incorporated in soil) and post-emergence (30 days after sowing at 2-3 leaf stage) by knapsack sprayer at spray volume of 600 l ha^{-1}. Each treatment was replicated three times and pots were arranged in completely randomized design. Harvests were made at an interval of 62 days from seeding. Foliage dry weights were obtained by clipping the plants at the soil surface and drying in oven. The data were compared with untreated control. The data were then subjected to one way of analysis of variance (ANOVA) and the treatment means were separated using Duncan's Multiple Range Test. GR_{50} value was calculated by using probit analysis (Finney, 1971).

Trifluralin

PPI or pre-emergence application of trifluralin was more effective as compared to its post-emergence application against *P. minor* but PPI was most effective (Table 1). Trifluralin applied as PPI was found very effective for the control of both R and S biotypes of *P. minor* at very low dose (62.5 g ha^{-1}). Trifluralin caused 100% reduction in foliage dry weight at 125 g ha^{-1} in both R and S biotypes of *P. minor* if applied as PPI and at 500 g ha^{-1} applied as PRE (Table 1). Trifluralin applied as POE did not give satisfactory control of *P. minor* biotypes. In PPI or PRE applied trifluralin, no remarkable differences in the activity of trifluralin against S (Charkhi) and R biotypes (Karnal and Kaithal) were observed at all the doses tested (Table 1).

Chlorsulfuron

PPI or PRE application of chlorsulfuron gave higher control than POE application (Table 1). S biotype (Charkhi) was found more sensitive than R biotypes 'Karnal' and 'Kaithal' to chlorsulfuron as PPI (Table 1). At 40 g ha^{-1}, 91, 85 and 82% reduction in foliage dry weight was obtained in Charkhi, Karnal and Kaithal biotypes, respectively. The S biotype (Charkhi) required 1.32 g ha^{-1} chlorsulfuron for 50%

Table 1. Relative foliage dry weight (% of untreated) per pot of *Phalaris minor* biotypes at 62 DAS as influenced by trifluralin, chlorsulfuron and their tank mixture applied as PPI, PRE and POE

Dose (g ha^{-1})	PPI			PRE			POE		
	Charkhi	Karnal	Kaithal	Charkhi	Karnal	Kaithal	Charkhi	Karnal	Kaithal
				Trifluralin					
0	100a	100a	100a	100a	100a	100a	100abc	100abc	100abc
62.5	1.34b	0.55b	12.8b	45ab	22cd	42bc	112ab	100abc	99abc
125	0b	0b	0.15b	22cd	12cd	20cd	96abc	98abc	127a
250	0b	0b	0.55b	1.5d	0d	13cd	85abcd	95abc	110ab
500	0b	0b	0b	0d	0d	0d	75abcd	80abcd	85abcd
1000	0b	0b	0b	0d	0d	0d	42cd	45cd	50cd
				Chlorsulfuron					
0	100a	100a	100a	100a	100a	100a	100a	100a	100a
2.5	38bcd	60abc	62.4ab	91abc	84abc	122a	78abcd	67bcde	101abc
5.0	29bcd	54abcd	59abcd	49bcd	54bcd	82abc	50def	55cdef	105ab
10.0	30bcd	37bcd	55abcd	41bcd	53bcd	45bcd	41def	52cdef	122a
20.0	9cd	36bcd	37bcd	25cd	35bcd	25cd	28ef	39def	86abcd
40.0	7d	15bcd	18bcd	9d	9d	9d	14f	22ef	56bcde
GR_{50}	1.32	5.37	7.22	7.54	8.73	10.97	6.91	7.95	42.6
				Trifluralin+Chlorsulfuron (25 : 1)					
0	100a	100a	100a	100a	100a	100a	100ab	100ab	100ab
62.5	9.5bc	0c	33b	16b	4.4b	36b	121a	86ab	81ab
125	0c	0c	4c	0b	0b	0.47b	64abc	79ab	67abc
250	0c	0c	0c	0b	0b	0b	47bc	77ab	67abc
500	0c	0c	0c	0b	0b	0b	16.5c	53bc	68abc
1000	0c	0c	0c	0b	0b	0b	Absent	16c	15c

Means followed by the same letter are not significantly different at the 5% level of significance using Duncan's Multiple Range Test.

reduction in foliage fresh weight; in contrast to R biotypes Karnal and Kaithal which required 5.37 and 7.22 g ha^{-1} chlorsulfuron for same level of control applied as PPI. No significant difference was observed in the reduction of foliage dry weight among the biotypes tested in the experiment when chlorsulfuron was applied as PRE (Table 1). About 90% reduction in foliage dry weight was recorded among all the biotypes of *P. minor* due to chlorsulfuron at 40 g ha^{-1} as PRE. S-biotype was found relatively more sensitive than R biotypes irrespective of time of application but cross-resistance could not be demonstrated against chlorsulfuron in any of *P. minor* biotypes.

Trifluralin+Chlorsulfuron

Herbicide mixture of different modes of action has been postulated as a key to delay/avert and manage the resistance (Wrubel and Gressel, 1994), however, they were of limited success. Mixture of trifluralin and chlorsulfuron was found very effective in controlling both R and S biotypes of *P. minor* when applied as PPI or PRE (Table 1). This tank mixture was more effective than their sole application irrespective of their time of application (Table 1). When mixture was applied POE, differential responses among the biotypes were observed; R biotypes Karnal and Kaithal were more tolerant than S biotype. Similar trends but with higher reduction in dry weight were also observed due to chlorsulfuron POE. Mixture when applied as PPI or PRE caused 100% reduction in dry weight at 125 g ha^{-1} and above both in R and S biotypes of *P. minor*. No significant differences were observed in the response of R and S biotypes of *P. minor* against tank mixture of trifluralin and chlorsulfuron when applied as PPI and PRE.

Trifluralin could be an effective tool for the control of R and S biotypes of *P. minor* as PPI or PRE. Tank mixture of trifluralin and chlorsulfuron resulted in very effective control of both R and S biotypes of *P. minor* when applied as PPI or PRE. Future research under field situations is needed to verify the present results also to quantify the balance between the *P. minor* control and crop injury.

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