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Performance of metsulfuron methyl and pendimethalin alone and their mixtures with isoproturon on weed control in wheat (*Triticum aestivum*) seed crop

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ABSTRACT

A field experiment was conducted during the winter seasons of 1996–97 and 1997–98 to study the comparative performance of different herbicides, their combinations and their reduced doses for weed control in wheat (*Triticum aestivum* L. emend. Fiori & Paol.) seed crop. Unchecked weeds caused nearly 37.7% seed yield loss. Maximum seed yield of 39.9 and 33.66 q/ha was recorded in weed-free treatment respectively during both the years. This high-yielding treatment was significantly at par with sequential application of herbicides and herbicide mixture but was statistically significant to full and half doses of Pendimethalin and Metsulfuron methyl in both the years. Pendimethalin @ 1.0 kg a.i./ha and Metsulfuron @ 0.008 kg a.i./ha significantly increased seed yield over unweeded control. Reduced dose of Isoproturon @ 0.5 kg a.i./ha, Pendimethalin @ 0.5 kg a.i./ha and Metsulfuron @ 0.004 kg a.i./ha was least effective in controlling weeds and had minimum impact on enhancing seed yield over the control.

Key words : Weed management, Wheat seed crop, Herbicides

Seed is the basic input in the agronomy of any crop. Without good seed the investment on the fertilizer and water will not pay the dividend which ought to be obtained. About 30–40% of the applied nutrients remove by weeds for their growth and development (Dryden and Krishnamoorthy, 1977). Effective weed-control measure increases the uptake of nutrients by the crop and decreases the removal through weeds (Rathi and Tiwari, 1981).

Wheat like other crops is also infested with mixed stands. The spectrum of weed flora is changing in such a way that many types of weeds infest the crop. Isoproturon is a recommended herbicide for the management of wild canary grass (*Phalaris minor* Retz.). When the field is infested with complex weed flora of grasses and broad-leaved weeds, the unacceptable control of complex weeds due to single herbicide re-

sults in significant loss in seed yield of wheat. Metsulfuron methyl has been found effective against most of broad-leaved weeds and problem weeds especially canada thistle *Cirsium arvense* L). Pendimethalin is effective against broad-leaved and *Phalaris minor* (L.) Retz., but ineffective in controlling problem weeds. For the control of such complex weed flora these, 2 herbicides may need to be mixed with Isoproturon to improve their efficacy. In the present investigation an attempt was made to test the feasibility of herbicides in recommended doses, combining grass herbicides with broad-leaf weed killer and their reduced doses.

MATERIALS AND METHODS

A field experiment having 10 treatment combinations (Table 1) with 4 replications was conducted in randomized block design during the winter seasons of 1996–97 and 1997–98 at Baraut, on sandy-loam soils having 0.42–0.47% organic carbon, 17.23 – 21.75 kg available P_2O_5/ha and 238–241 kg available K_2O/ha, with pH 7.8. 'HD 2329' wheat for seed crop was sown in lines 22.5 cm apart on 29 and 25 November in 1996 and 1997 respectively. Herbicides were sprayed using volume spray of 600 litres/ha with the help of knap-sack sprayer fitted with flat-fan nozzle. Post-emergence application (Isoproturon and Metsulfuron methyl) was done after 30 days after sowing (DAS).

Basal dose of nitrogen was applied @ 40 kg/ha at the time of sowing. Remaining dose of N was applied in 2 splits, 30 kg N each after the first and second irrigation. Three roguing were done to bring the seed plot to seed certification standards.

The data on total weed population, weed population (species-wise (no./0.5 m^2) and per cent control were counted 90 days after sowing from 2 random places from each plot, using quadrate of 50 cm × 50 cm. Data on weed population count showed considerable variation, hence were subjected to square-root transformation. The treatment means computed from original values are provided along with transformed means.

RESULTS AND DISCUSSION

Weed spectrum

The experimental field was infested with both grassy and broad-leaf weeds. *Phalaris minor* was the most predominant weed among *Melilotus indica* (L.) All., *Fumaria parviflora* Lam., *Chenopodium album* L., *Anagallis arvensis* L., *Cirsium arvense* L. and *Rumex dentatus* L. Among the sedges, *Cyperus rotundus* L. was present. The other grassy and broad-leaved weeds, *Poa annua* (L.) Desf., *Convolvulus arvensis* L. *Medicago denticulata* Willd., *Spergula arvensis* L. and *Coronopus didymus* were present in few numbers.

Weed population and weed dry weight

Weed-control methods significantly lowered the total weed population and total dry weight of weeds over weedy check during both the years. Maximum weed population and weed weight in unweeded check were the results of the uncontrolled weed growth. As Isoproturon is a persistent herbicide which on application @ 0.75 kg a.i./ha as post-emergence gave season-long

weed-free conditions and ultimately resulted in lower weed dry weight. The results are in accordance with the findings of Pandey *et al.* (1996).

The cumulative effect of Isoproturon @ 0.5 kg a.i. /ha with pendimethalin @ 0.5 kg a.i. / ha as sequential application and Isoproturon @ 0.5 kg a.i. / ha + Metsulfuron methyl @ 0.004 kg/ a.i. / ha as mixture application also produced significant effect on total weed population and total weed dry weight compared with weedy check and reduced doses of herbicides during both the years. Using herbicide mixtures in lower optimum doses reduces the cost of weed management, arrests weed shifts, prevents herbicide resistance in weeds and facilitates improvement in overall weed management (Rao, 1993).

Species-wise population of weeds

Application of Isoproturon @ 0.75 kg a.i. /ha controlled wild canary grass effectively (Table 2). It also reduced the population of *Chenopodium album, Fumaria parviflora, Anagalis arvensis, Melilotus indica* and *Rumex dentatus* during both the years. Application of Isoproturon @ 0.75 also suppressed the growth of *Poa annua* and proved effective. The results confirm the finding of Kumar and Singh (1997).

Application of pendimethalin @ 1.0 kg a.i./ha controlled *Chenopodium album* most effectively. It was also found effective against *Phalaris minor, Anagalis arvensis, Melilotus indica* and *Fumaria parviflora* (Table 3). However, it had less ability in controlling *Rumex dentatus* weed, which

Table 1. Influence of different herbicides and their combinations on total weed population and total weed dry weight in wheat 90 days after sowing

Treatment	Dose (kg a.i./ha)	Total weed population / 0.5 m²		Total weed dry weight (g)/0.5m²	
		1996–97	1997–98	1996–97	1997–98
Pendimethalin	1.0	(73)* 8.60	(85) 09.27	34.25	45.57
Isoproturon	0.75	(46) 6.85	(68) 08.27	16.31	28.98
Metsulfuron methyl	0.008	(78) 8.86	(86) 09.32	36.20	50.63
Isoproturon + Pendimethalin	0.5 + 0.5	(70) 8.39	(84) 09.20	30.18	40.43
Isoproturon + Metsulfuron methyl	0.5 + 0.004	(70) 8.43	(84) 09.21	30.81	43.54
Pendimethalin	0.5	(89) 9.49	(114) 10.70	40.30	57.88
Isoproturon	0.5	(85) 9.27	(105) 10.27	36.55	51.87
Metsulfuron methyl	0.004	(93) 9.54	(118) 10.88	44.81	62.69
Weed-free	-	(0) 1.00	(0) 1.00	00.00	00.00
Weedy check		(130) 11.44	(178) 13.36	60.17	90.95
CD (P = 0.05)		0.90	00.41	03.03	05.21

Table 2. Influence of different herbicides and their combinations on per cent control of different weeds in wheat at 90 days after sowing

Treatment	Dose (kg a.i./ha)	Percent control													
		P. minor		*M. indica*		*C. album*		*F. parviflon*		*C. arvense*		*R. dentatus*		*A. arvensis*	
		1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98	1996–97	1997–98
Pendimethalin (Pendi.)	1.0	52.91	45.53	25.82	42.04	96.24	94.40	38.57	21.25	03.57	11.11		12.5	35.41	78.12
Isoproturon (Iso.)	0.75	86.60	87.95	38.72	37.47	68.39	82.91	44.04	38.67	21.42	24.22		37.5	48.60	38.14
Metsulfuron methyl	0.008	30.71	20.05	59.80	67.30	64.38	71.73	68.97	55.11	100	100		62.5	49.99	79.64
Iso. + Pendi.	0.5 + 0.5	50.84	60.75	25.70	41.05	78.07	72.04	53.70	26.79	10.71	11.11		37.5	25.69	47.83
Iso. + Metsulfuron methyl	0.5 + 0.004	42.00	50.07	46.57	57.58	60.95	50.17	59.47	54.66	42.85	33.33		62.5	34.37	46.47
Pendimethalin	0.5	35.29	18.62	19.80	46.45	84.32	60.55	23.0	16.46	03.57	0		12.5	24.30	36.05
Isoproturon	0.5	50.78	44.10	15.65	34.82	44.86	43.74	3.86	16.65	14.28	11.11		25.0	22.91	24.35
Metsulfuron methyl	0.004	15.52	10.41	37.40	41.87	26.43	44.37	40.49	43.83	42.85	77.7		50.0	35.76	47.67
Weed-free		100	100	100	100	100	100	100	100	100	100		100	100	100
Weedy check		0	0	0	0	0	0	0	0	0	0		0	0	0

might be due to delay in germination and or emergence of *Rumex dentatus* when herbicide became ineffective. The better control of *Chenopodium album* and *P. minor* in terms of density and dry weight due to pre-emergence application of Pendimethalin could be explained on the basis of the fact that maximum uptake of dinitroanilines and better entry of herbicide as soon as weeds have emerged. Pandey *et al.* (1996) reported Pendimethalin at 1.0 to 1.5 kg/ha very effective against *Chenopodium album* and *P. minor* in wheat.

Metsulfuron methyl @ 0.008 kg a.i. /ha controlled the weed *Cirsium arvense* 100% (Table 2). It kills almost all the tender and aged plants of *Cirsium arvense*. Besides, the growth of grassy weeds was checked for a month and gave excellent control of broad-leaved weeds. Pandey and Singh (1994) and Panwar *et al.* (1996) also reported excellent control of these weeds.

Sequential application of Pendimethalin @ 0.5 kg a.i./ha pre-emergence and Isoproturon @ 0.5 kg a.i./ha as post-emergence or application of Isoproturon @ 0.5 kg a.i./ha in combination or metsulfuron-methyl @ 0.004 kg a.i./ ha controlled complex weed flora. It is desirable to incorporate the strength of 2 herbicides into 1 complementary mixture. Rao (1993) and Panwar *et al.* (1996) also had the similar opinion.

Effect on crop

Minimum seed yield of 24.8 and 21.05 q/ha was recorded in weedy check treatment respectively during both the years. Computation of yield variation revealed that there was nearly 37.8 and 37.5% seed yield loss compared to weed-free conditions in both the years. It was because of severe weed–crop competition in weedy check, as evident from the data on population and dry matter of weed. Severe infestation of weeds resulted in lower number of effective tillers and low spike weight and consequently significant reduction in seed yield. The results are in accordance with the findings of Panwar (1996) and Kumar *et al.* (1996).

Maximum seed yield was recorded in weed-free treatment. Higher seed yield was attributed to more number of effective tillers, spike weight/spike and weed-free environments. Application of Isoproturon @ 0.75 kg a.i./ha recorded the highest seed yield among all herbicidal treatments, since weeds dominated the experimental field were susceptible to Isoproturon which resulted in the lowest dry matter of weeds among the herbicidal treatments and highest weed-control efficiency.

This high-yielding treatment was significantly at par with weed-free season long and sequential application of herbicides and herbicide mixture but was statistically significant to full and half doses of Pendimethalin and Metsulfuron methyl.

Pendimethalin @ 1.0 kg a.i. /ha and metsulfuron @ 0.008 kg a.i./ha significantly increased seed yield over the unweeded control. The increased seed yield recorded by application of herbicides was owing to increased spikes/m row length and seed weight/spike which may be reflected owing to increase in the availability of nutrients, water, light and space which provide congenial environment for the development of crop.

Application of herbicides in sequence

Table 3. Influence of different herbicides and their combinations on weed-control efficiency, yield and weed index in wheat

Treatment	Dose (kg a.i./ ha)	Weed-control efficiency (%)		Weed index (%)		Seed yield (q/ha)	
		1996–97	1997–98	1996–97	1997–98	1996–97	1997–98
Pendimethalin	1.0	43.07	49.89	18.04	21.68	32.70	26.36
Isoproturon	0.75	72.89	68.13	06.01	05.76	37.50	31.72
Metsulfuron methyl	0.008	39.83	44.33	23.30	22.99	30.60	25.92
Isoproturon + Pendimethalin	0.5 + 0.5	49.84	55.54	12.28	13.30	35.00	29.18
Isoproturon + Metsulfuron methyl	0.5 + 0.004	48.79	52.13	14.03	14.97	34.30	28.62
Pendimethalin	0.5	33.02	36.36	28.07	28.55	28.70	24.05
Isoproturon	0.5	39.25	42.96	27.31	25.46	29.00	25.09
Metsulfuron methyl	0.004	25.52	31.07	33.08	30.77	26.70	23.30
Weed-free		100	100			39.90	33.66
Weedy check				37.84	37.46	24.8	21.05
CD (P=0.05)						4.86	2.73

Isoproturon + Pendimethalin @ 0.5 + 0.5 kg a.i./ha and herbicides in mixtures Metsulfuron + Isoproturon methyl @ 0.5 + 0.004 kg a.i./ha exhibited the seed yield at par with full dose of Isoproturon @ 0.75 kg a.i./ha but recorded more seed yield than Metsulfuron @ 0.008 kg a.i./ha and Pendimethalin @ 1.0 kg a.i./ha. Similar findings in respect of tank mixture performance on seed yield were also reported by Singh and Malik (1994) and Singh *et al.* (1997). During both the years reduced dose of Isoproturon @ 0.5 kg a.i./ha, Pendimethalin @ 0.5 kg a.i./ha and Metsulfuron @ 0.004 kg a.i./ha resulted in low seed yields than their higher doses. Lowest yield in Metsulfuron @ 0.004 kg a.i./ha may be due to less number of effective tillers and lower weed-control efficiency. These results imply that manipulation in reduced rate of these herbicides could not provide an alternative to recommended rates of herbicides.

Weed index

The weed index which express the competition offered by weeds as measured by % reduction in the yield. Minimum reduction in yield (6.01 and 5.76%) due to competition offered by weeds in plots treated with Isoproturon @ 0.75 kg a.i./ha as compared with weed-free treatment during both the years. This was followed by Isoproturon + Metsulfuron @ 0.5 + 0.004 kg a.i./ha and Isoproturon + Pendimethalin @ 0.5 + 0.5 kg a.i./ha in which yield reduction was 14 and 12 % in 1996–97 and 15 and 13% in 1997–98.

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