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Effect of metsulfuron-methyl against broad leaf weeds in wheat (*Triticum aestivum* L. emend. Fiori and Paol.)

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ABSTRACT

An experiment was conducted during rabi season of 2008-09 and 2009-10 at the Research Farm of Department of Agronomy, BHU, Varanasi. The experimental field was infested with Rumex dentatus, Chenopodium album, Melilotus spp and Lathyrus aphaca among broad leaf weed during both years of study. Post emergence application of metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant significantly reduced broad leaf weed population and total weed dry weight with highest wheat yield over other herbicidal treatments during both years. There was no phytotoxicity symptoms on crops. Weed control efficiency and harvest index was higher under metsulfuron-methyl 20% WG, 5 g ha^{-1} + 0.2% surfactant during both the years. The evaluation of weed dry weight and weed control efficiency of the different treatments and the regression of yield on it revealed that reduction in grain yield could be 8.05 kg ha^{-1} for weed dry weight and 1% increase in the weed control efficiency increased the grain yield by 13.27 kg ha^{-1}, respectively.

Keyword: Broad leaf weed, metsulfuron-methyl, weed control efficiency, weed index.

Sulfosulfuron has been reported to provide effective control of isoproturon resistant *Phalaris minor* along with marginal control of broad leaf weeds in wheat. Several broad leaf weeds are becoming a serious problem along with grassy weeds in wheat (Yadav *et al.*, 2009). In recent years, a new weed species *Ruumex spp.* has dominated the irrigated wheat eco-system (Verma *et al*., 2008). Herbicides are major tool to combat weed menace in most wheat growing areas of the country. However, complexity and diversity of weed flora require more than one herbicide either in sequence or as mixture (Yadav and Malik, 2005, Khokan and Chavak, 2011.

Metsulfuron-methyl has been recommended for the control of broad leaf weed in wheat. It is a selective systemic herbicide absorbed through the roots and foliages with rapid translocation both acropetally and basipettally. In susceptible plants it inhibits branched chain amino acid synthesis (ALS or AHAS) and interferes in biosynthesis of valine and isoleucine stopping cell division and plant growth (Banga and Yadav, 2004 ; Singh and Singh, 2005). The herbicide formulation plays an important role in its bio-efficacy and selectivity in crops. It also influences the easiness of application as well as its accurate measurement by the farmers. The herbicide metsulfuron-methyl was introduced as a wettable powder (WP) formulation which has some limitation in use. Therefore, in this study, an attempt was made to find out the bio-efficacy of metsulfuron-methyl on the dynamics of broad leaf weeds in wheat.

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MATERIALS AND METHODS

A field experiment was conducted during winter (*Rabi*) season 2008-09 and 2009-10 at the Agronomy Research Farm of Institute of Agricultural Sciences, BHU, Varanasi, which is geographically situated at 23.2^0 N latitude, 83.03^{0}E longitude and at an altitude of 113 msl in the north-eastern Gangetic Plains. This location has a typical sub tropical climate characterized by hot, dry summer and cool winter. The soil of experimental site was sandy clay loam in texture with slightly saline in reaction (pH-7.4). It was low in organic C (0.32%) and available nitrogen (206.9 **k**g ha^{-1}), medium in available phosphorus (24.6 **k**g ha^{-1}) and potassium (232.5 **k**g ha^{-1}) in soil surface. The total rainfall received during 2008-09 and 2009-10 was 78.8 and 151.20 mm respectively, of which 48.6 and 52.6, 11.8 and 70.4, 16.6 and 20.20, 1.8 and 8.0 mm, respectively was received during October, January, February and April. The field was kept under rice - wheat rotation for the last eight years. Treatments consist of *viz.* metsulfuron-methyl 20% WG (3 g ha^{-1}) + 0.2% surfactant, metsulfuron-methyl 20% WG (4 g ha^{-1}) + 0.2% surfactant, metsulfuron-methyl 20% WG (5 g ha^{-1}) + 0.2% surfactant**,** metsulfuron-methyl 20% WG (4 g ha^{-1}) + 0.2% surfactant (Registered product) market sample, 2, 4-D sodium salt (500 g ha^{-1}), hand weeding-weed free check and untreated control for comparison of treatments. Metsulfuron-methyl 20% WG (Algrip) + 0.2% urea and metsulfuron-methyl 20% WG + sulfosulfuron 75% WG + 0.2% surfactant for phytotoxicity studies in complete randomized block design with three replications. The wheat variety 'HUW 468' was sown with the help of ferti-seed drill at 22 cm row spacing using 100 kg seed ha^{-1} on 12 November 2005 and 30 November 2006 in 4.6 x 5.5m^2 gross plot size. All the herbicides were applied with the help of flat fan nozzle attached to the foot sprayer using volume of spray 400 liters ha^{-1}, at 32 days after sowing. Urea, diammonium phosphate and murate of potash were used as sources of nitrogen, phosphorus and potassium, respectively. An uniform dose of 40 kg N+60 kg P+ 40 kg K ha^{-1} was applied uniformly at the time of sowing and remaining 80 kg N was topdressed in two equal splits, each at after first irrigation and flowering time. Four irrigations were given to critical growth stages of crop and 6cm water were applied per irrigation. Density, dry weight and weed control efficiency of weeds were observed at 45 days after sowing of crop. Weed control efficiency was calculated by

$$\text{WCE (\%)} \quad \frac{\text{Weed population in Control plot} - \text{Weed population in treated plot}}{\text{Need population in control plot}} \text{x100}$$

Data on weed density was recorded from an area enclosed in the quadrate of 0.25 m^2 randomly selected at four places in each plot. Weed species were separately counted from each sample and their density was recorded as average number m^2. Oven dry weight of weeds was recorded at 70^{0}C for 48 hr. and expressed as dry matter production m^2. Weed data subjected to square root transformation ($\sqrt{}$ x+0.5) before statistical analysis. Data on yield contributing characters, grain and straw yield at harvest were studied for both years. The crop was harvested on 8th April 2006 and 15th April 2007. Data collected on various parameters were analyzed statistically (Gomez and Gomez, 1984) for valid conclusion.

RESULTS AND DISCUSSION

Effect on weeds

The experimental crop was infested with *Chenopodium album*, *Melilotus indica, Lathyrus aphaca*, *Rumex dentatus* among broad leaf weeds. *Phalaris minor* was the only major grassy weed in the crop. Similar results also reported by Rahaman and Mukherjee, 2009.

Metsulfuron methyl WG at rates from 4-8 g ha^{-1} effectively controlled all the broad leaf weeds (Table 1). Application of metsulfuron-methyl 20% WG,@ 5 g ha^{-1} + 0.2% surfactant significantly reduced broad leaf weed population over metsulfuron-methyl 20% WG@ 3 g ha^{-1} + 0.2% surfactant and 2, 4-D at 500 g ha^{-1} and it were at par to metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant and metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant (registered product) market sample during both the years. All the herbicide formulation irrespective of doses was at par to each other against *Rumex dentatus*. Further, all herbicide treatments were significantly superior to untreated control irrespective of weed species. None of the herbicidal treatments as effective as weed free check to reduce weed population. These results are conformity with the finding of Singh and Singh (2005), Yadav *et al*. (2009) and Bhullar *et al.* (2010).

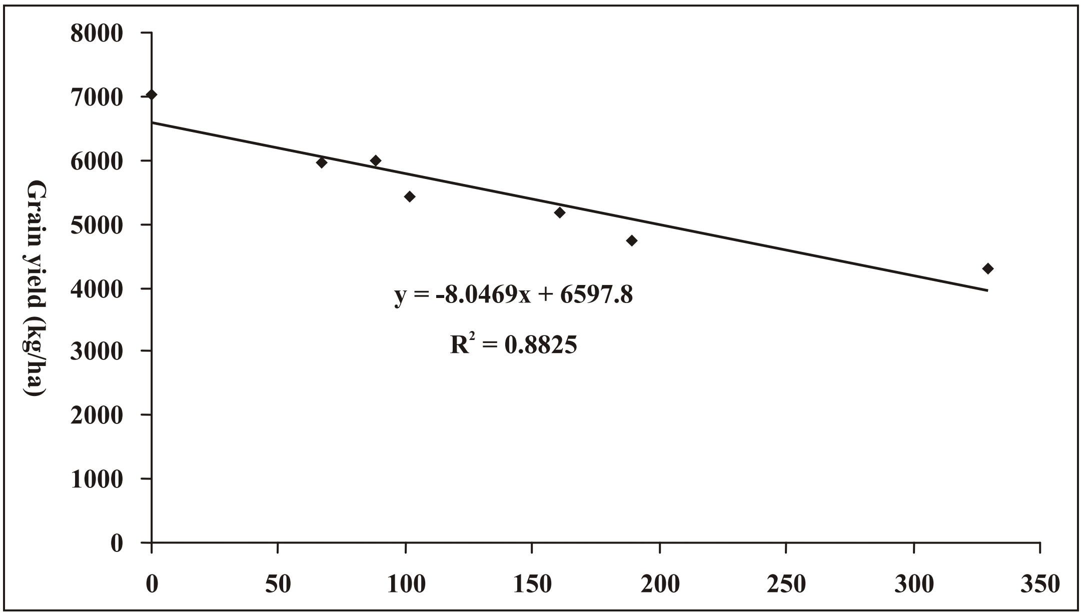
All the weed-control treatments significantly reduced the dry biomass of weeds than weedy check (Table 2). Metsulfuron-methyl 20% WG,@5 g ha^{-1} + 0.2% surfactant significantly reduced the total weed dry weight over metsulfuron-methyl 20% WG,@3 g ha^{-1} + 0.2% surfactant and 2, 4-D at 500 g ha^{-1} and these were at par to metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant and metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant market sample during both the years. The results are agreement with the findings of Yadav *et al*. (2009) and Saini and chopra (2010).

Contrary to broad leaf weeds, herbicide mixture of Sulfosulfuron+ Metsulfuron-methyl (25+4 g) was the most effective against *Phalaris minor*. However, all the herbicidal treatment registered their significant superiority over unweeded control in this respect. Among different rates of Metsulfuron methyl at 8 g/ha was most effective against Phalaris minor. Further, Metsulfuron-methyl WG at 4 g ha^{-1} was superior to WP formulation at similar rate and these treatments were significantly superior to 2, 4-D at recommended rate. One of the most striking results of this study was effect of mixed application of Metsulfuron-methyl with 0.2% urea which was at par to rest of the treatments with 0.2% surfactant.

Weed control efficiency varied from 46.5 to 83.7% in 2008-09 and 38.5 to 75.9% in 2009-10 under different weed control treatments. Among the herbicidal treatments highest weed control efficiency (83.7 and 75.9%) was also recorded under Metsulfuron-methyl 20% WG at 5 g ha^{-1} + 0.2% surfactant treated plots followed by metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant and metsulfuron-methyl 20% WG @ 4 g ha^{-1} + 0.2% surfactant market sample during both the years, respectively (Table 2). Hand weeding-weed free check has highest weed control efficiency (100%) over other weed control treatments, during both years.

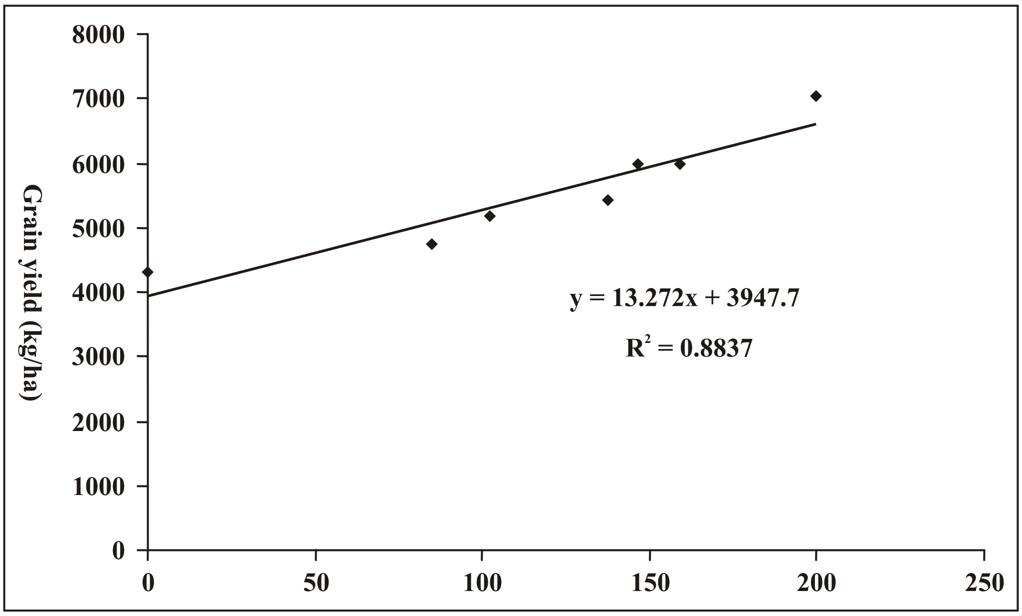
Phytotoxicity

On the basis of visual observation at 5 days after spraying of herbicide, the phytotoxicity of higher (2x) rate *e.i.* 8 g ha^{-1} was compared with untreated control and also lower rates of metsulfuron-methyl. The data revealed that no-phytotoxicity symptoms appeared in on



Weed dry weight (g/m^2)

Fig.1 Relationship between total weed dry weight and grain yield (Pooled data of two years)



Weed control efficiency (%)

Fig. 2: Relationship between weed control efficiency and grain yield (Pooled data of two years)

Table 1: Effect of metsulfuron-methyl 20 WG formulation on weed population in wheat

Treatment	Dose	Weed population (No. m^2) at 45 DAS							
		Rumex dentatus		*C. album*		*Lathyrus aphaca*		*Melilotus spp.*	
	(g ha^{-1})	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Metsulfuron-methyl 20% WG + 0.2% surfactant	3	3.23(10.0)	2.90(8.0)	3.65(13.0)	3.66(13.0)	3.88(14.67)	2.30(5.0)	4.09(16.33)	2.71(7.0)
Metsulfuron-methyl 20% WG + 0.2% surfactant	4	0.71(0.0)	1.85(3.0)	0.71(0.0)	2.41(5.3)	2.53(6.00)	2.18(4.3)	1.76(2.67)	2.20(4.3)
Metsulfuron-methyl 20% WG + 0.2% surfactant	5	0.71(0.0)	0.71(0.0)	0.71(0.0)	0.71(0.0)	2.79(7.33)	1.89(3.3)	1.79(2.80)	2.26(4.7)
Standard 1									
Metsulfuron-methyl 20% WG + 0.2% surfactant (Registered product) market sample	4	0.71(0.0)	2.18(4.3)	0.71(0.0)	2.63(6.7)	3.11(9.33)	2.40(5.3)	2.18(4.33)	2.84(7.7)
Standard 2									
2, 4-D sodium salt	500	0.71(0.0)	2.46(5.7)	3.38(11.0)	4.10(16.3)	3.93(15.00)	2.92(8.0)	4.03(16.00)	2.96(8.3)
Hand weeding-weed free check		0.71(0.0)	0.71(0.0)	0.71(0.0)	0.71(0.0)	0.71(0.00)	0.71(0.0)	0.71(0.00)	0.71(0.0)
Untreated control		6.23(41.0)	5.84(33.7)	7.03(49.0)	6.91(47.3)	5.11(25.67)	4.51(20.0)	5.21(26.67)	3.80(14.0)
LSD(0.05)		**1.10**	**0.26**	**0.38**	**0.30**	**0.78**	**0.43**	**0.8**	**0.27**

Note: *Figures in parenthesis indicate the original values.*

Table 2: Effect of metsulfuron-methyl 20 WG formulation on weed dry weight in wheat

Treatment	Dose	Rumex dentatus		C. album		Lathyrus aphaca		Melilotus spp.		Total weed dry weight		Weed control efficiency (%)	
	(g ha^{-1})	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Metsulfuron-methyl 20% WG + 0.2% surfactant	3	26.1	26.7	12.4	14.5	24	28.2	27.3	30.1	89.8	99.5	46.5	38.5
Metsulfuron-methyl 20% WG + 0.2% surfactant	4	0.0	15.3	0.0	10.6	12.0	16.8	15.3	17.9	27.3	60.6	83.7	62.5
Metsulfuron-methyl 20% WG + 0.2% surfactant	5	0.0	0.0	0.0	9.2	12.1	14.1	16.0	15.6	28.1	38.9	83.2	75.9
Standard 1													
Metsulfuron-methyl 20% WG + 0.2% surfactant (Registered product) market sample	4	0.0	20.7	0.0	11.1	13.5	21.8	14.5	20.2	28	73.8	83.3	54.4
Standard 2													
2, 4-D sodium salt	500	0.0	21.9	18.2	16.4	17.6	24.6	34.4	27.5	70.2	90.4	58.1	44.1
Hand weeding-weed free check		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	100.0
Untreated control		58.0	41.9	36.9	40.9	31.4	32.2	41.4	46.7	167.7	161.7		
LSD(0.05)		**5.0**	**0.38**	**2.8**	**0.14**	**5.0**	**0.41**	**6.8**	**0.15**	**19.6**	**1.08**		

Table 3: Effect of metsulfuron-methyl 20 WG formulation on yield and harvest index

Treatment	Dose ($g\ ha^{-1}$)	Grain yield ($kg\ ha^{-1}$)		Straw yield ($kg\ ha^{-1}$)		Biological yield ($kg\ ha^{-1}$)		Harvest index	
		2008-09	2009-10	2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Metsulfuron-methyl 20% WG + 0.2% surfactant	3	2143	2586	3680	3400	5823	5986	0.37	0.43
Metsulfuron-methyl 20% WG + 0.2% surfactant	4	3080	2933	4253	3966	7333	6899	0.42	0.43
Metsulfuron-methyl 20% WG + 0.2% surfactant	5	3050	2893	4010	3533	7060	6426	0.43	0.45
Standard 1									
Metsulfuron-methyl 20% WG + 0.2% surfactant (Registered product) market sample	4	2960	2480	3826	3336	6786	5816	0.44	0.43
Standard 2									
2, 4-D sodium salt	500	2736	2453	3956	3186	6692	5639	0.41	0.44
Hand weeding-weed free check		3946	3093	5846	4293	9792	7386	0.40	0.42
Untreated control		2100	2200	3323	3136	5423	5336	0.39	0.41
LSD (0.05)		**209**	**188**	**445**	**178**				

Table 4: Phytotoxicity studies of metsulfuron-methyl 20 WG on wheat

Treatment	Dose ($g\ ha^{-1}$)	Phytotoxicity symptoms					
		Hyponasty	Epinasty	LY	LS	LD	LM
Metsulfuron-methyl 20% WG + 0.2% surfactant	3	0	0	0	0	0	0
Metsulfuron-methyl 20% WG + 0.2% surfactant	4	0	0	0	0	0	0
Metsulfuron-methyl 20% WG + 0.2% surfactant	5	0	0	0	0	0	0
Metsulfuron-methyl 20% WG + 0.2% surfactant (2x)	8	0	0	0	0	0	0
Metsulfuron-methyl 20% WG (Algrip) + 0.2% surfactant	4	0	0	0	0	0	0
2, 4-D sodium salt	500	0	0	0	0	0	0
Metsulfuron-methyl 20% WG (Algrip) + 0.2% urea	4	0	0	0	0	0	0
*Metsulfuron-methyl 20% WG + sulfosulfuron 75% WG + 0.2% surfactant	4 + 25	0	0	0	0	0	0

*Note: Phytotoxicity Rating (0 = no appearance of symptoms, 10 = complete kill of plants); * Tank mixture of two individual separate herbicides; LY: Leaf Yellowing; LS: Leaf Scorching; LD: Leaf Drying; LM: Leaf Mortality.*

crop even at higher rate (8 g ha^{-1}) of the herbicide (Table 4).

Effect on crop

The grain and straw of yield of wheat was significantly affected by different weed control treatments (Table 3). Metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant was recorded significantly higher grain and straw yield and biological yield of wheat over metsulfuron-methyl 20% WG,@3 g ha^{-1} + 0.2% surfactant and 2, 4-D at 500 g ha^{-1} and it were at par to metsulfuron-methyl 20% WG @5 g ha^{-1} + 0.2% surfactant and metsulfuron-methyl 20% WG @4 g ha^{-1} + 0.2% surfactant market sample during both the years. Whereas, harvest index was higher under metsulfuron-methyl 20% WG @ 5 g ha^{-1} + 0.2% surfactant followed by metsulfuron-methyl 20% WG@ 4 g ha^{-1} + 0.2% surfactant market sample, 2, 4-D at 500 g ha^{-1} and metsulfuron-methyl 20% WG @ 4 g ha^{-1} + 0.2% surfactant during both the years, respectively. However, all the rates of herbicides were significant superior to untreated control. Higher yield under metsulfuron-methyl 20% WG at 4 and 5 g ha^{-1} + 0.2% surfactant was mainly due to effective control of mixed weed flora of wheat, leads to synergistic effect on growth and yield attributes. The results are in close conformity with the finding of Singh and Singh (2005), Chopra *et al*. (2008) and Yadav *et al*. (2009).

The regression equation predicted linear reduction in the grain yield with a unit increase in the dry weight of weeds (Fig.1). The extent of reduction could be 8.05 kg ha^{-1} for weed dry weight. The evaluation of weed control efficiency of the different treatments and the regression of yield on it revealed that 1% increase in the weed control efficiency increased the grain yield by 13.27 kg ha^{-1} (Fig.2). The decrease in grain yield by unit increase in the dry weight of weeds was also reported by Jat *et al*. (2007).

On the basis of present study it is recommended that water dispersible granule (WG) is a better formulation than wettable powder (WP) formulation of metsulfuron-methyl. Owing to its desirable physical properties of WG formulation should be preferred over wettable powder formulation of the herbicide.

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