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Bioefficacy and phytotoxicity of herbicide UPH-206 (clodinafop propargyl 15% + metsulfuron 1%) for the control of complex weed flora in wheat and its residual effect on succeeding sorghum crop

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ABSTRACT

Two field experiments were conducted at Chaudhary Charan Singh Haryana Agricultural University, Hisar during winter season of 2005-06 and 2006-07 to study the bioefficacy and phytotoxicity of herbicide UPH-206 (Clodinafop propargyl 15% + Metsulfuron 1%) for the control of complex weed flora in wheat (*Triticum aestivum* L.). Dominant grassy weeds, *viz.*, little seed canary grass (*Phalaris minor* Retz.), wild oat (*Avena ludoviciana* and broadleaf weeds like common lambsquartres (*Chenopodium album* L.), yellow sweet clover (*Melilotus indica* All), golden dock (*Rumex dentatus* L.) and swine grass (*Coronopus didymus* L.) were effectively controlled by post emergence (35 DAS) application of UPH-206, a ready-mix formulation of clodinafop 15% + metsulfuron 1%) at 60 + 4 g /ha. Maximum grain yield (4890 and 4894 kg/ha) was obtained with the use of UPH-206 + S at 75+5 g/ha which were at par with weed free check and ready mixture of sulfosulfuron + metsulfuron and UPH 206 + S at 60 + 4 g/ha but significantly higher than clodinafop and sulfosulfuron. No carry over effect of this herbicide at any of doses tested was observed on succeeding sorghum crop.

Key Words: UPH- 206, Clodinafop, Sulfosulfuron, Herbicide carry over, *Phalaris minor*, Wheat, DAS

Wheat (*Triticum aestivum* L. emend Fiori and Paol) crop gets infested with heavy population of wild canary grass (*Phalaris minor* Retz.), wild oat (*Avena ludoviciana* Dur.), common lambs quarters (*Chenopodium album* L.), yellow sweet clover (*Melilotus indica* All), swine grass (*Coronopus didymus* L.), jangli palak (*Rumex retroflexus* L.), common vetch (*Vicia sativa* L.) and scarlet pimpernel (*Anagallis arvensis* L.). Isoproturon was in use since 1982 in major belt of India for effective control of P.minor but, its efficacy has declined during the last 15 years due to development of resistance in Phalaris minor in some parts of India (Malik and Singh 1995). To tackle the resistance problem fenoxaprop-p-ethyl, sulfosulfuron and clodinafop- propargyl have been recommended (Chhokar and Malik 2002) 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 have resulted in tremendous increase in density of broadleaf weeds especially *Rumex retroflexus*, *C.album*, *M.indica* and *Fumaria parviflora* at farmers fields. Hence there is a need to evaluate more herbicides with different mode of action for the control of complex weed flora in wheat. Keeping it in view, the present investigation on the bioefficacy of new herbicide molecule coded as UPH-206 sponsored by M/s United Phosphorus Ltd. Mumbai was under taken.

MATERIALS AND METHODS

To evaluate the efficacy of UPH-206, a ready-mix formulation of clodinafop 15% + metsulfuron 1%) registered with trade name Vesta against weeds in wheat, field experiments were conducted during the rabi (winter) 2005-06 and 2006-07 at 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 November 14, 2005 and November 28, 2006 during first and second year respectively, on raised beds in furrow irrigated raised bed system (FIRBS) at a seed rate of 87.5 kg/ha. Three rows of wheat per bed were grown and the plot size was 7.0 x 2.1 m (3 beds per plot). Recommended dose of fertilizers and irrigations were applied uniformly. Different doses of UPH-206 (clodinafop 15% + metsulfuron 1%) either alone or with surfactant and other treatments were applied at 35 DAS (details in Table 1). Thus, fourteen treatments were replicated thrice in randomized block design. Herbicides were applied with knapsack sprayer at 375 liters of water /ha. The data on

weed population (no/m^2), dry matter accumulation (g/m^2) was recorded at 120 DAS. Similarly data on no. of earheads/m^2 and grain yield (q/ha) were also recorded at harvest. The data on percent visual control (phytotoxicity) of weeds was 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. To study the phytotoxic effects of this herbicide on crop, visual rating on scale of 0-10 for different treatments of UPH -206 was made and compared with untreated check.

Residual effect of these herbicides applied in wheat was studied through bioassay studies by planting sorghum var. SSG-Hara chara in the same plots by giving slight disking without disturbing the original layout. Data on plant population, plant height and green fodder yield was recorded 30 days after planting sorghum.

RESULTS AND DISCUSSION

During 2005-06, *Phalaris minor* Retz. was the only grassy weed constituting 14.6% of total weed population. *C.album, Rumex dentatus* were the major broadleaf weeds with a population of 58.6% of total weed flora. In the second year 2006-07, grassy weeds *P.minor* and *Avena ludoviciana* constituted 35.2% of total weed population

Table 1. Effect of UPH-206 on weed density and weed dry weight at 60 and 120 DAS

Treatment	Dose (g)		Density (No./m^2) 60 DAS				Dry wt. of weeds(g/m^2) 120 DAS			
	a.i./ha	Product (g)	2005-06		2006-07		2005-06		2006-07	
			P.minor	*C.album*	*P.minor*	*C.album*	Grassy	BLW	Grassy	BLW
Weedy Check		-	3.4* (10.7)	6.7(44.0)	4.71(21.2)	5.7(32.0)	260.4	113.3	286. 8	129.6
Isoproturon75 % WP	1000	1333	2.5(5.3)	1.0(0)	4.0(15.3)	2.7(6.5)	208.3	4.7	228.6	48.9
Sulfosulfuron 75 % WP	25	33.33	1.9(2.7)	3.1(8.7)	2.2(5)	3.0(8.0)	26.5	39.3	36.2	46.2
Clodinafop15 % WP	60	160	1.8(2.7)	6.4(40)	2.0(3.2)	5.9(34)	25.1	115.0	24.1	125.0
Metsulfuron20 %WP	4	20	5.1(25.3)	1.4(1.3)	4.6(20.3)	1.7(2.0)	263.6	7.9	271.9	10.6
UPH206	45+3	120	2.8(6.7)	3.7(13.3)	9.2(7.6)	3.4 (10.8)	59.3	19.7	84.0	26.8
UPH206	60+4	160	2.7(6.7)	2.1(4.0)	2.8(7.0)	2.4(5.0)	41.4	1.6	71.6	0.0
UPH206	75+5	200	1.5(1.3)	1.5(1.3)	2.2(4.0)	1.0(0)	22.6	0.7	25.3	0.0
UPH206+S	120+8	320	1.5(1.3)	1(0)	1.0(0)	1(0)	3.7	0.0	0.0	0.0
UPH206+S	45+3+S	120+S	1.8(2.7)	1.4(1.3)	2.0(3.2)	1(0)	25.4	1.1	20.8	0
UPH206+S	60+4+S	160+S	1(0)	0(1.0)	1(0)	1.0(0)	0	0.0	0.0	0.0
UPH206+S	75+5+S	320+S	1(0)	1(0)	1(0)	1.0(0)	0	0.4	0.0	0.0
Sulfosulfuron+ Metsulfuron (Total)	30+2	40	2.3(4.7)	1(0)	2.0(3.0)	1.0(0)	0.0	3.7	0.0	0.0
Weed Free			1(0)	1(0)	1(0)	1(0)	0.0	0.0	0.0	0.0
LSD (P= 0.05)			**0.72**	**0.4**	**0.65**	**0.43**	**18.0**	**6.85**	**11.2**	**5.2**

*Dose on product basis . *Transformed values ($\sqrt{x+1}$), original values are given in parenthesis
Note: Herbicide treatments were applied 35 days after wheat sowing. S =Surfactant was used at 0.2%.

where as *C.album, Rumex dentatus, Coronopus didymus, Melilotus indica, Medicago denticulate* were major broadleaf weeds infesting experimental area.

Efficacy against grassy weeds

Data presented in table 1 and 2 revealed that application of all herbicides significantly reduced the population and dry matter of weeds recorded at 60 DAS and 120 DAS as compared to weedy check. UPH 206 alone (with out surfactant) at 45 + 4 and 60 + 4 g/ha was not much effective in controlling *P. minor* but with the addition of surfactant at 0.2%, UPH-206 at 60 +4 and 75+5 g/ha was most effective and provided 97-98% control of grassy weeds which was even higher than already recommended herbicides like clodinafop-propargyl and sulfosulfuron as shown by density, dry weight and per cent control of weeds (Table 1 and 2). Among grassy herbicides, Isoproturon 75% WP at 1000 g/ha was found least effective for the control of grassy weeds which provided only 61 and 52% control of *P.minor* during 2005-06 and 2006-07, respectively Singh *et al.* (2007) also reported excellent control of grassy as well as broadleaf weeds in wheat with the application of UPH 206 at 60+4 and 75+5 g/ha.

Efficacy against broad leaf weeds

Data recorded at 120 DAS and presented in table 2 indicated that UPH 206 alone (without surfactant) at 45+4 and 60+4 g/ha provided only 65-85% control of

Coronopus didymus, Rumex dentatus and *C. album* but with the addition of surfactant at 0.2% this herbicide showed excellent efficacy against all broadleaf weeds even at 45+4 g/ha which was at par with recommended metsulfuron-methyl at 8 g/ha and ready mix combination of sulfosulfuron+ metsulfuron (Total). However, the treatments UPH-206 at 60+4 g/ha + surfactant at 0.2% and UPH-206 at 75+5 g/ha +surfactant at 0.2% were statisti-

Table 2. Percent weed control, number of effective earheads/m ^{2} and grain yield of wheat as affected by different treatments

Treatment	Dose (g)		Percent control 120 DAS				No. of effective earheads/m^2		Grain yield(Kg/ha)	
	a.i./ha	Product (g)	2005-06 Grassy	2005-06 BLW	2006-07 Grassy	2006-07 BLW	2005-06	2006-07	2005-06	2006-07
Weedy Check	-	-	0	0	0	0	371	365	3478	3265
Isoproturon75 % WP	1000	1333	61	76	52	70	383	386	3867	3960
Sulfosulfuron75 % WP	25	33.33	93	83	75	70	395	392	4630	4760
Clodinafop15 % WP	60	60+4	92	0	90	0	392	396	4640	4820
Metsulfuron20 %WP	4	20	0	87	0	95	382	379	3925	3756
UPH206	45+3	120	52	65	50	70	382	382	4012	4010
UPH206	60+4	160	70	85	70	80	387	385	4350	4560
UPH206	75+5	200	72	86	95	100	389	405	4520	4740
UPH206+S	120+8	320	95	100	100	100	400	386	4738	4024
UPH206+S	45+3+S	120+S	100	100	92	100	388	404	4496	4680
UPH206+S	60+4+S	160+S	97	100	100	100	404	408	4746	4860
UPH206+S	75+5+S	320+S	98	100	100	100	402	406	4890	4894
Sulfosulfuron+ Metsulfuron(Total)	30+2	40	100	100	90	100	399	401	4755	4820
Weed Free	-	-	100	100	100	100	404	403	4863	4896
LSD (P= 0.05)							10.4	12.0	336	218

cally at par and proved most effective. 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).

Effect on yield and yield attributed characters

The data presented in table 4 revealed that all herbicidal treatments significantly increased the number of effective tillers/m^2 and grain yield of wheat over untreated check. UPH 206 at 75+5 and 60+4 g/ha along with surfactant, which were at par with each other, resulted in significant higher number of earheads/m^2 and therefore, increased grain yield as compared to UPH-206 alone at 45+4 & 60+4 g/ha. Among herbicidal treatments, maximum grain yield (4890 and 4894 kg/ha) was obtained with the use of UPH-206+S at 75+5 g/ha which were at par with weed free check and ready mixture of sulfosulfuron+ metsulfuron and UPH-206+S at 60+4 g/ha but effective than UPH-206+S at 45+4 g/ha, clodinafop at 60 g and sulfosulfuron at 25 g/ha.

Phytotoxicity on wheat crop

No phytotoxicity symptoms were observed in case of UPH-206 even at higher dose at 120+8 g/ha (800 g/ha product) at any stage of crop growth in the first year but in second year UPH-206, ready mixture of sulfosulfuron + metsulfuron (Total) and sulfosulfuron alone showed yellowing of leaves at 10 and 20 DAT but it recovered later on (Table 3).

Residual effect of UPH 206 applied in wheat on the succeeding sorghum crop

Residues of UPH-206 applied in wheat even at 800 g/ha (product) did not cause any adverse effect on crop growth and germination of succeeding sorghum crop (Table 4). Plant height of sorghum, no. of plants/m^2 and green fodder yield was statistically similar in UPH-206 treated plots as well as untreated control.

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Table 3. Effect of different herbicidal treatments on phytotoxicity on wheat at 3, 10 and 20 DAT (2005-06 and 2006-07 pooled data)

Treatments	Dose (g)		Yellowing			Necrosis			Scorc hing			Epinasty			Hyponasty		
	a.i./ha	Product (g)	3 DAT	10 DAT	20 DAT	3 DAT	10 DAT	20 DAT	3 DAT	10 DAT	20 DAT	3 DAT	10 DAT	20 DAT	3 DAT	10 DAT	20 DAT
Weedy Check	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isoproturon 75 % WP	1000	1333	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Sulfosulfuron 75 % WP	25	33.33	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Clodinafop 15 % WP	60	60+4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Metsulfuron 20 %WP	4	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206	45+3	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206	60+4	160	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206	75+5	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206+S	120+8	320	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206+S	45+3+S	120+S	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
UPH206+S	60+4+S	160+S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UPH206+S	75+5+S	320+S	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sulfosulfuron + Metsulfuron (Total)	32	40	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0
Weed Free			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

DAT - Days after treatment

Table 4. Residual effect of different herbicides applied in wheat on succeeding sorghum crop at 30 DAS

Treatments	Dose (g)		No. of plants/m^2	Plant height (cms)	Green fodder Yield (qt/ha)
	a.i./ha	Product (g)			
Untreated Check	-	-	24	127	380
Isoproturon75 % WP	1000	1333	25	128	390
Sulfosulfuron75 % WP	25	33.33	4.2	24	30.3
Clodinafop15 % WP	60	60+4	25	128	384
Metsulfuron20 %WP	4	20	22	127	392
UPH206	45+3	120	24	129	386
UPH206	60+4	160	25	130	386
UPH206	75+5	200	23	129	389
UPH206+S	120+8	320	26	127	386
UPH206+S	45+3+S	120+S	25	126	384
UPH206+S	60+4+S	160+S	26	124	390
UPH206+S	75+5+S	320+S	25.3	128	
Sulfosulfuron+ Metsulfuron (Total)	30+2	40	4.0	27	29.5
Weed Free	-	-	26	126	392
LSD (P= 0.05)	-	-	3.3	12.1	10.3