

Efficacy of new formulations of triasulfuron on weeds in wheat (*Triticum aestivum*) and their residual effects on succeeding maize (*Zea mays*)

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Received : February 2014; Revised accepted : December 2014

ABSTRACT

A field experiment was carried out at research farm, Institute of Pesticide Formulation Technology, Gurgaon over 2 years (2011 and 2012) to evaluate the bioefficacy of triasulfuron 20 WG (New source) in wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.] and its residual effect on succeeding maize (*Zea mays* L.) crop. Different doses of triasulfuron 20 WG (New source) @ 75 and 100 g/ha; triasulfuron 20 WG (existing source) @ 75 and 100 g/ha; metsulfuron 20 WG @ 20 g/ha were applied at 35 days after sowing of crop with knapsack sprayer using flat fan nozzle @ 450 litres water/ha and 3 hand weedings at 15 days interval after emergence of the crop in weed free check. The effect of above mentioned treatments on weed density, weed biomass and weed control index (WCI %) were recorded at 60 days after application (DAA) against broad leaved weeds in wheat fields. The results indicated that the main broad-leaved weeds in wheat field were *Chenopodium album* L., *Anagallis arvensis* L., *Melilotus* sp., *Rumex* sp. and *Lathyrus aphaca* L. Metsulfuron 20 WP @ 20 g/ha and existing source of triasulfuron 20 WG @ 75 g/ha was least effective against broad leaf weeds. New source of triasulfuron 20 WG @ 100 g/ha was most effective in respect of weed control and dry-matter accumulation by weeds. Grain yield of wheat with the use of triasulfuron 20 WG (New source) @ 100 g/ha was 3.96 and 3.95 t/ha during first and second year of experimentation, which was the highest among the herbicide formulation. No carry over effect of these herbicides was observed on succeeding maize.

Key words : Broad leaf weeds, Efficacy, Herbicide, Residual effect, Triasulfuron, Wheat

Wheat is an important crop worldwide and in India, its production increased from a mere 11.0 million tons during 1960-61 to 93.9 million tons during 2011-12. This more than eight-fold increase in wheat production was mainly due to the adoption of short stature high yielding varieties, increased fertilizers use, irrigation and herbicides. Beside this, Weed infestation is one of the major biotic constraints in wheat production. Wheat is infested with diverse type of weed flora, as it is grown under diverse agroclimatic conditions, different cropping sequence, tillage and irrigation regimes. The yield losses due to weeds vary depending on the weed species, their density and environmental factors. Among weeds, *Phalaris minor* Retz. is single most dominant grassy weed in northern Indian plains causing significant yield losses. For controlling weeds in wheat, chemical control seems indispensable and has proved efficient in controlling weeds (Kahramanoglu and Uygur, 2010).

The Sulfonylurea group of herbicide shows extremely high potency at a very low dose, thereby reducing the chemical requirement of the field, making the amount of herbicide application needed much lower than that of conventional herbicides. Triasulfuron is one such sulfonyl urea herbicide introduced for the control of broad-leaved weeds in wheat and barley crop. Yadav *et al.*, (2004) studied triasulfuron efficacy against complex weed flora in wheat. Samara *et al.*, (1993) reported that Diclofop-methyl applied alone and in combination with Isoproturon significantly increased the grain yield of wheat.

Excessive herbicide usage caused serious ecological and environmental problems, such as resistance and shifts in weed population. Minor weeds becoming dominant which possess greater environmental and health hazards. It is not possible to prevent the development of resistance to any herbicide product. However, using new formulation of triasulfuron 20 WG to control weeds might delay development of resistance in grassy and broad leaved weeds in wheat. Therefore, herbicidal efficacy of a novel herbicide triasulfuron 20 WG was evaluated comparing with other recommended herbicides against various weeds in wheat

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and its residual effect on succeeding crop of maize.

MATERIALS AND METHODS

A field experiment was conducted during winter seasons of 2011 and 2012 at Research Farm of Institute of Pesticide Formulation Technology, Gurgaon (Haryana) to evaluate the bioefficacy of different doses of triasulfuron 20 WG (New source) as a post emergence herbicide along with standard triasulfuron 20 WG from existing source for comparison in wheat crop. The experiment was conducted in a simple randomized block design with seven treatments and three replications using wheat Cv. 'DBW 543' in a plot of 5 × 4 m size in row to row distance 22.5 cm. Wheat seed was treated by chloropyrifos 20% EC @ 20.0 ml/litre of water for termite control. The site of experimental field was sandy loam with pH 7.4. One spray of different doses of new formulation of triasulfuron 20 WG at 35 days after sowing of crop was carried out with knapsack sprayer using flat fan nozzle @ 450 litres water/ha and three hand weeding were followed at 15 days interval after emergence of the crop in weed free check.

Data on weed density (species wise) were recorded at 60 days after imposition of treatments using quadrates of 0.5 m × 0.5 m and the data on weed density were analysed after subjecting the original data to square root transformations. Weeds, species-wise in 0.5 m × 0.5 m area were uprooted and dried in shade for recording weed dry matter at 60 days after sowing. The weed density, weed dry weight and per cent weed control index (% WCI) was calculated using standard formulae.

At maturity, the wheat crop was harvested and air dried in the field for 3 days. Final yield was recorded from each plot and converted into tonnes/ha and analysed statistically. To study the residual behaviour of triasulfuron 20 WG on succeeding crop, plots treated with different doses of triasulfuron during winter (*rabi*) 2011 and 2012 were slightly disked after harvest of wheat. Maize seeds were sown in the respective plots and the observations on germination, plant height, cob length, number of grains per row, number of rows per cob and yield were recorded.

RESULTS AND DISCUSSION

Weed count (m²), weed dry weight (g/m²) and WCI (%)

Field data revealed that weed flora of experimental plots were comprised of *Chenopodium* sp., *Anagallis arvensis* L., *Melilotus* sp., *Rumex* sp., *Lathyrus aphaca* L. Different doses of new formulation of triasulfuron demonstrated a significant effect on broad leaved weeds in unweeded and treated plots during both the crop seasons and the pooled data (Table 1). The minimum density of *Chenopodium album* (4.16/m²) was found at triasulfuron @ 100 g/ha as compared to untreated check (23.83/m²).

Table 1. Effect of triasulfuron 20% WG (New Source) against broad-leaved weeds on wheat crop at 60 days after application (pooled data over 2 seasons)

Treatment	<i>Chenopodium album</i>			<i>Anagallis arvensis</i>			<i>Melilotus</i> sp			<i>Rumex</i> sp			<i>Lathyrus aphaca</i>			Total		
	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)	Weed count/m ²	Weed dry wt. (g/m ²)	WCI (%)
Triasulfuron 20 WG (New source) @75 g/ha	6.16 (2.46)	12.75	72.65	8.58 (3.00)	19.85	69.76	8.33 (2.81)	14.76	75.79	6.66 (2.64)	11.87	72.53	12.50 (3.59)	19.6	72.49	42.16	78.86	70.88
Triasulfuron 20 WG (New source) @100 g/ha	4.16 (2.13)	8.94	80.87	6.51 (2.68)	13.9	78.83	4.66 (2.22)	11.95	80.41	3.00 (1.77)	9.55	77.89	9.33 (3.12)	19.11	73.18	27.99	45.46	80.67
Triasulfuron 20 WG (Existing source) @75 g/ha	7.33 (2.13)	15.35	67.06	9.24 (3.09)	22.13	66.30	9.66 (3.03)	20.81	65.87	8.00 (2.69)	16.98	60.67	14.33 (3.82)	21.10	70.41	48.66	96.38	66.4
Triasulfuron 20 WG (Existing source) @100 g/ha	5.5 (2.35)	13.46	71.09	7.24 (2.75)	21.5	67.25	7.00 (2.62)	16.55	72.87	4.66 (2.14)	12.24	71.68	10.83 (3.35)	22.28	68.69	35.16	86.03	75.72
Metasulfuron 20 WP @20 g/ha	6.16 (2.52)	14.55	68.78	6.67 (2.65)	20.05	69.25	8.00 (2.84)	18.10	69.51	6.17 (2.52)	18.11	58.06	11.00 (3.33)	23.76	66.56	39.00	95.08	73.07
Untreated check	23.83 (4.86)	46.6		32.5 (5.5)	65.65	24.00	61.00 (4.62)			26.00 (4.97)	43.18		38.50 (6.11)	71.36		144.83	287.8	
Weed free check	0.00 (0.71)			0.00 (0.71)	0.00		0.00 (0.71)			0.00 (0.71)	0.00		0.00 (0.71)	0.00		0.00	0.00	0.00
SEm±	0.45			0.54			0.77			0.68			0.40					
CD (P=0.05)	1.39			1.65			2.34			2.05			1.22					

*Mean of 3 replications, Figures in parenthesis are $\sqrt{x} + 0.5$ transformed values, DAA, days after application

The minimum population of *Anagallis arvensis* (6.51/m²), *Melilotus* spp. (4.66/m²), *Rumex* spp. (3.00/m²) and *Lathyrus aphaca* (9.33/m²) were also observed with triasulfuron 20 WG (New source) at 100 g/ha and average weed control was found 27.99/m² at 60 DAA respectively. A significant reduction in broad leaf weeds was recorded by test sample of triasulfuron 20 WG (New Source) @ 100 g/ha irrespective of stage of application, which was statistically at par with test sample at same rate of application. Present findings supports the results of others researchers (Shehzad *et al.*, 2012), who reported that the highest reduction in weed population and weed dry weight differed according to weed species, herbicidal efficacy and the predominant agroclimatic conditions. Naseer-ud-din *et al.*, (2011) observed reduced broad and narrow leaved weeds after the application of herbicides. Other workers found that the application of post emergence herbicide bromoxynil + MCPA proved effective in controlling weeds (Soltani *et al.*, 2006). Metsulfuron 20 WP @ 20 g/ha and existing source triasulfuron 20 WG @ 75 g/ha was least effective herbicide against broad leaf weeds. In the first season, the dry weight of total weeds with triasulfuron @ 100 g/ha was 61.93 g/m² at 60 DAA of experimentation, which was significantly lower than other doses. The new formulation of triasulfuron 20 WG @ 100 g/ha is most effective in respect of dry matter accumulation by weeds. The total dry weight was observed at 45.46 g/m² at 60 DAA. These results clearly indicate that the weed density and weed biomass of the broad leaved weeds varied from season to season.

All the herbicidal treatments significantly decreased the weed population of prevailed broad leaved weeds compared to untreated check (Table 1). The new formulation of triasulfuron 20 WG @ 100 g/ha gave the highest % WCI (80.7%) followed by triasulfuron 20 WG @ 100 g/ha (existing source) (75.7%), metsulfuron 20 WP @ 20 g/ha

(73.1%), triasulfuron 20 WG @ 75 g/ha (new source) (70.9%), triasulfuron 20 WG @ 75 g/ha (existing source) (66.4%) at 60 DAA. Data obtained indicated that the new source of herbicide treatment gave the minimum weed population and weed biomass that gave the highest WCI compared with unweeded check.

Effect on yield and economics of wheat

All the treatments resulted in significant increase in grain biological yields of the wheat over weedy check, which may be attributed to a significant reduction in weed density and dry matter of weed during both the cropping season (Table 2). The highest mean pooled wheat grain yield (4.01 tonnes/ha) was recorded in weedy free check and it was significantly similar to that of triasulfuron 20 WG @ 100 g/ha and 75 g/ha (3.96 and 3.70 tonnes /ha, respectively). The highest grain yield with hand weeding may probably be owing to better weed management resulting in improvement in all growth and sink parameters, which contributed higher grain yield owing to favourable conditions in absorbing soil moisture content, nutrients and sufficient sunlight penetrating during the crop period (Billore *et al.*, 1998). The data of triasulfuron 20WG @ 75 and 100 g/ha did not show any crop toxicity.

Maximum mean gross returns of ₹70,104/- were recorded under weed free check over rest of the treatments, whereas minimum were in weedy plot (₹47,463/ha). Among herbicidal treatments, maximum gross returns (₹68,680/ha) were found in triasulfuron at 100 g/ha. Trend similar to gross returns was also observed in net returns.

Effect on succeeding crop

After harvesting wheat crop each treated plots was sown with maize seeds for studying the residual effect of triasulfuron 20 WG (New source) on succeeding crop.

Table 2. Effect of triasulfuron 20 WG on yield & economics of wheat (pooled data over 2 seasons)

Treatment	Yield (tonnes/ha)		Total cost of cultivation ($\times 10^3$ ₹/ha)	Gross returns ($\times 10^3$ ₹/ha)	Net returns ($\times 10^3$ ₹/ha)	Benefit : cost ratio
	Grain	Straw				
Triasulfuron 20 WG (New source) @ 75 g/ha	3.70	4.84	18.76	63.20	44.44	2.37
Triasulfuron 20 WG (New source) @ 100 g/ha	3.96	5.52	18.85	68.68	49.83	2.64
Triasulfuron 20 WG (existing source) @ 75 g/ha	3.45	4.16	18.76	57.87	39.10	2.08
Triasulfuron 20 WG (existing source) @ 100 g/ha	3.59	4.88	18.85	61.94	43.09	2.29
Metsulfuron 20 WP @ 20 g/ha	3.55	5.03	18.79	61.88	43.09	2.28
Weed free check	4.01	6.23	24.00	70.10	46.10	1.60
Untreated check	2.78	3.58	18.00	47.46	29.46	1.63
SEm \pm	0.21	0.18	0.28	1.35	1.80	
CD (P=0.05)	0.65	0.56	0.84	4.08	5.38	

Price of Wheat @ ₹12,850/t; Labour charge @ ₹200/day; Spray charge @ ₹500/ha; Triasulfuron @ ₹350/ha; Metsulfuron ₹287.50/ha; Cost of straw @ ₹3,000/-.

Table 3. Residual effect of triasulfuron 20 WG (New source) on succeeding maize crop (pooled data over 2 seasons)

Treatment	Germination (%)	Plant height (cm) (30 DAS)	No. of Cobs/plant	Cob length (mm)	No. of grains/rows	Grain yield (t/ha)
Triasulfuron 20 WG (New source) @ 75 g/ha	96.6	59.2	1.01	185.5	17.2	3.43
Triasulfuron 20 WG (New source) @ 100g/ha	93.2	60.3	1.03	187.5	15.8	3.41
Triasulfuron 20 WG (New source) @ 200 g/ha	97.5	54.8	1.02	184.5	17.7	3.31
Triasulfuron 20 WG (Existing source) @ 75 g/ha	97.0	61.8	1.02	189.5	19.9	3.37
Triasulfuron 20 WG (Existing source) @ 100 g/ha	94.6	54.1	1.02	206	18.9	3.41
Metsulfuron methyl 20 WP@ 20 g/ha	95.8	56.5	1.01	195	15.9	3.21
Untreated control	98.1	61.5	1.00	197	17.9	3.44
SEm±	1.72	3.30	0.014	9.27	1.54	1.28
CD (P=0.05)	NS	NS	NS	NS	NS	NS

Follow up studies showed that all the doses, viz. 75 and 100 g/ha of triasulfuron 20 WG (New source) had no phytotoxic residual effect on per cent germination, plant height, number of grains per row, number of grains per ear cob, number of cobs per plant, cob length and yield of succeeding maize (Table 3). The grain yields in treated and untreated plots were at par which indicates that triasulfuron 20 WG (New source) at 75 and 100 g/ha in wheat had no effect on the succeeding crops of maize in terms of crop stand and grain yields. Kaur *et al.* (2007) also reported no residual phytotoxicity of clodinafop in any of the rainy (*kharif*) crop planted in succession after wheat.

Based on two years study, it can be concluded that application of triasulfuron 20 WG @ 100 g/ha (new source) can safely be used to control broad leaved weeds in wheat crop without any phytotoxicity on wheat crop and no residual effect on succeeding maize crop. It can be used as a cost effective, economical and environmentally friendly approach to minimize weed pressure.

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