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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

NISHA CHOPRA[1], HARPAL SINGH, H.P. TRIPATHI AND N.K. CHOPRA

Department of Agronomy, J.V. College, Choudhary Charan Singh University, Baraut, Meerut, Uttar Pradesh 250 611

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ABSTRACT

A field experimental was conducted during the winters 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 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 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 @ 0.05 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

Growing wheat year after year in the same field under high levels of fertilizer and irrigation has led to the development of high infestations of the crop with grassy weed, *viz.* wild canary grass (*Phalarisminor* Retz.). Isoproturon is a recommended herbicide for the management of wild canary grass. Its efficacy against broad-leaf weeds is less than against wild canary grass. 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 results 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.) Scop.] and

Present address: [1]Research Station, IARI, Karnal, Haryana 132 001

objectionable weed field bindweed (*Convolvulus arvensis* L.). Pendimethalin is effective against broad-leaved and *Phalaris minor* 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 season of 1996–97 and 1997–98 at Baraut, on sandy-loam soil 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 during 29–25 November in 1996 and 1997 respectively. Herbicides were sprayed using volume spray of 600 litres/ha with the help of knapsack sprayer fitted with flat-fan nozzle. Pre-emergence application (Pendimethalin) was done immediately after sowing, whereas post-emergence application (isoproturon and metsulfuron methyl) was done 30 days after sowing.

Basal dose of N, P_2O_5 and K_2O applied was @ 40, 60 and 40 kg/ha, respectively, at the time of sowing. Remaining dose of N was applied in 2 splits, 30 kg N each after first and second irrigation. Roguing was done 3 times 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 control % were counted at 90 days from 2 random places from each plot using quadrat of 50 cm × 50 cm. Data on weed population count showed considerable variation, hence were subjected to square-root transformation (n + 1) where (n, is actual weed count) before statistical analysis.

RESULTS AND DISCUSSION

Weed spectrum

The experimental field was infested with both grassy and broad-leaf weeds. *Phalaris minor* (L.) Retz. was the most predominant weed among weeds *Melilotus indica* (L.) All., *Fumaria parviflora* Lam., *Chenopodium album* L., *Anagallis arvensis*, *Cirsium arvense* L. and *Rumex dentatus* L. Among the sedges, *Cyperus rotandus* L. was present. The other grassy and broad-leafed weeds, *Poa annua* (L.) Desf., *Convolvulus arvensis* L., *Medicago denticulata* L., *Spergula arvensis* L. and *Cornopus 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. 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 + 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 to weedy check and also with reduced doses of herbicides during both the years. Application of lower optimum doses of herbicides reduced the cost of weed management, arrested weed shifts, prevented herbicide resistance in weeds and facilitated improvement in overall weed management by using herbicide mixture (Rao,1983).

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*. Application of isoproturon @ 0.75 also suppresses the growth of *Poa annua* and proved effective. The results are in close conformity with the findings of Kumar and Singh (1998).

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

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

Treatment	Dose (kg a.i./ha)	Total weed population/0.5 m²		Total weed dry weight (g)/0.5 m²	
		1996–97	1997–98	1996–97	1997–98
Pendimethalin	1.0	(73)* 8.60	(85) 9.27	34.25	45.57
Isoproturon	0.75	(46) 8.85	(68) 8.27	16.31	28.98
Metsulfuron methyl	0.08	(78) 8.86	(86) 9.32	36.20	50.63
Isoproturon + pendimethalin	0.5+0.5	(70) 8.39	(84) 9.20	30.18	40.43
Isoproturon+ metsulfuron methyl	0.5+0.004	(70) 8.43	(84) 9.21	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) 01.00	0	0
Weedy check		(130) 11.44	(178) 13.36	60.17	90.95
CD (P = 0.05)		0.90	0.41	3.03	5.21

soon as weeds have emerged. Pandey *et al.* (1996) reported that application of pendimethalin at 1.0 to 1.5 kg/ha was 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 killed almost all the tender and aged plants of *Cirsium arvense*. Besides, the growth of grassy weeds it checked for a month and gave excellent control of broadleaf weeds. Pandey and Singh (1994) and Panwar *et al.* (1996) also reported excellent control of these weeds.

Sequential applications of pendimethalin @ 0.5 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 was recorded in weed check treatment. There was 37.8–37.5% seed yield loss compared to weed-free condition. It was because of severe weed–control 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 and spike weights/spike and weed-free environments. Application of isoproturon @ 0.75 kg a.i./ha recorded highest seed yield among all herbicidal treatments, since the weeds dominated the experimental field were susceptible to isoproturon and which resulted in lowest dry matter of weeds among the herbicidal treatments and highest weed-control efficiency in 1996–97 and 1997–98 respectively. 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 the seed yield over the unweeded control. The increased seed yield recorded with the application of herbicides was owing to increased number of 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 isoproturon + pendimethalin @ 0.5 + 0.5 kg a.i./ha and herbicides in mixtures isoproturon + metsulfuron 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. Singh and Malik (1994) and Singh *et al.* (1997) reported similar findings in respect of tank mixture performance on seed yield. During both the

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

Treatment	Dose (kg a.i./ha)	Control (%)													
		P. minor		*M. indica*		*C. album*		*F. parviflora*		*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	1.0	52.91	45.53	25.82	42.04	96.24	94340	38.57	2	0.3.57	11.1	12.5		35.41	78.12
Isoproturon	0.75	86.60	87.95	38.72	37.47	68.39	82.91	44.04	38	21.42	24.22	37.5		48.60	38.14
Metsulfuron methyl	0.008	30.71	20.05	59.80	67.30	67.38	71.73	68.97	55	100	100	62.5		49.99	79.64
Isoproturon + pendimethalin	0.5+0.5	50.84	60.75	25.70	41.05	78.07	72.04	53.70	26	10.71	11.11	37.5		25.69	47.83
Isoproturon+ metsulfuron methyl	0.5+0.004	42.00	50.07	46.57	57.58	60.95	50.17	59.47	5?	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	23.00	16	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	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	42.85	77.7	50.0		35.76	47.67
Weed-free		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	0
CD (P = 0.05)															

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

Treatment	Dose (kg a.i./ha)	WCE (%)		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	00.00	00.00	39.90	33.66
Weedy check		00	00	37.84	37.46	24.8	21.05
CD(P=0.05)						04.86	02.73

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 @ 0.04 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

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 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, showing yield reduction of 14 and 12% in 1996–97 and 15 and 13% in 1997–98.

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