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Bio-efficacy of ready-mix formulation of clodinafop-propargyl + metsulfuron for control of mixed weed flora in wheat

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ABSTRACT

Field efficacy of ready mix formulation of clodinafop-propargyl + metsulfuron-methyl was evaluated against mixed weed flora in wheat during winter seasons of 2010-11 and 2011-12 at Punjab Agricultural University, Ludhiana. The results indicated that ready-mix of clodinafop+ metsulfuron at 75 g/ha + 0.2% surfactant recorded effective control of grass and broadleaf weeds and recorded similar wheat grain yield to sequential application of clodinafop 60 g/ha and metsulfuron 4 g/ha and weed free without any phytotoxicity symptoms on the crop.

Key words: Clodinafop, Metsulfuron, Ready-mix formulation, Weeds, Wheat

In India, wheat is the second important food crop, being next to rice. Punjab covers 14% of the total wheat area and accounts for 25% of national wheat production. The wheat crop is invaded by grass and broad-leaved weeds which can reduce the grain yield up to 80%. Loss in yield depends upon weed type, density, timing of emergence, wheat density, wheat cultivar and soil and environmental factors (Malik and Singh 1995, Chhokar and Malik 2002). Among grass weeds, *Phalaris minor* and among broad-leaved weeds, *Rumex dentatus*, *Chenopodium album*, *Anagallis arvensis*, *Medicago denticulata*, *Melilotus alba*, *Fumaria parviflora*, *Coronopus didymus etc*. are of major concern in irrigated wheat under rice–wheat system (Chhokar *et al*. 2006). The farmers end up with applying two herbicides at different timings for the control of grasses and broad-leaved weeds which add to the labour costs and many times the delayed application of any of the herbicides results in poor control of weeds.

Hence, there is a need for compatible herbicide combinations which could control the weeds in a single pass. Already, a few herbicides are there which controls a variety of weeds in wheat, but one or the other weeds escape with the use of these herbicides. Farmers are using different mixtures of herbicides in wheat already at their own. In some cases, the herbicide mixtures, when used at higher doses, cause phytotoxicity in wheat. However, in ready-mix formulations, the different herbicides are mixed in desired concentration to avoid any phytotoxicity on the crop. The use of ready mix formulations are advantageous over sequential applications, due to saving in application timing and cost. Herbicide mixtures, besides providing control of complex weed flora, also helps in managing and delaying the herbicide resistance in weeds (Wruble and Gressel 1994). The field efficacy of ready mix formulation of clodinafop and metsulfuron was evaluated for control of mixed weed flora in wheat.

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MATERIALS AND METHODS

A field experiment was conducted at Punjab Agricultural University Ludhiana during *Rabi* 2010-11 and 2011-12. Fifteen treatments, *viz*. ready-mix formulation of clodinafop-propargyl 15% + metsulfuron-methyl 1% at 45, 60, 75, 90 and 120 g/ha applied with and without 0.2% surfactant, clodinafop 60 g /ha, metsulfuron 4 g/ha + surfactant 0.2%, clodinafop followed by metsulfuron at 60 *fb* 4 g/ha, weed free and unsprayed control, were evaluated in RCBD with three replications. All the herbicides were applied at 35 days after sowing (DAS) with knapsack sprayer having discharge rate of 375 liters water/ha.

The wheat variety '*PBW 550*' was sown in 22.5 cm spaced rows using 100 kg seed/ha on 16.11.2010 and 17.11. 2011 during first and second years, respectively. The crop was fertilized with 125 kg N, 60 kg P_2O_5 and 30 kg K_2O per ha. The nitrogen was applied in the form of urea (46% N), P_2O_5 in form of diammonium phosphate and K_2O in form of muriate of potash (60% K_2O). Entire quantity of phosphorus and potassium and one-half of nitrogen was drilled at the time of sowing. Remaining N was broadcasted with the first irrigation. Data on weed count and dry

matter accumulation of weeds was taken, with quadrate measuring 0.5 x 0.5m placed randomly at three spots per plot, at 60 DAS. Weeds were cut from the ground level, dried in sun and then oven dried at 60 °C and then weighed. The weed data were subjected to square root transformation before analysis. The data on panicle length, effective tillers per square metre and grain yield of wheat were recorded at the time of crop harvest.

RESULTS AND DISCUSSION

Effect on weeds

The experimental field was infested with grass weed *Phalaris minor* and few broad-leaved weeds, *viz*. *Chenopodium album, Anagallis arvensis, Medicago denticulata, Rumex dentatus* and *Coronopus didymus*.

Ready mix formulation of clodinafop + metsulfuron, when applied with surfactant, recorded similar population but lower dry matter of *P. minor* during both the years, as compared to its application without surfactant. However, addition of surfactant in clodinafop + metsulfuron ready mix significantly reduced the population and dry matter accumulation of broad-leaved weeds as compared to without surfactant during both the years. Clodinafop is basically a grass herbicide and provide effective control of grass weeds without the use of external surfactant. Metsulfuron is a broad-leaved herbicide and applied along with surfactant for effective control of weeds. Hence, the control of *P. minor* was similar when the ready-mix of clodinafop and metsulfuron was used even without surfactant while addition of surfactant enhanced the control of broad-leaved weeds. The population and dry matter did not vary among different doses of clodinafop and metsulfuron applied with surfactant, however, the dry matter was remarkably reduced at 75 g/ha which was significantly lower than its lower dose and at par with its higher doses and clodinafop alone (Table 1).

The control of broad-leaved weeds was significantly reduced with the increase in the dose of ready-mix clodinafop and metsulfuron up to 75 g/ha and was at par to use of metsulfuron + surfactant applied alone. The application of ready mix clodinafop and metsulfuron at 75 g/ha recorded the highest weed control efficiency, for grass and broad-leaved weeds and was at par to sequential application of clodinafop and metsulfuron during both the years. Clodinafop alone at 60 g/ha recorded effective control of *P. minor,* however, being only a grass killer it did not control broad-leaved weeds. Metsulfuron alone at 4 g/ha recorded effective control of only broad-leaved weeds, being a broa-leaved weed killer. Ready-mix formulation of clodinafop and metsulfuron did not provide effective control of broad-leaved weeds at all the doses, when applied without surfactant. The ready-mix of clodinafop and metsulfuron when applied with and without surfactant at 45 and 60 g/ha was poor on grass and broa-leaved weeds (Table 1 and 2). Effective control of complex weed flora in wheat with tank-mix or ready-mix formulation of clodinafop + metsulfuron and ready-mix formulation

Table 1. Effect of herbicide treatments on weed density and dry matter of weeds in wheat during *Rabi* 2010-11

Treatment	Dose g/ha	60 DAS				WCE (%)	
		P. minor population (no./m^2)	BLW population (no./m^2)	Dry weight of *P. minor* (g/m^2)	Dry matter of BLW (g/m^2)	Grass weeds	Broad-leaved weeds
Clodinafop + metsulfuron	45+3	2.2 (4)	3.0 (8)	4.6 (20)	7.6 (56)	89.5	56.9
Clodinafop + metsulfuron	60+4	2.0 (3)	2.9 (7)	4.5 (19)	6.7 (44)	90.1	66.2
Clodinafop + metsulfuron	75+5	1.9 (3)	2.8 (7)	4.2 (17)	5.5 (29)	91.1	77.7
Clodinafop + metsulfuron	90+6	1.7 (2)	1.8 (2)	4.0 (15)	4.4 (19)	92.1	85.4
Clodinafop + metsulfuron	120+8	2.1 (3)	1.4 (0.8)	3.4 (11)	4.8 (22)	94.2	83.1
Clodinafop + metsulfuron + S	45+3+S	2.1 (3)	2.6 (6)	5.1 (25)	6.0 (34)	86.9	73.8
Clodinafop + metsulfuron + S	60+4+S	1.8 (2.2)	2.0 (3)	3.3 (10)	3.9 (15)	94.8	88.5
Clodinafop + metsulfuron + S	75+5+S	1.6 (2)	1.7 (2)	2.6 (6)	3.3 (10)	96.9	92.3
Clodinafop + metsulfuron + S	90+6+S	1.5 (1)	1.6 (2)	2.8 (7)	3.5 (11)	96.3	91.5
Clodinafop + metsulfuron+ S	120+8+S	1.2 (0.7)	1.5 (1)	2.4 (5)	2.7 (6)	97.4	95.4
Clodinafop *fb* metsulfuron	160 *fb* 4	2.1 (3)	1.8 (2)	3.2 (9)	3.6 (12)	95.3	90.8
Metsulfuron	4	5.2 (26)	2.1 (4)	13.2 (187)	5.0 (24)	2.1	81.5
Clodinafop	160	2.5 (5)	4.2 (17)	3.3 (10)	10.8 (125)	91.1	3.8
Weed free	-	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	100	100
Unweeded control	-	5.3 (28)	4.4 (18)	13.9 (191)	11 (130)	-	-
LSD (P=0.05)		0.5	0.4	0.5	0.5	-	-

Parentheses are original means and data is subjected to square root transformation; S=Surfactant 1250 mL/acre

at 64 g/ha has been reported from Haryana (Punia *et al.* 2004, Malik *et al.* 2013). Application of clodinafop + metsulfuron at 75+5 g/ha with surfactant was found to be most effective and provided 97.3% control of grassy weeds and excellent control (96.5%) of broad-leaved weeds were reported by Singh *et al.* (2012).

All the weed control treatments recorded significantly higher wheat grain yield than unsprayed control during both the years. Ready-mix formulation of clodinafop + metsulfuron at 75 g/ha with 0.2% surfactant produced the highest wheat grain yield (5.77 and 5.50 t/ha) during both the years. Its higher dose of 90 and 120 g/ha though controlled weeds effectively (Table 1 and 2) but recorded significant reduction in effective tillers and grain yield (Table 3). The differences in wheat grain yield were reflected in the effective tillers and panicle length under different weed control treatments. Application of clodinafop and metsulfuron alone recorded lower grain yield due to poor control of broad-leaved and grass weeds, respectively. The ready-mix formulation of clodinafop and metsulfuron did not show any phytotoxicity on wheat plants at all the doses tested.

Table 2. Effect of different treatments on weed count and dry matter of weeds during *Rabi* 2011-12

Treatment	Dose g /ha	60 DAS				WCE (%)	
		P. minor (no./m^2)	Broad-leaved weeds (no./m^2)	Dry wt. *P. minor* (g/m^2)	Dry wt. BLW (g/m^2)	Grass weeds	Broad-leaved weeds
Clodinafop + metsulfuron	45+3	3.1 (9)	3.7 (13)	4.3 (17)	6.8 (44)	73.8	33.3
Clodinafop + metsulfuron	60+4	3.2 (9)	3.3 (10)	4.0 (15)	6.0 (35)	76.9	47.0
Clodinafop + metsulfuron	75+5	2.8 (7)	2.9 (7)	3.7 (13)	4.9 (23)	80.0	65.2
Clodinafop + metsulfuron	90+6	2.5 (6)	2.7 (7)	3.3 (10)	3.8 (14)	84.6	78.8
Clodinafop + metsulfuron	120+8	1.7 (2)	1.4 (1)	1.8 (2)	1.7 (2)	96.9	97.0
Clodinafop + metsulfuron + surfactant	45+3+S	3.0 (8)	3.5 (12)	4.2 (17)	6.1 (37)	73.8	43.9
Clodinafop + metsulfuron + surfactant	60+4+S	2.0 (3)	2.4 (5)	2.4 (5)	3.2 (9)	92.3	86.4
Clodinafop + metsulfuron + surfactant	75+5+S	1.5 (1)	1.9 (3)	1.6 (2)	2.0 (3)	95.4	92.4
Clodinafop + metsulfuron + surfactant	90+6+S	1.6 (2)	1.8 (2)	1.8 (3)	2.2 (4)	95.4	93.9
Clodinafop + metsulfuron + surfactant	120+8+S	2.7 (6)	3.1 (8)	1.3 (0.8)	2.8 (7)	98.8	89.4
Clodinafop *fb* metsulfuron	160 *fb* 4	1.8 (2)	1.8 (2)	2.0 (3)	2.4 (5)	96.9	95.5
Metsulfuron	4	4.1 (16)	2.5 (6)	6.0 (35)	3.1 (9)	46.2	86.4
Clodinafop	160	3.4 (11)	4.5 (19)	3.7 (13)	7.8 (54)	80.0	18.2
Weed free	-	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	100	100
Unweeded control	-	3.9 (15)	5.2 (26)	8.1 (65)	8.2 (66)	-	-
LSD (P=0.05)	-	0.5	0.4	0.4	0.4	-	-

Parentheses are original means and data is subjected to square root transformation; S=Surfactant 1250 ml/acre

Table 3. Effect of herbicide on yield and yield components of wheat during 2010-11 and 2011-12

Treatment	Dose g/ha	Panicle length (cm)		Effective tillers (no./m^2)		Grain yield (t/ha)	
		2010-11	2011-12	2010-11	2011-12	2010-11	2011-12
Clodinafop + metsulfuron	45+3	10.3	10.7	319.2	334.5	4.09	4.03
Clodinafop + metsulfuron	60+4	10.4	11.1	323.0	346.9	4.49	4.60
Clodinafop + metsulfuron	75+5	10.4	11.2	333.7	350.0	5.10	4.75
Clodinafop + metsulfuron	90+6	10.8	11.2	335.0	350.0	5.21	4.73
Clodinafop + metsulfuron	120+8	10.5	11.1	328.0	348.0	4.84	4.56
Clodinafop + metsulfuron + surfactant	45+3+S	10.9	11.1	335.0	353.0	5.22	5.15
Clodinafop + metsulfuron + surfactant	60+4+S	11.0	11.2	338.1	355.0	5.52	5.22
Clodinafop + metsulfuron + surfactant	75+5+S	11.1	11.3	346.0	357.3	5.77	5.50
Clodinafop + metsulfuron + surfactant	90+6+S	10.8	11.1	335.0	351.5	5.28	4.92
Clodinafop + metsulfuron+ surfactant	120+8+S	10.7	11.1	333.0	351.0	5.06	4.95
Clodinafop *fb* metsulfuron	160 *fb* 4	11.0	10.8	338.0	333.3	5.52	4.18
Metsulfuron	4	10.8	11.2	334.0	351.0	5.23	4.97
Clodinafop	160	10.4	11.2	327.0	354.0	4.72	5.29
Weed free	-	11.0	11.2	338.8	353.0	5.49	5.34
Unweeded control	-	9.3	9.9	284.1	284.5	2.84	3.38
LSD (P=0.05)	-	0.05	0.04	5.9	3.0	0.11	0.11

S-Surfactant 1250 ml/acre

The similar wheat grain yield with ready-mix formulation of clodinafop + metsulfuron at 60 g /ha to sequential application of clodinafop and metsulfuron has been reported earlier by Malik *et al.* 2013. Punia *et al.* 2008 also reported maximum grain yield with the use of clodinafop + metsulfuron + surfactant at 75 + 5 g/ha which were at par with weed free check and ready mixture of sulfosulfuron + metsulfuron and clodinafop + metsulfuron + surfactant at 60 + 4 g/ha but significantly higher than clodinafop and sulfosulfuron alone. Similar results were reported by Singh *et al.* (2012). One post-emergence application of ready-mix formulation of clodinafop + metsulfuron (Vesta) at 75 g/ha along with 0.2% surfactant recorded effective control of grass and broad-leaved weeds in wheat.

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