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Bioefficacy of Fenoxaprop, Clodinafop, Metribuzin Alone and in Combination Against Weeds in Wheat and their Residual Effect on Succeeding Crops

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ABSTRACT

Clodinafop and fenoxaprop alone could successfully control *Phalaris minor* but were found ineffective against *Rumex maritimus*, *Melilotus indica* and *Coronopus dydimus*. Tank mixture of clodinafop (60 g ha^{-1}) and fenoxaprop (100 g ha^{-1}) with carfentrazone (20 g ha^{-1}) controlled both grassy and broadleaf weeds resulting in 88-90% weed control efficiency and significantly increased seed yield of wheat over sole application of clodinafop and fenoxaprop, tank mix of metribuzin and isoproturon with carfentrazone and metsulfuron. Metribuzin sole as well as in tank mix with carfentrazone and metsulfuron was not found suitable due to its toxicity to wheat. The succeeding crops of moongbean, cowpeas and forage sorghum did not show any residual activity of herbicides applied in wheat.

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INTRODUCTION

The acute problem of both grassy and broadleaf weeds is becoming very common in wheat growing areas of north-western zone of India, which often results in huge yield losses and makes the weed control more complex (Singh *et al.*, 2002). After the development of resistance by *Phalaris minor* against isoproturon, clodinafop-propagyl and fenoxaprop-p-ethyl were recommended to combat the resistant biotypes. These alternate herbicides have been found to be ineffective against the broadleaf weeds, resulting in build-up of *Rumex maritimus, Coronopus dydimus, Medicago denticulata*, *Anagallis arvensis* and *Melilotus indica*. Lack of knowledge and due to higher prices of alternate herbicides many growers are using metribuzin and isoproturon to control the weeds in wheat. 2,4-D was recommended for weed control in wheat but has shown its ineptness towards the above mentioned broadleaf weeds hence there is an urgent need to appraise new herbicides for broadleaf weed control and also their compatibility as tank mixture with grass herbicide to increase the weed control spectrum.

Carfentrazone and metsulfuron have been found effective herbicides against broadleaf weeds. Carfentrazone-ethyl belongs to the Aryl Trizoline group and its mode of action results in membrane disruption, which ultimately kills the sensitive weeds by interfering with the chlorophyll biosynthetic pathway. Singh *et al.* (2004) recorded excellent control of *Chenopodium album, Melilotus indica, Vicia sativa, Medicago denticulata, Rumex acetosella, Melilotus alba* and *Lathyrus aphaca* with carfentrazone at 20 g ha^{-1}. To make use of these herbicides as tank mixture with clodinafop and fenoxaprop it is necessary to test their compatibility. Since many crops in rotation follow wheat it becomes essential to evaluate the residual effect of these herbicides in succeeding crops. Keeping all this in view, the present study was undertaken to assess the efficacy of herbicides and their mixtures on weeds and wheat.

MATERIALS AND METHODS

Field experiment was conducted during winter seasons of 2002-03 and 2003-04 at Research Farm of Indian Agricultural Research Institute Regional Station, Karnal.The soil of the experimental field was clay loam in texture with 7.8 pH. Twelve treatments consisting of clodinafop-propagyl, fenoxaprop-p-ethyl and metribuzin alone, their tank mixture with carfentrazone and metsulfuron, tank mix of isoproturon+carfentrazone, isoproturon+metsulfuron and weedy check were tried in randomized block design with four replications in wheat variety HD 2687 sown on December 4 and 5 in 2002 and 2003, respectively, after rice. Recommended doses of fertilizers were applied uniformly. Herbicides were applied 30 days after sowing through knapsack sprayer using 600 l ha^{-1}. Weed count and weed dry matter were recorded at 90 DAS. For residual study in the month of July from the undisturbed plots, three composite soil samples (0-30 cm) were taken from each plot to fill pot of 9-inch diameter. In these pots, moongbean (Pusa Vishal), cowpea (V 130) and forage sorghum (PC-23) were sown. Emergence per cent was observed on 10th day and 10 plants were selected randomly for dry matter accumulation on 20th day.

RESULTS AND DISCUSSION

Density of Weeds

On an average, the relative density of *P. minor* Retz., *R. maritimus* L., *M. indica* L. and *C. dydimus* L. was 59.0, 14.0, 14.0 and 13.0%, respectively. Besides, *Poa annua, L. aphaca* and *A. arvensis* were found in few numbers.

Density of *P. minor* was significantly reduced with the application of fenoxaprop at 100 g ha^{-1}, clodinafop at 60 g ha^{-1}, metribuzin at 200 g ha^{-1}, isoproturon 1000 g ha^{-1} and their mixtures with metsulfuron and carfentrazone compared to weedy check. Clodinafop, fenoxaprop and metribuzin recorded 90, 89 and 64% more control of *P. minor* than isoproturon (Table 1). Significantly higher density of *P. minor* was recorded when metribuzin was tankmixed with metsulfuron and carfentrazone compared to metribuzin alone representing the antagonism between two herbicides. Significantly higher density of *R. maritimus,, M. indica* and *C. dydimus* was recorded in clodinafop and fenoxaprop alone compared to their mixtures with metsulfuron and carfentrazone confirming the findings of Yadav *et al.* (2004). Total weed density was significantly reduced in clodinafop and fenoxaprop tankmixed with carfentrazone and metsulfuron due to higher control of grass and broadleaf weeds compared with mixture of metribuzin, isoproturon and weed check.

Significantly lower weed dry matter was found in fenoxaprop+carfentrazone and clodinafop+ carfentrazone due to elimination of both grassy and broadleaf weeds resulting in weed control efficiency

Table 1. Effect of herbicides on weed density (No. m^{-2}) in wheat (Pooled data of two seasons)

Treatment	Dose (g ha^{-1})	*Phalaris minor*	*Rumex maritimus*	*Melilotus indica*	*Coronopus dydimus*	Total weed density
Clodinafop	60	(13) 3.66	(72) 8.50	(49) 7.08	(52) 7.29	(186) 13.66
Clodinafop+Carfentrazone	60+20	(12) 3.63	(0) 1.00	(8) 3.04	(9) 3.02	(29) 5.45
Clodinafop+Metsulfuron	60+4	(16) 4.06	(0) 1.00	(7) 2.68	(9) 3.05	(31) 5.68
Fenoxaprop	100	(13) 3.73	(63) 7.90	(56) 7.56	(61) 7.88	(184) 13.57
Fenoxaprop+Carfentrazone	100+20	(10) 3.36	(2) 1.75	(16) 4.05	(17) 4.07	(45) 6.78
Fenoxaprop+Metsulfuron	100+4	(30) 5.56	(0) 1.13	(1) 1.33	(8) 2.98	(39) 6.34
Metribuzin	200	(47) 6.93	(0) 1.00	(6) 2.69	(4) 2.27	(58) 7.68
Metribuzin+Carfentrazone	200+20	(79) 8.93	(0) 1.00	(5) 2.41	(3) 1.98	(87) 9.37
Metribuzin+Metsulfuron	200+4	(84) 9.23	(0) 1.00	(7) 2.87	(4) 2.22	(96) 9.83
Isoproturon+Carfentrazone	1000 +15	(132) 11.5	(0) 1.00	(6) 2.62	(8) 2.98	(146) 12.11
Isoproturon+Metsulfuron	1000+4	(108) 10.4	(0) 1.00	(6) 2.75	(5) 2.35	(120) 10.98
Weedy check	-	(299) 17.2	(57) 7.50	(72) 8.45	(65) 8.14	(492) 22.18
C. D. at 5%	-	(29) 1.28	(14) 0.99	(13) 1.11	(9) 1.15	(37) 1.347

Original values are given in parentheses.

Table 2. Effect of herbicides and their mixture on weed growth and seed yield in wheat (Pooled data of two seasons)

Treatment	Dose (g ha^{-1})	Weed dry weight (g m^{-2})	Effective tillers (No. m^{-2})	Spike length (cm)	1000-seed weight (g)	Seed yield (kg ha^{-1})
Clodinafop	60	64.7	417.0	9.34	44.78	24.31
Clodinafop+Carfentrazone	60+20	14.9	462.0	10.14	45.95	35.48
Clodinafop+Metsulfuron	60+4	26.7	406.0	9.80	44.92	29.74
Fenoxaprop	100	66.9	378.0	9.50	44.85	24.32
Fenoxaprop+Carfentrazone	100+20	15.7	438.0	10.11	45.27	33.67
Fenoxaprop+Metsulfuron	100+4	33.7	392.0	9.53	45.18	29.04
Metribuzin	200	33.2	323.0	9.43	44.95	28.91
Metribuzin+Carfentrazone	200+20	76.0	312.0	9.21	44.90	24.43
Metribuzin+Metsulfuron	200+4	82.0	315.0	9.58	44.73	24.05
Isoproturon+Carfentrazone	1000+15	123.6	295.0	9.33	43.42	17.96
Isoproturon+Metsulfuron	1000+4	100.1	275.0	9.23	43.35	18.40
Weedy check		238.8	251.0	8.60	43.10	11.56
C. D. at 5%		26.5	90.4	0.61	1.41	6.58

of 93.3-93.7%. Miller *et al.* (2001) recommended the use of fenoxaprop+carfentrazone with a control of 90-95% of grass and broadleaf weeds. Higher weed dry weight in isoproturon+metsulfuron and isoproturon+carfentrazone was due to its ineffectiveness towards control of *P. minor* though most of the broadleaf weeds were controlled. Significantly higher weed dry weight was recorded with clodinafop and fenoxaprop alone due to their failure to control broadleaf weeds.

Effect on Crop

Clodinafop+carfentrazone recorded significantly higher number of effective tillers and spike length compared to clodinafop, fenoxaprop alone and weedy check (Table 2). Metribuzin produced lower effective tillers when applied alone and in mixture indicating its toxic effect to wheat. Significantly lower effective tillers and length of spike in isoproturon were due to its ineffectiveness towards *P. minor.* Carfentrazone-ethyl when tankmixed with grass herbicides produced white speclings on the top wheat leaf, which disappeared within 10-12 days without any effect on yield attributes.

There was 70.0 and 65.6% yield reduction under weedy check conditions compared to clodinafop+carfentrazone and fenoxaprop+carfentrazone, respectively. Highest seed yield of 3548 kg ha^{-1} was obtained with clodinafop+carfentrazone followed by fenoxaprop+carfentrazone (3367 kg ha^{-1}) and clodinafop+metsulfuron (2974 kg ha^{-1}) remained statistically at par (Table 2). The seed yield among clodinafop 60 g ha^{-1}, fenoxaprop 100 g ha^{-1} and metribuzin 200 g ha^{-1} and mixture of metribuzin with carfentrazone and metsulfuron remained at par though metribuzin reduced the total weed density and weed dry weight significantly more than clodinafop and fenoxaprop. This indicated the detrimental effects of metribuzin to wheat when used alone or in combination with other herbicides. Similar findings have been reported by Singh *et al.* (2004). Significantly lower seed yield was obtained under isoproturon+carfentrazone which was 49.3 and 45.3% less than clodinafop+carfentrazone and fenoxaprop+carfentrazone, respectively.

None of the treatments had any residual effect on the succeeding crops of moongbean, cowpea and forage sorghum.

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