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Efficacy of Tank Mixtures of Sulfosulfuron with Clodinafop and Fenoxaprop on Weeds in Wheat (*Triticum aestivum* L.)

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ABSTRACT

Tank mixture of clodinafop+sulfosulfuron (3 : 1) at 60 g ha^{-1} and fenoxaprop+ sulfosulfuron (4 : 1 and 5 : 1) at 120 g ha^{-1} provided 85-90% control of *Avena ludoviciana* and *Phalaris minor* and 60% control of broadleaf weeds like *Chenopodium album, Melilotus indica* and *Rumex retroflexus*. None of the herbicide combinations was effective against *Convolvulus arvensis*. Clodinafop+sulfosulfuron at lower dose of 50 g ha^{-1} and fenoxaprop+sulfosulfuron at 100 g ha^{-1} although provided good control of broadleaf weeds but poor control of grassy weeds. Maximum grain yield (5240 kg ha^{-1}) was obtained in weed-free treatment which was at par with clodinafop+sulfosulfuron (3 : 1) at 60 g ha^{-1} and fenoxaprop+sulfosulfuron (4 : 1 or 5 : 1) at 120 g ha^{-1}.

INTRODUCTION

Wheat [*Triticum aestivum* (L.) emend Fiori & Paol) crop gets infested with heavy population of *Phalaris minor* Retz., *Avena ludoviciana* Dur., common *Chenopodium album* L., *Melilotus indica* All., *Coronopus didymus* L., *Rumex retroflexus* L., *Vicia sativa* L. and *Anagallis arvensis* L. Isoproturon is in use since 1982 in major belt of India for effective control of *P. minor*. But its efficacy has declined during the last 8-9 years due to development of resistance in *P. minor* in some parts (Malik and Malik, 1994). To tackle the resistance problem, fenoxaprop-p-ethyl, sulfosulfuron and clodinafop-propargyl have been recommended (Malik and Yadav, 1997) and are being used by the farmers on large scale. Fenoxaprop and clodinafop are very specific to *P. minor* and *A. ludoviciana* control but are ineffective against broadleaf weeds of wheat. Continuous use of these herbicides for 2-3 seasons has resulted in tremendous increase in density of broadleaf weeds especially *R. retroflexus, C. album, M. indica* and *Fumaria parviflora* at farmers' fields. These two herbicides show antagonism when used as tank mixtures with 2, 4-D and metsulfuron, leading to poor efficacy on *P. minor* and *A. ludoviciana* (Yadav *et al.*, 2002). Sulfosulfuron in addition to *P. minor* gives 65-70 % control of broad leaf weeds also (Banga *et al.*, 2003). To broaden the weed control spectrum, use of herbicide mixtures is essential (Wruble and Gressel, 1994). Keeping it in view, the present investigation on herbicide combinations was conducted.

MATERIALS AND METHODS

To evaluate the efficacy of fenoxaprop and clodinafop as tank mixed with sulfosulfuron against weeds in wheat, field experiment was conducted during the **rabi** (winter) 2001-02 and 2002-03 at the Agronomy Research Area of CCS Haryana Agricultural University, Hisar. The experimental soil was sandy loam (Typic Ustochrepts) with 61% sand, 22.1% silt and 19.1% clay, medium in fertility with 0.29% organic carbon and pH of 8.2. Wheat variety PBW-343 was drilled on October 28, 2002 and November 6, 2003 on raised beds in furrow irrigated raised bed system (FIRBS) at 87.5 kg seed ha^{-1}. Three rows of wheat per bed were grown and the plot size was 6.5 x 2.1 m (3 beds per plot). Recommended doses of fertilizers and irrigations were applied uniformly. Tank mixtures of clodinafop-propargyl, fenoxaprop-ethyl and sulfosulfuron at various doses in different ratios were evaluated (Table 1).

Thus, 15 treatments were replicated thrice in randomized block design. Herbicides were applied with knapsack sprayer at 375 litres of water ha^{-1}.

Table 1. Effect of different treatments on weed density (No. m^{-2}) (Average of two seasons)

Treatment	Mixing ratio	Dose (g a. i. ha^{-1})	*A. ludoviciana*	*P. minor*	*C. album*	*R. retroflexus*	*M. indica*	*C. arvensis*
Clodinafop+Sulfosulfuron	1:1	50	6.0 (39)	2.7 (8)	2.8 (8)	1.0 (0)	1.0 (0)	1.9 (4)
Clodinafop+Sulfosulfuron	2:1	50	3.8 (15)	2.4 (6)	2.8 (9)	1.2 (1)	1.7 (3)	1.8 (3)
Clodinafop+Sulfosulfuron	3:1	50	3.1 (9)	2.3 (5)	3.2 (11)	2.0 (3)	1.4 (1)	1.5 (2)
Clodinafop+Sulfosulfuron	1:1	60	5.4 (29)	2.3 (5)	3.6 (13)	1.0 (0)	1.4 (1)	1.2 (1)
Clodinafop+Sulfosulfuron	2:1	60	3.6 (12)	1.4 (1)	3.7 (15)	1.9 (3)	1.0 (0)	1.4 (1)
Clodinafop+Sulfosulfuron	3:1	60	2.4 (5)	1.9 (3)	3.1 (9)	1.0 (3)	1.2 (1)	1.5 (2)
Fenoxaprop+Sulfosulfuron	4:1	100	7.0 (49)	2.5 (7)	3.0 (8)	1.9 (3)	1.9 (4)	1.7 (3)
Fenoxaprop+Sulfosulfuron	5:1	100	5.9 (35)	3.5 (12)	2.7 (8)	1.4 (1)	1.9(3)	1.5 (1)
Fenoxaprop+Sulfosulfuron	4:1	120	3.1 (11)	1.4 (1)	1.9 (3)	1.0 (0)	2.7 (7)	1.8 (3)
Fenoxaprop+Sulfosulfuron	5:1	120	3.2 (9)	1.5 (2)	3.3 (10)	1.4 (1)	1.4 (1)	1.5 (2)
Clodinafop		60	1.9 (3)	1.0 (0)	4.5 (20)	1,6 (2)	2.7 (7)	1.5 (2)
Fenoxaprop		120	1.2 (1)	1.4 (1)	5.9 (35)	1.9 (3)	3.4 (12)	1.0 (0)
Sulfosulfuron		25	8.0 (65)	4.7 (22)	3.3 (11)	1.0 (0)	1.0 (0)	1.2 (1)
Weedy			10.6 (112)	5.7 (33)	4.5 (20)	2.3 (5)	3.4 (11)	1.8 (3)
Weed-free			1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)
LSD (P=0.05)			2.0	1.84	1.1	0.96	1.4	NS

Data in parentheses indicate original values, which were transformed to $\sqrt{X+1}$ for analysis. NS-Not Significant.

Weed count and dry weight were recorded at 70 and 110 DAS during both the growing seasons. The data on per cent visual control of weeds were recorded at 120 DAS on 0-100 scale, where, 0 is no control and 100 is complete control and subjected to arc sin transformation before analysis. Pooled data analysis was made.

RESULTS AND DISCUSSION

Effect on Weeds

A. ludoviciana and *P. minor* were the main weeds consisting of 61 and 18% of the total weed flora. The relative density of *C. album* was the dominant weed alongwith *M. indica, R. retroflexus* and *Convolvulus arvensis* was 10.8, 6.0, 2.7 and 1.6%, respectively. All the herbicide treatments reduced density and dry matter of weeds significantly as compared to weedy check (Tabel 2). Clodinafop and fenoxaprop at recommended doses provided 90-95% control of grassy weeds but sulfosulfuron gave only 40% control of *A. ludoviciana* and *P. minor*. Tank mixtures of clodinafop+sulfosulfuron in various ratios at 50 g ha^{-1} although provided 50-65% control of broad leaf weeds but did not give desirable control of grassy weeds. But tank mix application of clodinafop+ sulfosulfuron (3 : 1) at 60 g ha^{-1}, proved very effective in minimizing the density and dry weight of weeds and provided acceptable control (90%) of grassy as well as broad leaf weeds. Similarly, fenoxaprop+ sulfosulfuron in 4 : 1 and 5 : 1 ratio at 120 g ha^{-1} gave 85-90% control of grassy and 60% control of broad leaf weeds. Per cent control of broad leaf weeds increased with the increase in proportion of sulfosulfuron in the mixture but grassy weeds decreased. None of the combinations was effective against *C. arvensis*.

Effect on Crop

Grain yield and number of tillers m^{-2} varied significantly among different treatments. In every combination of clodinafop+sulfosulfuron, numbers of crop shoots were significantly higher at 60 g ha^{-1} than 50 g ha^{-1} (Table 2). Highest grain yield (5240 kg ha^{-1}) was obtained in weed-free plots which was at par with clodinafop+sulfosulfuron (3 : 1) at 60 g ha^{-1} and fenoxaprop+sulfosulfuron in 4 : 1 and 5 : 1 ratio at 120 g ha^{-1}, clodinafop at 60 g ha^{-1} and

Table 2. Effect of treatments on wheat crop (Mean of two seasons)

Treatment	Mixing ratio	Dose (g a. i. /ha)	Weed dry weight (g m^{-2})				Weed control (%)		No. of crop shoots m^{-2}	Grain yield (kg ha^{-1})
			70 DAS		110 DAS					
			BLW	Grassy	BLW	Grassy	BLW	Grassy		
Clodinafop+Sulfosulfuron	1:1	50	1.6	26.2	10.9	127.6	60	45	369	3666
Clodinafop+Sulfosulfuron	2:1	50	2.6	10.4	15.8	96.0	65	55	424	4262
Clodinafop+Sulfosulfuron	3:1	50	4.5	6.2	18.5	78.1	50	60	463	4565
Clodinafop+Sulfosulfuron	1:1	60	1.3	6.8	4.5	65.8	65	65	470	4735
Clodinafop+Sulfosulfuron	2:1	60	2.0	5.9	6.4	56.0	60	70	476	4781
Clodinafop+Sulfosulfuron	3:1	60	2.2	3.4	5.4	11.1	60	90	495	5148
Fenoxaprop+Sulfosulfuron	4:1	100	2.0	16.3	9.3	119.5	60	46	408	4193
Fenoxaprop+Sulfosulfuron	5:1	100	3.7	6.2	12.6	106.1	57	56	433	4380
Fenoxaprop+Sulfosulfuron	4:1	120	2.2	4.9	9.9	20.5	60	85	480	5000
Fenoxaprop+Sulfosulfuron	5:1	120	3.0	3.8	6.5	12.6	60	90	492	5120
Clodinafop		60	12.4	0.9	40.2	5.7	0	98	498	5060
Fenoxaprop		120	16.3	3.7	36.1	8.5	0	95	497	5030
Sulfosulfuron		25	6.0	45.3	12.2	176.8	65	40	367	3412
Weedy			16.0	94.0	39.0	511.1	0	0	296	2610
Weed-free			0	0	0	0	100	100	507	5240
LSD (P=0.05)			0.9	2.4	12.1	4.6	4	7	20	296

fenoxaprop at 120 g ha^{-1}. Similar trend was observed in respect of number of crop shoots m^{-2}. Presence of weeds throughout the growth period reduced the grain yield by 49%.

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