

Efficacy of herbicides in wheat (*Triticum aestivum*) with special reference to wild oat (*Avena sterilis ludoviciana*) in vertisols

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ABSTRACT

A field experiment was conducted during winter season of 2004-05 and 2005-06 at Jabalpur to assess the efficacy of clodinafop-propargyl, sulfosulfuron and isoproturon as post-emergence in wheat (*Triticum aestivum* L. emend. Fiori & Paol.). Clodinafop @ 60 g/ha significantly reduced the density and dry matter of wild oat (*Avena sterilis* ssp. *ludoviciana* Dur.), but could not combat the problem of broad-leaved weeds, viz., *Medicago hispida* Gaertn., *Lathyrus aphaca* L., *Chenopodium album* L. and *Vicia sativa* L. Sulfosulfuron 25 g/ha provided effective control of both wild oat and broad-leaved weeds. Isoproturon 1,000 g/ha did not cause significant reduction in the population and dry matter of wild oat, but significantly reduced the problem of broad-leaved weeds. Infestation of weed throughout the crop-growth period caused 48.8% reduction in grain yield of wheat. Higher yield attributes and maximum grain yield (47.6 q/ha) of wheat were recorded from two hand-weedings at 30 and 60 days after sowing (DAS). Amongst herbicidal treatments, application of sulfosulfuron 25 g/ha (43.6 q/ha), being on a par with that of clodinafop 60 g/ha (41.5 q/ha), 120 g/ha (43.4 q/ha) and 240 g/ha (44.5 q/ha), significantly increased the grain yield of wheat and recorded the maximum net return (Rs 11,940/ha).

Key words : Wheat, Wild oat, Herbicides, Weed control, Yield

Introduction of dwarf, high-yielding varieties of wheat (*Triticum aestivum* L. emend. Fiori and Paol.), responsive to intensive irrigation and fertilizers, has led to the problem of grassy weeds, particularly littleseed canary grass (*Phalaris minor* Retz.) and wild oat (*Avena sterilis* ssp. *ludoviciana* Dur.) in India. Wild oat mimics the wheat plant in morphology and growth behaviour, and hence it is very difficult to control wild oat manually. It germinates along with wheat, grows quickly, establishes a deep and extensive root system, and responds dramatically to high levels of nitrogen (Carlson and Hill, 1986). It is a serious competitor in wheat and generally sheds seeds 2 to 3 weeks prior to wheat harvest (Valyan *et al.*, 1991; Yadav and Singh, 2005). Losses due to wild oat in wheat have been reported up to 16-65%, depending on the intensity of its infestation (Balyan and Malik, 1989; Yadav *et al.*, 2004). Isoproturon, the most common herbicide against grassy weeds in wheat, has been found less effective against wild oat (Mishra *et al.*, 2005). Clodinafop-propargyl has been found very effective against wild oat but ineffective against non-grassy weeds (Singh and Singh, 2005). Keeping these facts in view, the present investigation was undertaken to find out the bio-efficacy of post-emergence herbicides in wheat in vertisols.

MATERIALS AND METHODS

The present experiment was conducted during winter season of 2004-05 and 2005-06 at National Research Centre for Weed Science, Jabalpur (23° 90' N, 79° 58' E, 412 m above mean sea-level). The soil was clay loam (Typic chromusterts) in nature, medium in organic carbon (0.66%), low in available nitrogen (239 kg/ha), medium in available phosphorus (17 kg/ha) and potassium (298 kg/ha), and neutral in reaction (pH 7.2). The treatments comprised clodinafop-propargyl 60, 120 and 240 g/ha, sulfosulfuron 25 g/ha, isoproturon 1,000 g/ha, one hand-weeding (HW) at 30 days after sowing (DAS), two HW at 30 and 60 DAS and a weedy check. There were replicated four times in randomized block design. Wheat 'MP 1106' was sown on 22 December 2004 and 28 December 2005 with the help of ferti-seed drill at a row spacing of 22.5 cm with 125 kg seed/ha. The herbicides were applied at 30 DAS in 500 litres water/ha using flat fan nozzle. The crop was raised under irrigated condition with recommended package of practices. The population (no/m²) and dry matter of weeds (g/m²) were recorded at 90 DAS by placing a quadrat of 0.50 m × 0.50 m (0.25 m²) size randomly at four places in a plot. The data on number and dry weight of weeds were subjected to square-root transfor-

mation ($\sqrt{x+0.5}$) before statistical analysis.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was dominated with grassy weed *Avena sterillis ludoviciana* Dur. (78.2%). The important broad-leaved weeds were *Medicago hispida* Gaertn. (15.3%), *Lathyrus aphaca* L. (3.3%), *Chenopodium album* L. (1.8%) and *Vicia sativa* L. (1.3%).

Irrespective of the doses (60-240 g/ha), clodinafop significantly reduced the population of *Avena sterillis ludoviciana* compared with other treatments (Table 1). However, this herbicide did not control the broad-leaved weeds, viz. *M. hispida*, *L. aphaca*, *C. album* and *V. sativa*. Singh and Singh (2005) also reported that clodinafop has no effect on broad-leaved weeds. Sulfosulfuron 25 g/ha significantly reduced the population of wild oat as well as broad-leaved weeds; however, its efficacy in reducing wild oat population was lower than that of clodinafop. Isoproturon 1,000 g/ha did not significantly reduce the population of *A. sterillis ludoviciana*, but significantly reduced that of broad-leaved weeds compared with clodinafop. Mishra and Yaduraju (2005) also reported lower efficacy of sulfosulfuron and isoproturon against wild oat in wheat. Hand-weeding at 30 DAS, though reduced the population of *A. sterillis ludoviciana* compared with isoproturon 1,000 g/ha and the weedy check, the differences were not significant.

Clodinafop, irrespective of its dose, and sulfosulfuron 25 g/ha significantly reduced the dry weight of *A. sterillis ludoviciana* compared with other herbicides, one hand-weeding and the weedy check (Table 1). Clodinafop was, however, more effective than sulfosulfuron. Hand-weeding twice at 30 and 60 DAS significantly reduced the dry matter of weeds. Application of sulfosulfuron 25 g/ha and isoproturon 1,000 g/ha significantly reduced the dry weight of broad-leaved weeds.

Total dry weight of weeds in all the herbicidal treatments except under sulfosulfuron 25 g/ha and clodinafop 240 g/ha were on a par with that of weedy check. Higher total dry-matter accumulation in clodinafop-treated plots was contributed by broad-leaved weeds, which were not controlled by this herbicide irrespective of its dose. Similarly, higher total dry-matter accumulation with plot tread with isoproturon 1,000 g/ha was contributed by *A. sterillis ludoviciana*, which was not effectively controlled by this herbicide. The lower dry-matter accumulation in the plot treated with sulfosulfuron 25 g/ha was due to effective control of both *A. sterillis ludoviciana* and broad-leaved weeds.

Effect of crop

Plant height, spike length and grains/spike were not

Table 1. Effect of weed-control measures on weed density and weed dry weight (mean data of 2 years)

Treatment	Dose (g/ha)	Weed density (no./m ²) at 90 DAS*					Total	Weed dry weight (g/m ²) at 90 DAS*					Total
		Grassy weeds		Broad-leaved weeds				Grassy weeds		Broad-leaved weeds			
		<i>A. sterilis</i> <i>ludoviciana</i>	<i>M.</i> <i>hispida</i>	<i>C.</i> <i>album</i>	<i>L.</i> <i>aphaca</i>	<i>V.</i> <i>sativa</i>		<i>s. ludoviciana</i>	<i>M.</i> <i>hispida</i>	<i>C.</i> <i>album</i>	<i>L.</i> <i>aphaca</i>	<i>V.</i> <i>sativa</i>	
Clodinafop	60	1.6 (2.1)	6.8 (5.7)	2.5 (5.8)	3.1 (9.1)	1.7 (2.4)	8.2 (66.7)	1.2 (0.9)	8.9 (78.7)	1.6 (2.1)	4.8 (22.5)	1.6 (2.1)	10.1 (101.5)
Clodinafop	120	1.4 (1.5)	8.3 (68.4)	2.1 (3.9)	3.7 (13.2)	1.5 (1.8)	9.7 (93.6)	1.1 (0.7)	9.5 (89.8)	1.3 (1.2)	4.6 (20.7)	1.7 (2.4)	11.5 (131.8)
Clodinafop	240	1.2 (0.9)	7.3 (52.8)	2.5 (5.8)	3.7 (13.2)	1.4 (1.5)	8.8 (76.9)	1.0 (0.5)	7.6 (57.3)	1.6 (2.1)	4.4 (18.9)	1.5 (1.8)	9.1 (82.3)
Sulfosulfuron	25	4.2 (17.1)	4.3 (18.0)	0.7 (0.0)	2.0 (3.5)	0.8 (0.1)	6.6 (43.1)	5.7 (32.0)	3.6 (12.5)	0.7 (0.0)	1.3 (1.2)	0.7 (0.0)	7.6 (57.2)
Isoproturon	1,000	8.7 (75.2)	3.7 (13.2)	1.1 (0.7)	1.6 (2.1)	1.2 (0.9)	9.9 (97.5)	9.6 (91.7)	4.7 (21.6)	0.8 (0.1)	1.3 (1.2)	0.7 (0.0)	11.2 (124.9)
Hand-weeding (30 DAS)		7.8 (60.3)	3.7 (13.2)	1.5 (1.8)	2.4 (5.3)	1.3 (1.2)	8.9 (78.7)	9.6 (91.7)	2.8 (7.3)	1.1 (0.7)	1.8 (2.7)	1.3 (1.2)	9.7 (93.6)
Hand-weeding (30 and 60 DAS)		2.5 (5.6)	3.0 (8.5)	1.2 (0.9)	2.2 (4.3)	0.9 (0.3)	4.9 (23.5)	3.0 (8.5)	2.4 (5.3)	0.8 (0.1)	1.5 (1.8)	0.9 (0.3)	6.8 (45.7)
Weedy check		9.6 (91.7)	4.3 (18.0)	1.6 (2.1)	2.1 (3.9)	1.4 (1.5)	11.1 (122.7)	10.8 (116.1)	6.4 (40.5)	0.8 (0.1)	1.6 (2.1)	1.3 (1.2)	12.6 (158.3)
CD (P=0.05)		1.9	1.1	0.5	0.5	0.4	2.1	1.8	1.6	0.4	2.0	0.4	2.6

Data subjected to square-root transformation; values in parentheses are original

Table 2. Yield attributes, yield and economics of wheat as influenced by different weed-control treatments (mean data of 2 years)

Treatment	Dose (g/ha)	Effective tillers/m at harvest	1,000-grain weight (g)	Grain yield (q/ha)	Weed index (%)	Additional net returns over weedy check (Rs/ha)
Coldinafop	60	48.7	42.2	41.5	12.8	9,991
Clodinafop	120	48.1	42.4	43.4	8.9	9,529
Clodinafop	240	52.6	43.3	44.5	6.5	6,848
Sulfosulfuron	25	48.9	41.5	43.6	8.4	11,940
Isoproturon	1,000	43.4	42.7	33.3	30.0	5,669
Hand-weeding (30 DAS)		48.6	44.4	41.9	12.0	7,243
Hand-weeding (30 and 60 DAS)		56.4	45.8	47.6		8,254
Weedy check		31.4	40.9	24.4	48.8	
CD (P=0.05)		4.3	4.2	5.1		

affected significantly due to various herbicides. Yield attributes, viz. number of effective tillers/m row length and 1,000-grain weight were significantly influenced due to application of herbicides (Table 2). Application of clodinafop (60-240 g/ha), sulfosulfuron 25 g/ha, isoproturon 1,000/ha and hand-weeding significantly increased the number of effective tillers/m row length compared with weedy check. Higher yield attributes and maximum grain yield of wheat (47.6 q/ha) were recorded from two hand-weedings at 30 and 60 DAS. Application of clodinafop, irrespective of its dose, and sulfosulfuron 25 g/ha significantly increased the grain yield of wheat, though the differences among themselves were not significant. The lowest grain yield (24.4 q/ha) was obtained from weedy check. Application of isoproturon 1,000 g/ha (33.3 q/ha) proved significantly superior to weedy check. Infestation of weeds throughout the crop-growth period caused 48.8% reduction in grain yield of wheat. Although the total dry-matter accumulation of weeds in clodinafop, isoproturon and hand-weeding at 30 DAS did not vary significantly, the grain yield obtained due to the application of clodinafop was significantly higher than that due to the application of isoproturon, mainly due to effective control of wild oat. This clearly indicated that *A. sterillis ludoviciana* was more troublesome weed than the broad-leaved weeds.

Economics

The net additional return due to weed control varied with the various treatments. Among the herbicides, application of sulfosulfuron 25 g/ha recorded the maximum net return (Rs 11,940/ha), followed by clodinafop-propargyl

60 g/ha (Rs 9,91/ha), clodinafop 120 g/ha, (Rs. 9,529/ha) and hand-weedings at 30 and 60 DAS (Rs 8,254/ha).

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