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Control of complex weed flora in wheat by metribuzin + clodinafop application

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ABSTRACT

A field experiment was carried out at Pantnagar during *Rabi* season of 2010-11 and 2011-12 to test the efficacy of different doses of metribuzin 42% + clodinafop-propargyl 12% WG in wheat and associated weeds. The soil of the experimental field was clay loam in texture, medium in organic carbon (0.67%), available phosphorus (29.6 kg/ha) and potassium (176.4 kg/ha) with pH 7.2. Results revealed that metribuzin + clodinafop-propargyl 500 g/ha was significantly at par with its higher dose at 600g/ha, and two hand weedings at 30 and 50 DAS recorded the lowest density of *Phalaris minor* and *Chenopodium album*, *Coronopus didymus*, *Melilotus* spp., *Rumex* spp. and *Fumaria parviflora* at 30 and 60 days after application as compared to rest of the treatments. Maximum grain yield was recorded in metribuzin 42%+ clodinafop-propargyl at 600 g/ha, which was statistically at par with its lower dose of 500 g/ha due to effective control of grassy and broad-leaf weeds in wheat.

Key words: Chemical control, Clodinafop-propargyl, Metribuzin, Wheat

Wheat gets heavily infested with *Phalaris minor*, *Avena ludoviciana*, *Chenopodium album*, *Medicago denticulata*, *Melilotus alba*, *Melilotus indica*, *Fumaria parviflora*, *Vicia hirsuta*, *Vicia sativa*, *Coronopus didymus* and *Rumex acetocella.* Uncontrolled weeds are reported to cause up to 66% reduction in wheat grain yield (Angiras *et al.* 2008, Kumar *et al.* 2011) or even more depending upon the weed densities, type of weed flora and duration of infestation. Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding especially in broadcast wheat. Combination of isoproturon and 2,4-D as tank mixture have been recommended against complex weed flora. This combination has been found promising in the situation where isoproturon was effective against *P. minor*, whereas against complex weed flora dominated by *A. ludoviciana*, *Lolium temulentum* and *Poa annua*, combination of isoproturon + 2,4-D was not very effective. Under such situation, a suitable combination of clodinafop or pinoxaden with some broad-spectrum herbicides like sulfosulfuron and metribuzin was needed. Hence, the present investigation was carried out to evaluate the efficacy of metribuzin in combination with recommended clodinafop against mixed weed flora in wheat.

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MATERIALS AND METHODS

A field trial was carried out during *Rabi* 2010-11 and 2011-12 at G.B Pant University of Agriculture and Technology, Pantnagar to evaluate the bio-efficacy of metribuzin 42% + clodinafop-propargyl 12% WG. The soil of the experimental field was clay loam in texture, medium in organic C (0.67%), available P (29.6 kg/ha) and K (176.4 kg/ha) with pH 7.2**.** Ten treatments were evaluated in randomized block design with three replications. The treatments comprised of there doses of metribuzin + clodinafop-propargyl 400, 500 and 600 g/ha as test product and isoproturon 75% WP 1333.3 g/ha, metribuzin 70% WP 300 g/ha, sulfosulfuron 75% WG 33.3 g/ha, clodinafop-propargyl 15% WP 400 g/ha, mesosulfuron-methyl 3% + iodosulfuron-methyl sodium 0.6% WG 400 g/ha as commercial standards, as well as two manual weedings at 30 and 50 days after sowing (DAS), and untreated control. Wheat "*UP- 2565*" was sown on November 23, 2010 and November 18, 2011, respectively. The data on density and dry weight of total weeds were taken at 30 and 60 DAS and grain yield (t/ha) was recorded at the time of harvesting.

In addition to bio-efficacy, a separate experiment was also carried out to observe the phytotoxicity of metribuzin + clodinafop-propargyl on wheat crop and to see the residual effect of metribuzin + clodinafop-propargyl on succeeding

crop of maize. Metribuzin + clodinafop-propargyl at 500 and 1000 g/ha were applied at 35 DAS of wheat crop using prescribed volume of water and surfactant and untreated check was maintained for comparison. Phytotoxicity symptoms, *viz*. yellowing, necrosis, epinasty, hyponasty and scorching were recorded at 7, 15 and 30 days after treatment using rating scale of 0 - 10 where, where, 0 = no effect on plant and 10 = complete death of the plant.

Maize crop was planted by dibbling method after one week of harvesting of wheat crop in the plots which were treated with metribuzin + clodinafop-propargyl at 500 and 1000 g/ha in wheat to see the residual effect on germination and growth of maize crop. Untreated check was also maintained for comparison.

RESULTS AND DISCUSSION

Effect on weeds

Experimental field was naturally dominated with *Phalaris minor* (5.74 and 40.7%) as a grassy weed and *Chenopodium album* (2.8 and 13.3%), *Coronopus didymus* (2.8 and 10.4%), *Melilotus indica*, (2.5 and 9.4%) *Rumex* spp., (2.0 and 4.8%) and *Fumaria parviflora* (1.8 and 3.8%), were major broad-leaved weeds infesting experimental area during 2010 and 2011, respectively.

Efficacy against grassy weeds

Metribuzin + clodinafop-propargyl at 500 and 600 g/ha was significantly at par with two hand weedings at 30 and 50 DAS of wheat, which recorded the lowest weed density at 30 and 60 days as compared to rest of the treatments (Table 1 and 2). Application of sulfosulfuron 33.3 g/ha and mesosulfuron-methyl + iodosulfuron-methyl sodium 400 g/ha were however, significantly superior over untreated control, but found to be least effective against *P. minor* as compared to rest of the treatments, when observed at 30 and 60 days after treatment.

Efficacy against broad-leaved weeds

Metribuzin + clodinafop-propargyl 500 g/ha was at par with its higher dose, *i.e*. 600 g/ha and mesosulfuron-methyl + iodosulfuron-methyl sodium 400 g/ha, metribuzin 300 g/ha and two hand weedings at 30 and 50 DAS recorded lowest density of weeds at 30 and 60 days after treatment against broad-leaved weeds, *viz. C. album*, *C. didymus*, *Melilotus* spp.,and *F. parviflora (*Table 1 and 2). Clodinafop-propargyl 400 g/ha was found to be ineffective against broad-leaved weeds. Excellent control of complex weed flora in wheat was observed with the tank mix application of clodinafop + metsulfuron (15:1 ratio) at 60 g/ha(Punia *et al*. 2004).

Table 1. Effect of metribuzin+clodinafop-propargyl and other herbicides on density of weeds at 30 DAS during 2010 and 2011.

Treatment	Product dose (g/ha)	Surfactant volume (ml/ha)	Weed density*/m^2 at 30 DAS											
			P. minor		*C. didymus*		*C. album*		Rumex spp.		*M. indica*		*F. parviflora*	
			2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Metribuzin + clodinafop-propargyl	400	1250	19.3 (4.5)*	4.28 (17.3)	5.3 (2.5)	2.54 (6.7)	4.0 (2.2)	2.49 (5.3)	4.0 (2.2)	2.49 (5.3)	2.3 (1.8)	2.08 (4.0)	3.0 (2.0)	1.83 (2.7)
Metribuzin + clodinafop-propargyl	500	1250	7.7 (2.9)	2.75 (6.7)	0.3 (1.1)	1 (0.0)	0.0 (1.0)	1 (0.0)	1.0 (1.4)	1.42 (1.3)	0.0 (1.0)	1.42 (1.3)	0.0 (1.0)	1.0 (0.0)
Metribuzin + clodinafop-propargyl	600	1250	2.3 (1.8)	1.83 (2.7)	15.7 (4.1)	4.43 (18.7	14.3 (3.9)	5.97 (34.7)	5.3 (2.5)	3.40 (10.7	11.3 (3.5)	3.60 (12.0	7.0 (2.8)	3.20 (9.3)
Isoproturon	1333.3	-	32.0 (5.7)	5.29 (27)	1.0 (1.4)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.42 (1.3)	1.0 (1.4)	1.0 (0.0)
Metribuzin	300	-	33.0 (5.8)	5.13 (25.3)	4.7 (2.4)	2.08 (4.0)	3.7 (2.2)	1.83 (2.7)	3.7 (2.2)	2.49 (5.3)	1.7 (1.6)	1.42 (1.3)	1.0 (1.4)	1.42 (1.3)
Clodinafop-propargyl	400	-	3.7 (2.2)	1.83 (2.7)	1.7 (1.6)	1.42 (1.3)	1.0 (1.4)	1.42 (1.3)	2.3 (1.8)	1.83 (2.7)	1.3 (1.5)	1.83 (2.7)	0.7 (1.3)	1.83 (2.7)
Mesosulfuron-methyl + iodosulfuron-methyl sodium + surfactant	400	500	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	1.0 (1.4)	1.0 (0.0)	0.7 (1.3)	1.0 (0.0)	0.7 (1.3)	1.42 (1.3)
Sulfosulfuron + surfactant	33.3	1250	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	1.0 (1.4)	1 (0.0)
Hand weeding at 30 and 50 DAS	-	-	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	0.0 (1.0)	1.0 (0.0)	1.0 (1.4)	1.0 (0.0)	0.0 (1.0)	1 (0.0)
Untreated control	-	-	72.0 (8.5)	8.15 (65.3)	13.7) (3.8	4.87 (22.7	17.0 (4.2)	5.85 (33.3)	6.0 (2.6)	3.78 (13.3	13.0 (3.7)	3.40 (10.7	6.3 (2.7)	3.58 (12.0
LSD (P=0.05)			0.46	0.69	0.41	1.06	0.23	0.70	0.53	0.73	0.43	1.01	0.47	0.84

* Figures in parentheses indicates original values # Mean of three replications

Table 2. Effect of metribuzin + clodinafop-propargyl and other herbicides on density of weeds during 2010 and 2011

Treatment	Product dose (g/ha)	Surfactant volume (ml/ha)	Weed density/m^2 at 60 DAS											
			P. minor		*C. didymus*		*C. album*		Rumex spp.		*M. indica*		*F. parviflora*	
			2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Metribuzin + clodinafop-propargyl	400	1250	17.0 (4.2)	3.95 (14.7)	7.0 (2.8)	2.49 (5.3)	3.0 (2.0)	2.08 (4.0)	3.3 (2.1)	2.08 (4.0)	5.0 (2.4)	2.08 (4.0)	2.0 (1.7)	1.83 (2.7)
Metribuzin + clodinafop-propargyl	500	1250	5.0 (2.4)	2.08 (4.0)	0.3 (1.1)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	1.7 (1.6)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)
Metribuzin + clodinafop-propargyl	600	1250	3.3 (2.1)	1.83 (2.7)	16.7 (4.2)	4.10 (16.0)	18.3 (4.4)	4.57 (20.0)	5.0 (2.4)	2.54 (6.7)	10.3 (3.4)	3.32 (10.7)	5.0 (2.4)	2.54 (6.7)
Isoproturon	1333.3	-	29.7 (5.5)	4.86 (22.7)	0.0 (1.0)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	1.0 (1.4)	1.00 (0.0)
Metribuzin	300	-	25.0 (5.1)	4.43 (18.7)	4.7 (2.4)	1.83 (2.7)	6.7 (2.8)	1.83 (2.7)	4.0 (2.2)	2.08 (4.0)	1.0 (1.4)	1.82 (2.7)	0.0 (1.0)	1.00 (0.0)
Clodinafop-propargyl	400	-	3.7 (2.2)	1.83 (2.7)	0.7 (1.3)	1.42 (1.3)	1.7 (1.6)	1.42 (1.3)	1.0 (1.4)	1.42 (1.3)	1.0 (1.4)	1.42 (1.3)	0.7 (1.3)	1.00 (0.0)
Mesosulfuron-methyl + iodosulfuron-methyl sodium + surfactant	400	500	0.7 (1.3)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.7 (1.3)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.7 (1.3)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)
Sulfosulfuron + surfactant	33.3	1250	0.7 (1.3)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.3 (1.1)	1.00 (0.0)	1.0 (1.4)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)
Hand weeding at 30 and 50 DAS	-	-	2.0 (1.7)	1.83 (2.7)	0.3 (1.1)	1.42 (1.3)	1.0 (1.4)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)	0.7 (1.3)	1.00 (0.0)	0.0 (1.0)	1.00 (0.0)
Untreated control	-	-	65.3 (8.1)	7.64 (57.3)	15.0 (4.0)	3.87 (14.7)	14.0 (3.9)	4.43 (18.7)	6.7 (2.8)	2.54 (6.7)	11.0 (3.5)	3.73 (13.3)	6.0 (2.6)	2.49 (5.3)
LSD (P=0.05)			0.52	0.91	0.28	0.98	0.42	0.84	0.71	NS	0.51	0.89	0.40	0.89

Figures in parentheses indicates original values; Data are mean of three replications

Table 3. Effect of metribuzin + clodinafop-propargyl and other herbicides on dry weight of weeds (mean of 2010 and 2011)

Treatment	Product dose (g/ha)	Surfactant (ml/ha)	Weed dry weight (g/m^2) at 30 DAS			WCE %	Weed dry weight (g/m^2) at 60 DAS			WCE%
			GW	BLW	Total		GW	BLW	Total	
Metribuzin + clodinafop-propargyl	400	1250	2.0	7.9	9.9	93.79	4.8	8.9	13.7	93.45
Metribuzin + clodinafop- propargyl	500	1250	0.0	1.3	1.3	99.18	0.0	0.0	0.0	100.0
Metribuzin + clodinafop- propargyl	600	1250	0.0	0.0	0.0	100.00	0.0	0.0	0.0	100.0
Isoproturon	1333.3	-	12.6	23.0	35.6	77.68	26.3	37.5	63.8	69.50
Metribuzin	300	-	5.2	3.1	8.3	94.79	6.7	1.7	8.4	95.98
Clodinafop-propargyl	400	-	1.7	52.3	54.0	66.14	4.5	93.5	98.0	53.15
Mesosulfuron-methyl + iodosulfuron-methyl sodium + surfactant	400	500	23.8	2.3	26.1	83.36	40.8	3.3	44.1	78.91
Sulfosulfuron + surfactant	33.3	1250	21.3	13.5	34.8	78.18	29.9	20.9	50.8	75.71
Hand weeding at 30 and 50 DAS	-	-	0.0	0.0	0.0	100.00	4.0	3.4	7.4	96.46
Untreated control	-	-	74.1	85.4	159.5	00.00	117.5	91.7	209.2	00.00
LSD (P=0.05)			11.8	5.8	13.1	-	35.2	5.3	35.0	-

Data are mean of three replications, GW= Grassy weeds, BLW= Broad-leaved weeds

Weed dry matter production

Weed management treatments significantly reduced the population and dry matter of grassy as well as broad-leaved weeds as compared to weedy check (Table 3). At 30 and 60 DAS, significantly lowest grassy weed dry weight was recorded with metribuzin + clodinafop-propargyl 500 g/ha at par with its higher dose *i.e.* at 600 g/ha and mesosulfuron-methyl + idosulfuron-methyl sodium 400 g/ha, metribuzin 300 g/ha, and twice hand weedings at 30 and 50 DAS. Similar trend was observed in case of dry matter accumulation in broad-leaved weeds at both the stages of observations *i.e.* at 30 and 60 DAS during 2010 and 2011.

Table 4. Effect of metribuzin + clodinafop- propargyl and other herbicides on yield attributes and grain yield of wheat during 2010 and 2011

Treatment	Product dose (g/ha)	Surfactant (ml/ha)	Plant height (cm)		No. of spikes/m^2		1000 grain wt. (g)		Grain yield (t/ha)	
			2010	2011	2010	2011	2010	2011	2010	2011
Metribuzin + clodinafop-propargyl	400	1250	100.6	100.4	258.7	255.0	46.0	44.7	5.61	5.55
Metribuzin + clodinafop-propargyl	500	1250	101.9	101.3	256.0	251.7	45.4	45.1	5.60	5.54
Metribuzin + clodinafop-propargyl	600	1250	101.9	100.9	268.0	259.3	45.1	44.9	5.63	5.59
Isoproturon	1333.3	-	100.5	100.7	257.0	235.3	44.7	43.2	5.35	5.41
Metribuzin	300	-	102.2	102.3	266.0	247.0	46.6	43.9	5.57	5.47
Clodinafop-propargyl	400	-	101.3	101.7	261.7	245.3	45.6	44.3	5.54	5.49
Mesosulfuron-methyl + iodosulfuron-methyl sodium + surfactant	400	500	99.8	101.3	248.7	231.7	44.1	42.9	4.90	5.11
Sulfosulfuron + surfactant	33.3	1250	100.1	99.8	259.0	224.0	44.5	42.3	5.31	4.88
Hand weeding at 30 and 50 DAS	-	-	100.1	100.3	260.0	240.0	46.5	43.5	5.57	5.47
Untreated control	-	-	103.2	103.3	241.3	157.7	42.1	41.8	4.26	3.14
LSD (P=0.05)			NS	NS	14.4	29.4	2.3	1.3	0.62	0.90

Data are mean of three replications

Weed control efficiency

Among the herbicidal treatments, the hundred per cent weed control efficiency against grassy and broad-leaved weeds was recorded with the application of metribuzin + clodinafop-propargyl 600 g/ha, which was followed by its lower dose applied at 500 g/ha at 30 and 60 DAS, respectively. However, lowest weed control efficiency was recorded with sole application of metribuzin 300 g/ha at both the stages of observations *i.e*. 30 and 60 DAS.

Effect on crop

Unchecked weed growth reduced grain yield of wheat by 43% when compared with metribuzin + clodinafop-propargyl 600 g/ha. Maximum yield (5.63 and 5.59 t/ha) was recorded from metribuzin + clodinafop-propargyl 600 g/ha, which was followed by its lower dose 500 g/ha (4.15 t/ha) and twice hand weeding at 30 and 50 DAS (5.60 and 5.54 t/ha). Higher grain yield with metribuzin + clodinafop-propargyl 600 g/ha was due to more number of effective tillers and number of grains/ear.

Phytotoxicity

There was no phytotoxic effect of metribuzin + clodinafop-propargyl at 500 and 1000 g/ha on wheat crop.

Residual effect on succeeding maize crop

Residues of metribuzin + clodinafop-propargyl applied in wheat even at 500 and 1000 g/ha did not cause any adverse effect on germination and growth of succeeding maize crop.

On the basis of field study, it can be concluded that metribuzin + clodinafop-propargyl 500 g /ha was found optimum dose in wheat for effective control of weeds and to attain higher grain yield of wheat without any phytotoxicity to wheat or on maize, which was grown as succeeding crop after harvest of wheat.

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