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Bio-efficacy of clodinafop-propargyl + metsulfuron methyl against complex weed flora in wheat

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ABSTRACT

Clodinafop 60 g/ha and metsulfuron methyl 4 g/ha + surfactant 0.02% alone, combinations of clodinafop and metsulfuron + surfactant at the similar and double dose and isoproturon + 2, 4-D were evaluated against complex weed flora in wheat during 2007-08 and 2008-09. *Phalaris minor, Avena ludoviciana* and *Lolium temulentum* were the major grassy weeds. *Vicia sp., Anagallis arvensis* and *Lathyrus aphaca* were among the broad-leaved weeds found growing in association with wheat crop. All the herbicidal treatments significantly reduced the dry weight of weeds. Tank mixture of clodinafop 60 g/ha + metsulfuron 4 g/ha and clodinafop 120 g/ha + metsulfuron 8 g/ha with and without 0.2% surfactant provided excellent control of weeds and produced significantly higher grain yield of wheat. Weeds caused 55.7% reduction in wheat grain yield.

Keywords: Clodinafop propargyl, metsulfuron methyl, surfactant, complex weed flora, wheat

wheat varieties coupled with improved facilities of irrigation and fertilizers have led to the problem to grassy weeds particularly *Phalaris minor* Retz and wild oats (*Avena ludoviciana* Dur). Losses due to *A. ludoviciana* in wheat have been to the extent of 16 to 65% depending upon intensity of its infestation. The acute problem of grassy weeds along-with broadleaf weeds is also not uncommon in many parts of country, which often results in huge yield losses and makes the weed management issue more complex (Singh and Singh 2002, Malik *et al.* 2005). Tank mixture of isoproturon with 2,4-D (Na salt) was successful against complex weed flora and has been recommended to the growers. However, repeated use of same herbicidal treatment may lead to development of resistant. Hence, there is a need to find out some suitable alternative herbicide mixture to tackle the problem of mixed weed flora. Therefore, it was realized to evaluate clodinafop and metsulfuron methyl alone and in tank mix application with and without surfactant against complex flora of weeds in wheat.

MATERIAL AND METHODS

Field experiment was conducted during the *Rabi* seasons of 2007-08 and 2008-09 at Palampur. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.6) and medium is available N (318 kg N/ha), P (19.2 kg/ha) and K (226.2 kg/ha). Eight weed control treatments *viz.* metsulfuron 4 g/ha+ 0.2% surfactant, clodinafop propargyl 60 g/ha, metsulfuron 4 g/ha + clodinafop 60 g/ha + 0.2% surfactant, metsulfuron 4 g/ha + clodinafop 1 60 g/ha, metsulfuron 8 g/ha + clodinafop 120 g/ha + 0.2% surfactant, metsulfuron 8 g/ha + clodinafop 120 g/ha, isoproturon 1.0 kg/ha + 2, 4-D 0.75 kg/ha and unweeded check were tested in randomized block design with three replications. Wheat variety HPW 155 was sown on November 8, 2007 and November 18, 2008. Except weed control treatments, the crop was raised in accordance with the recommended package of practices. The crop was fertilized with 60 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha as basal dose. Remaining half dose of nitrogen (60 kg/ha) was applied in two equal splits. The herbicides were sprayed with Knapsack sprayer fitted with flat fan nozzle using 700 L of water/ha after 40-45 days after sowing (DAS). Weed count and dry weight were recorded at 120 DAS and at harvest from two randomly selected spots (0.25 m^2) in each plot and expressed as No. m^{-2} and g m^{-2}, respectively. The data on count and dry weight of weeds were subjected to $\sqrt{x \quad 1}$ (square root transformation) for statistical analysis. Yields were harvested from net plot (4.0 m x 2.8 m).

RESULTS AND DISCUSSION

The dominant weeds in the experimental field were *Phalaris minor, Avena ludoviciana, Lolium temulentum, Vicia sativa, Lathyrus aphaca, Stellaria media, Coronopus didymus, Anagallis arvensis, Spergulla arvensis* and *Polygonum alatum*. The other weed species of minor importance were *Poa annua*, *Alopecurus myosuriodes* and *Plantago sp.*

The count and dry weight of *P. minor* was significantly affected under treatments during both the years. Tank mix application of metsulfuron at 4 g/ha + clodinafop at 60 g/ha with 0.2% non ionic surfactant (NIS) resulted in significantly lower dry weight of *P. minor* than its application without surfactant during both the years. However, the former treatment combination could not significantly reduce the count of *P. minor* over the later. The combination of metsulfuron and clodinafop with or without surfactant at higher dose was not significantly different from lower dose in influencing both count and dry weight of *P. minor* during both the years. Clodinafop was equally good in reducing the count of *Phalaris minor* during 2008-09. However, metsulfuron + NIS and isoproturon + 2, 4-D were poor against *P. minor as* they did not significantly reduce either its count or dry weight over weedy check.

Treatments under study brought about significant variation in the count of *Lolium temulentum* during 2007-08. All treatments except metsulfuron + NIS were significantly superior to weedy check in reducing *Lolium* count. Metsulfuron + clodinafop at both doses with NIS remaining at par with its application without surfactant significantly reduced the count of *L. temulentum* over other treatments. Clodinafop was at par with isoproturon + 2, 4-D in reducing the count of *L. temulentum.* Metsulfuron + clodinafop at both the doses with or without surfactant and clodinafop alone were at par in significantly reducing the count and dry weight of *A. ludoviciana* over isoproturon + 2, 4-D/weedy check during both the years. However, isoproturon + 2, 4-D was statistically at par with weedy check in influencing the count and dry weight of *A. ludoviciana* in 2007-08.

Preponderance of grasses had smothering effect on broadleaved weeds (Table 2). All treatments except clodinafop differed significantly from weedy check in influencing count and dry weight of *A. arvensis* during both the years and that of *V. sativa* during 2008-09 and count of *C. didymus in* 2007-08. However, clodinafop 60 g + NIS and Metsulfuron 4 g/ha + NIS significantly reduced the count and all treatments except clodinafop 60 g/ha significantly reduced the dry weight of *V. sativa* over weedy check.

Metsulfuron + clodinafop with and without surfactant was significantly superior to all the other treatments in reducing total weed count and total weed dry weight during 2007-08. However, for weed count isoproturon + 2, 4-D and for total weed dry weight metsulfuron + NIS and clodinafop were at par with metsulfuron 8 g/ha + clodinafop 120 g/ha with and without surfactant and metsulfuron 4 g/ha + clodinafop 60 g/ha without surfactant during 2008-09. All treatments significantly reduced the total weed count during both the years, but metsulfuron + NIS, clodinafop and isoproturon + 2, 4-D could not significantly reduced total weed dry weight over weedy check during 2008-09.

All treatments were significantly superior to weedy check in increasing grain yield of wheat during both the years. Owing to significantly superior weed control, tank mix application of metsulfuron + clodinafop with surfactant remaining at par with metsulfuron + clodinafop without surfactant during both the years and clodinafop 60 g/ha during 2007-08 was superior to other treatments and recorded significantly higher grain yield of wheat (Table 3). Isoproturon + 2, 4-D was as good as metsulfuron + clodinafop without surfactant. Similar findings were also reported by Malik *et al.* (2005). Weeds in unweeded check reduced the grain yield of wheat by 82.5 and 64.8 per cent over the best treatment of metsulfuron 4 g/ha + clodinafop 60 g/ha with 0.2 % NIS during 2007-08 and 2008-09, respectively. Chahal *et al.* (2003) have also reported 54% higher grain yield of wheat over unweeded check with the application of clodinafop. The compatibility test indicated that metsulfuron methyl 20 WG and clodinafop propargyl 15 WP were compatible with each other.

The present investigation conclusively inferred that while metsulfuron and clodinafop alone were either ineffective or less effective against one or the other category of weeds but in combination because of being compatible with each other were quite effective against mixed weed flora in wheat. Because of having superior weed killing ability metsulfuron 4 g + clodinafop 60 g/ha with NIS (0.02%) may be the better alternative to isoproturon 1250 g/ha + 2, 4-D 750 g/ha against mixed weed flora in wheat.

Table 1. Effect of treatments on grassy weeds at their maximum population (no/m^2) and dry matter (g/m^2) stage in wheat

Treatments	Dose (g /ha)	Species wise weed count (no./m^2) *Phalaris minor*				*Lolium temulentum*				*Avena ludoviciana*				*Poa annua*			
		2007-08		2008-09		2007-08		2008-09		2007-08		2008-09		2007-08		2008-09	
		Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count		Dry wt.	
Metsulfuron methyl + surfactant	4	7.5(56)	6.4(39.9)	6.9(46.7)	3.9(18.0)	2.6(8.0)	1.4(1.0)	2.2(4.4)	1.0(0.0)	3.1(10.7)	5.5(27.2)	2.2(4.0)	1.1(0.3)	2.2(6.7)	1.5(1.6)	1.0(0.0)	1.0(0.0)
Clodinafop propargyl	60	4.1(12)	2.5(5.5)	4.7(26.0)	3.7(13.6)	1.9(4.0)	1.0(0.0)	1.9(4.0)	1.0(0.0)	2.0(5.3)	1.5(1.3)	2.7 (6.7)	1.2 (0.4)	2.1(4.0)	1.1(0.2)	1.0(0.0)	1.0(0.0)
Metsulfuron methyl + Clodinafop + Surfactant	4+ 60	2.3(12)	1.4(1.0)	3.9(17.3)	2.5(8.7)	1.0(0.0)	1.0(0.0)	1.4(1.3)	1.0(0.0)	1.7(2.7)	1.2(0.6)	2.1(4.0)	1.1(0.2)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Metsulfuron methyl + Clodinafop	4+ 60	2.9(8)	2.4(4.9)	5.2(28.0)	3.8(16.0)	1.4(1.3)	1.1(0.2)	1.0(0.0)	1.9(4.3)	2.1(4.0)	1.6(2.0)	2.5(5.3)	1.2(0.5)	1.4(1.3)	1.2(0.6)	1.0(0.0)	1.0(0.0)
Metsulfuron methyl+ Clodinafop + Surfactant	8+ 120	3.1(9.8)	1.5(1.3)	5.4 (29.3)	2.5(8.7)	1.0(0.0)	1.0(0.0)	1.4(1.3)	1.0(0.0)	2.1(4.0)	1.4(1.1)	2.1(4.0)	1.1(0.2)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.1(0.1)
Metsulfuron methyl+ Clodinafop	8+120	3.4(16)	1.7(2.1)	5.6(32.0)	2.6(8.8)	1.4(1.3)	1.1(0.2)	1.0(0.0)	1.0(0.0)	2.2(4.7)	1.7(2.1)	2.5(5.3)	1.2(0.5)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Isoproturon + 2,4-D	1250 +0750	6.7(48)	4.9(23.4)	6.5(44.0)	4.9(24.0)	1.7(2.7)	1.2(0.5)	1.7(2.7)	1.0(0.0)	5.0(24.0)	6.1(36.7)	6.6(42.7)	4.0(15.2)	1.4(1.3)	1.1(0.2)	1.0(0.0)	1.0(0.0)
Unweeded	-	10.3(112)	7.2(50.9)	7.9(66.7)	5.3(27.9)	2.5(6.7)	1.2(0.4)	2.8(13.3)	1.3(0.7)	5.0(24.0)	6.4(40.5)	8.2(66.7)	6.5(40.8)	1.0(0.0)	1.0(0.0)	2.7(12.0)	1.0(0.0)
LSD (P=0.05)		1.1	1.0	1.9	1.3	0.5	NS	NS	NS	2.0	0.6	1.1	0.3	NS	NS	NS	NS

Values in the parentheses are the means of original values

Table 2. Effect of treatments on broadleaf weeds at their maximum count (no/m^2) and dry weight (g/m^2) stage in wheat

Treatments	Dose (g/ha)	Species wise weed count (no./m^2) *Vicia sativa*				*Anagallis arvensis*				*Coronopus*		*Lathyrus*	
		2007-08		2008 -09		2007-08		2008-09		2007-08		2008-09	2007-08
		Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.	Count	Dry wt.
Metsulfuron methyl+ surfactant	4	2.5(6.7)	1.4(0.8)	1.8(2.7)	1.1(0.2)	1.2(0.4)	1.8 (2.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.(0.0)
Clodinafop propargyl	60	5.4(28.0)	2.3(4.8)	7.2(50.7)	5.0(24.6)	5.4(28.6)	7.0 (48.0)	9.2(86.7)	1.7(2.7)	4.7(22.0)	2.1(4.0)	1.7(2.7)	1.7(2.7)
Metsulfuron methyl+ Clodinafop + Surfactant	4+ 60	1.0(0.0)	1.3(0.8)	1.7 (2.7)	1.2(0.4)	1.1(0.4)	1.7 (2.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Metsulfuron methyl+ Clodinafop	4+ 60	3.4(10.7)	1.8(2.3)	2.2(4.0)	1.1(0.2)	1.6(2.0)	3.6 (12.0)	1.8(2.7)	1.0(0.0)	1.1(0.2)	1.0(0.0)	1.4(1.3)	1.0(0.0)
Metsulfuron methyl+ Clodinafop+ Surfactant.	8+ 120	2.9(8.0)	1.4(1.3)	1.7(2.7)	1.2(0.5)	1.2(0.5)	2.1 (4.0)	1.8(2.7)	1.0(0.0)	1.1(0.2)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Metsulfuron methyl+ Clodinafop	8+120	3.4(10.7)	2.2(4.0)	2.2(4.0)	1.0(0.0)	1.8(2.2)	2.7 (8.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Isoproturon +2,4-D.	1250 +0750	3.7(13.3)	1.5(1.5)	1.8(2.7)	1.1(0.2)	1.7(2.0)	3.1 (10.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)
Unweeded.	-	3.6(12.0)	3.1(9.0)	1.8(2.7)	1.1(0.2)	1.4(1.2)	2.7 (8.0)	1.0(0.0)	1.0 (0.0)	1.0(0.0)	**1.1**	2.0(5.3)	1.0(0.0)
LSD (P=0.05)		2.4	1.2	1.0	0.3	0.7	2.1	1.3	NS	0.6	0.1	NS	NS

Values in the parentheses are the means of original values

Table 3. Effect of different treatments on total weed count, total weed dry weight and grain yield of wheat

Treatment	Dose (g/ha)	Total weed count (no./m^2)		Total weed dry weight (g/m^2)		Grain yield (kg/ha)	
		2007-08	2008-09	2007-08	2008-09	2007-08	2008-09
Metsulfuron methyl+ surfactant	4	9.8 (97.3)	10.6(111.1)	7.0 (47.5)	5.7(34.1)	2576	2615
Clodinafop propargyl	60	9.7 (93.3)	13.6(186.7)	6.8 (44.8)	5.7(36.1)	3748	2889
Metsulfuron methyl+ Clodinafop + Surfactant	4 + 60	5.0 (24.0)	4.9(22.7)	2.4 (4.8)	3.4(18.3)	4053	3448
Metsulfuron methyl+ Clodinafop	4 + 60	6.3 (41.3)	6.6(42.7)	3.1 (8.9)	5.2(26.7)	3833	3111
Metsulfuron methyl+ Clodinafop+ Surfactant.	8 + 120	5.9 (33.3)	5.7(32.0)	2.6 (6.0)	4.3(19.8)	3819	3281
Metsulfuron methyl+ Clodinafop	8+120	6.4. (43.3)	5.7(32.0)	3.3 (10.8)	5.0(25.2)	3788	3111
Isoproturon +2,4-D.	1250 + 750	9.0 (80.3)	7.5(56.0)	8.1 (63.8)	7.2(52.3)	3489	2815
Unweeded.	-	13.4(178.3)	14.8(217.3)	10.8(116.4)	7.4(56.0)	1433	1889
LSD (P=0.05)		1.7	2.6	1.0	1.8	315	342

Values in the parentheses are the means of original values

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