

Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat (*Triticum aestivum*)

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ABSTRACT

A field experiment was carried out on sandy clay-loam soil in North-western Himalayas of India and the experimental field had enough weed population. An average decrease in grain yield by 29% was observed due to season-long weed-crop competition. The best weed-control efficiency (85.7–93.8%) was achieved with metribuzin compared to other herbicides, i.e. Sulfosulfuron, isoproturon and 2, 4-D (55.4–87.5%). Earlier timing of metribuzin application (40 days stage) provided excellent control of *Phalaris minor* (Retz.) Pers., while control of *Polygonum plebeium* R.Br. and *Mellilotus indica* All. was better with application at 60 days stage. Sulfosulfuron showed high activity against all weed species except *P. plebeium* and at equivalent doses, control was greater at the earlier timing of application. Slight crop injury in terms of yellowing of leaves and stunted growth was observed in the plots treated with sulfosulfuron. It was more pronounced under delayed application of the herbicide. The injury, however, disappeared with the advancement of crop growth. All the treatments except 2.4-D application gave significantly higher grain yield compared to weeded check. The highest grain yield was recorded in manual weeding treatment. Lower doses of sulfosulfuron (20 to 25 g/ha) and metribuzin (230 to 245 g/ha) both applied at 40 days stage gave yields similar to manual weeding treatment.

Key words : Metribuzin, Sulfosulfuron, Weed control, Wheat

During the last 4 decades wheat production and productivity increased almost 6 times in India and it alone contributes about one-third of the total foodgrain production. In recent years, however, there is stagnation in the wheat productivity. A formidable factor that limits its productivity is severe weed competition. Continuous and inappropriate use of isoproturon since 1978 (Gill *et al.*, 1978) has caused shifts in weed flora and development of resistance in *Phalaris minor* to the herbicide (Malik and Singh, 1995). Thus it is imperative to screen herbicides, with alternate modes of action, for effective weed control and to ensure better crop yield. Many sulfonylurea herbicides have been increasingly used in wheat due to their low application rate and less persistence in environment (Parrish *et al.*, 1995). Metribuzin at low doses provides effective weed control in wheat (Pandey *et al.*, 2002). This trial assessed weed-control efficacy, crop injury and effect on wheat yield due to sulfosulfuron and metribuzin applied at different dose and time of application.

MATERIALS AND METHODS

A field experiment was conducted at the institute's research farm (29° 56' N, 79° 40' E and located at 1,250 m

above mean sea-level) in the north-western Himalayas of India. The trial was conducted during winter (*rabi*) 2000–01 and 2001–02 in maize-wheat crop sequence. The soil was sandy clay loam with pH 5.9, organic C 1.05%, available P and K 15.5 and 182.2 kg/ha respectively. The bulk density of the soil was 1.38 Mg/m³. The mean minimum and maximum temperature was – 1.5 and 32.9 °C, respectively, during the cropping season. Twelve herbicide treatments, viz. 3 doses of sulfosulfuron (20, 25 and 30 g/ha) each applied 40 and 60 days after sowing (DAS), isoproturon 1,000 g/ha, 2, 4-D 500 g/ha, 3 doses of metribuzin (230, 245 and 260 g/ha) each applied 40 days after sowing (DAS) and metribuzin 260 g/ha applied 60 DAS were compared with manual weeding (4 times, viz. 25, 50, 75 and 100 DAS) and uncontrolled weedy checks. The treatments were replicated thrice in randomized block design.

Wheat 'VL 738' was sown 23 cm apart in lines on 23 November 2000 and 16 November 2001. The crop was fertilized with 120, 60 and 40 kg/ha of N, P₂O₅ and K₂O, respectively, and irrigated adequately. Half the dose of N and full dose of P₂O₅ and K₂O was applied at sowing, while the remaining N was applied with first irrigation,

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given 25 DAS. Herbicides were applied post-emergence with a manually operated knapsack sprayer, delivering a spray volume of 600 litres/ha through flat-fan nozzle. All sulfosulfuron treatments included 0.2% v/v of the cationic surfactant (Leader mix).

Data on weed intensity were recorded 120 days after wheat sowing in each plot in 2 quadrats, each measuring 50 cm × 50 cm. Crop was manually harvested on 16 May 2001 and 10 May 2002. The grain yield data were recorded and adjusted to 14% of the moisture content. Data on weeds were subjected to square-root transformation ($\sqrt{X+1.0}$) before statistical analysis.

RESULTS AND DISCUSSION

Weeds

There was an average of 309 weeds/m² in the experimental field and *P. plebeium* (28%) and *P. minor* (25%) were the major weed species which severely competed with the wheat crop (Table 1). Besides these, *Melilotus indica*, *Stellaria media*, *Anagallis arvensis*, *Lolium temulentum*, *Avena ludoviciana*, *Salvia anthemifolia*, *Chenopodium album*, *Polypogon fugax*, *Cynodon dactylon* and *Cyperus rotundus* were also observed, but the competition by these species was insignificant as their populations were very small. All the weed-control treatments except sulfosulfuron 20 g/ha applied 60 days after sowing (DAS) gave significant reduction in weed population compared to weedy check (Table 1). Metribuzin 260 g/ha (regardless of application time) was at par with its lower doses and manual weeding, and this treatment recorded significantly lower weed population than the other treat-

ments. At equivalent doses, sulfosulfuron application at 40 days stage showed better weed control compared to that applied 60 DAS. Sulfosulfuron 30 g/ha applied 40 DAS recorded lower weed population and proved significantly superior to its later stage application at all doses. At lower doses of sulfosulfuron, earlier timing of sulfosulfuron application showed high activity against weeds resulting in significant reduction in weed biomass. At higher dose (30 g/ha), however, both spray timings had similar effect on weed biomass. Similarly to other studies (Gopinath and Pandey, 2004), in our trials the best efficacy of total weed biomass control was obtained by metribuzin compared to other herbicides.

Higher doses of sulfosulfuron applied 40 DAS killed all the plants of *M. indica* and gave excellent control of *P. minor*. An increase in the population of *P. plebeium* was observed in the plots treated with sulfosulfuron 60 DAS. Satisfactory control of all the other weeds might have created better environment for the increase in population and growth of *P. plebeium*. Pandey (1999) found that sulfosulfuron gave excellent control of grassy weeds but was not effective against *C. album* and *Convolvulus arvensis*. Earlier timing of Metribuzin application provided excellent control of *P. minor*, while control of *P. plebeium* and *M. indica* was better with application at 60 days stage. Isoproturon showed very good control of *P. minor* and *P. plebeium*, but was ineffective against *M. indica*.

Crop growth and yield attributes

Manual weeding recorded significantly higher plant height than the application of sulfosulfuron at 60 days

Table 1. Effect of herbicides on population and biomass of weeds (120 days after sowing, pooled mean)

Treatment	Dose (g/ha)	Time of application (DAS)	Weed population (No./m ²)	Weed biomass (g/m ²)	Weed-control efficiency (%)	Decrease in weed species (%)		
						<i>P. minor</i>	<i>P. plebeium</i>	<i>M. indica</i>
Sulfosulfuron	20	40	11.2 (125)	6.54 (42.2)	78.6	93	9	82
Sulfosulfuron	25	40	11.3 (130)	4.89 (25.0)	87.3	97	12	100
Sulfosulfuron	30	40	9.3 (92)	4.97 (24.7)	87.5	95	31	100
Sulfosulfuron	20	60	16.0 (262)	9.39 (87.9)	55.4	95	-117	64
Sulfosulfuron	25	60	14.6 (214)	7.96 (65.1)	66.9	93	-72	76
Sulfosulfuron	30	60	13.1 (174)	6.53 (43.7)	77.8	94	-8	88
Isoproturon	1,000	40	7.8 (64)	5.06 (28.6)	85.5	97	81	58
2, 4-D	500	40	11.1 (124)	6.56 (43.9)	77.7	82	59	53
Meteribuzin	230	40	6.3 (40)	5.05 (28.2)	85.7	95	92	64
Metribuzin	245	40	6.2 (38)	3.79 (14.8)	92.5	99	98	76
Metribuzin	260	40	5.2 (26)	3.49 (12.1)	93.8	98	94	82
Metribuzin	260	60	5.4 (28)	4.11 (16.9)	91.4	92	99	88
Manual weeding			6.8 (46)	3.13 (8.9)	95.5	99	96	97
Weedy check			17.5 (309)	13.85 (197.2)				
CD (P=0.05)			2.0	2.78				

Figures in parentheses indicate original values

stage regardless of dosage (Table 2). Slight crop injury in terms of yellowing of leaves and stunted growth was detected visually in crop plants treated with sulfosulfuron. The herbicide had more phytotoxic effect on the crop when applied at 60 days stage. Crop injury, however, diminished with time and crop picked up normal growth 3 weeks after treatment. Similar findings were also reported by Pandey *et al.* (2002) and Gopinath and Pandey (2004). Metribuzin 230 g/ha and sulfosulfuron 30 g/ha both applied 40 DAS recorded higher number of tillers/m row length compared to other herbicide treatments. At equivalent doses, significantly higher number of tillers was recorded with the earlier timing of sulfosulfuron application. The effect of metribuzin applied at all doses and at both stages and sulfosulfuron applied at earlier stage was similar to hand-weeding for ear length (Table 2). However, no statistical increase in ear length was obtained due to sulfosulfuron applied 60 DAS regardless of dosage compared to weedy check. All the treatments involving metribuzin had similar effect on grains/ear but proved significantly superior to sulfosulfuron treatments except its application 40 DAS at 20 g/ha. On the contrary, sulfosulfuron 25 g/ha applied 60 DAS recorded the highest 1,000-grain weight and proved significantly superior to other treatments except sulfosulfuron 20 and 30 g/ha applied 60 DAS, 20 g/ha applied 40 DAS, 2, 4-D and manual weeding. In general, sulfosulfuron application was better in increasing the 1,000-grain weight compared to metribuzin.

Grain yield

An average yield decrease by 29% was observed due

to season-long weed-crop competition as compared to repeated manual weeding. All the treatments except 2, 4-D application resulted in significantly higher yield than weedy check (Table 2). Manual weeding, sulfosulfuron 20 and 25 g/ha and metribuzin 230 and 245 g/ha each applied 40 DAS resulted in similar and significantly higher yields than sulfosulfuron at all doses applied 60 DAS, 2, 4-D 500 g/ha and weedy check. Increase in grain yield in these treatments may be ascribed to the excellent control of weeds (Table 1) and marked improvement in crop growth and yield attributes (Table 2). Higher doses of sulfosulfuron (30 g/ha) and metribuzin (260 g/ha) resulted in less grain yield than their respective lower doses, though the decrease was significant only in case of sulfosulfuron applied 40 DAS. The lower yield in sulfosulfuron 30 g/ha and metribuzin 260 g/ha may be due to adverse effect on crop growth and most of the yield attributes. Kumar *et al.* (2001) and Pandey *et al.* (2002) also found that metribuzin and sulfosulfuron at higher doses had adverse effects on growth and yield of wheat.

Economic returns

Owing to higher yield and low cost of herbicides, all herbicides gave higher net returns than manual weeding (Table 2). Maximum net returns were recorded by application of sulfosulfuron 20 g/ha (40 DAS) and this treatment was followed by its higher dose (25 g/ha) and metribuzin 230 g/ha both applied 40 DAS. The lowest net returns were recorded in manual weeding treatment which was due to more labour requirement. About 150 man-days were required to manually remove the weeds in these plots.

Table 2. Effect of herbicides on growth, yield attributes and yield of wheat (pooled mean)

Treatment	Dose (g/ha)	Time of application (DAS)	Plant height (cm)	Tillers/m row length	Ear length (cm)	Grains/ear	1,000-grain weight (g)	Grain yield (q/ha)	Net returns over weedy check (Rs/ha)
Sulfosulfuron	20	40	115.6	89.1	9.3	43.4	43.73	60.6	10,404
Sulfosulfuron	25	40	115.6	90.5	9.4	41.8	43.42	60.7	10,297
Sulfosulfuron	30	40	114.8	95.5	9.7	40.1	43.02	54.2	3,841
Sulfosulfuron	20	60	113.7	86.5	9.1	44.6	44.13	53.4	6,028
Sulfosulfuron	25	60	114.0	86.3	9.0	42.6	45.56	51.7	2,545
Sulfosulfuron	30	60	113.1	85.5	8.6	39.8	44.52	50.7	1,743
Isoproturon	1,000	40	115.7	86.6	9.1	42.0	43.37	55.2	6,513
2, 4-D	500	40	115.8	85.1	9.2	47.8	44.38	48.1	2,403
Metribuzin	230	40	116.0	96.6	9.6	46.0	42.75	59.6	10,160
Metribuzin	245	40	115.9	89.8	9.7	48.5	41.31	60.1	9,301
Metribuzin	260	40	116.2	85.8	9.9	47.1	42.84	57.2	7,349
Metribuzin	260	60	115.8	93.1	9.5	45.1	40.85	57.8	7,199
Manual weeding			116.6	91.8	9.4	44.8	45.15	60.9	1,406
Weedy check			111.5	80.5	8.7	41.1	42.79	43.2	
CD (P=0.05)			2.3	7.4	0.6	4.8	1.95	6.0	

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