Indian Journal of Weed Science **46**(2): 129–131, 2014

Residual effect of sulfonylurea herbicides applied to wheat on succeeding maize

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Received: 15 March 2014 Revised: 13 April 2014

ABSTRACT

The field experiment was conducted to assess the residual effects of sulfosulfuron (25, 37.5 and 50 g/ha) and mesosulfuron + iodosulfuron (12, 18 and 24 g/ha) herbicides applied to wheat on maize (*Zea mays* L.) grown in sequence at Ludhiana, Punjab (India). None of the sulfonylurea herbicides (sulfosulfuron and mesosulfuron + iodosulfuron) applied to wheat at different doses affected the emergence of maize crop during both the years. But the effect was evident on growth characters and yield during 2005 whereas in 2004, plant height and dry matter at all stages of maize was not affected significantly. This might be due to difference in rainfall received at different stages of the crop growth in both the years. The rainfall received from April to June (optimum sowing time) was 137 mm and 54.2 mm in 2004 and 2005, respectively, however, in July rainfall was more in 2005 but the earlier status of rainfall was more responsible for the residual effect in 2005 as the reduced rainfall presumably left the soil dry for long time and might have resulted in slow dissipation rate of the herbicides. Again in August, rainfall was more in 2004 (+45.7 mm departure from normal rainfall in 2004) than 2005 so this might have enhanced the movement of the herbicide to lower surface and thus no residual effect was observed on the crop. Hence, it is not safe to grow maize in rotation after application of these sulfonylurea herbicides on wheat, as significant effect on the growth and yield of maize was recorded during the years of less rainfall.

Key words: Herbicide, Maize, Mesosulfuron + iodosulfuron, Residual effect, Sulfosulfuron, Wheat

Wheat *(Triticum aestivum* L.) is one of the most extensively grown cereal crops of the world. The sole application of isoproturon over a period of 10-12 years posed the problem of its resistance in *Phalaris minor* as it started defying the killing potential of this herbicide even at its higher doses in Punjab state (Malik and Singh 1993, Walia *et al.* 1997). The use of new alternate herbicides including clodinafop, fenoxaprop-p-ethyl, sulfosulfuron, mesosulfuron + iodosulfuron were recommended which provided a great relief to wheat crop from the isoproturon resistant population of *Phalaris minor* (Malik and Singh 1995*)*.

The sulfonylurea herbicides though applied at very low rates but are known for their residue under varied type of environmental conditions because of less dissipation rates (Pandey and Singh 1994). Sulfonylurea herbicides have been commercialized for use under a wide variety of agronomic conditions in numerous crops (Brown and Cotterman 1994) as this group is having low mammalian toxicity and degrades to innocuous compounds after application. Sulfonylurea herbicides are highly active in the soil and some crops in rotation can be sensitive to even low soil residues (Walker and Brown 1982), additionally, excessive mobility and persistence of herbicides in soils may cause groundwater contamination and phytotoxic effects to sensitive crops grown in the following season. As the crops in which sulfonylurea herbicides find place are grown in varied agro ecosystems, it becomes imperative to investigate the persistence of sulfonylurea herbicides under different growing conditions so as to avoid any hazard, which may arise due to its continued use. These herbicides are known for their persistence in soil (Blair and Martin 1988) and thus have soil residual toxicity to some of the sensitive crops (Moyer 1995). Balyan (1998) also reported that with the exception of 0.4 mg glufosinate on mung bean and soyabean, the three herbicides (0.4 or 0.6 mg/litre sulfosulfuron, chlorsulfuron or glufosinate) were phytotoxic and decreased dry matter in all the crops *i.e.* mung bean, soyabean, pearl millet, maize and sorghum. Yadav *et al*. (2004) reported that the sulfosulfuron at 25 g/ha and pendimethalin at 1500 g/ha applied in wheat caused residual toxicity to maize but not to mung bean and cotton.

The application of mesosulfuron+ iodosulfuron at 15.0 + 3.0 and 30.0 + 6.0 g/ha applied in wheat had no residual effect on the succeeding crops of transplanted rice and urdbean (Singh *et al*. 2003). However, maize crop in succession was adversely affected due to these treatments.

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As the research regarding the residual effect of sulfonylurea herbicides on the succeeding crops is limited so the present work was carried out with the objective to assess the effect of doses of sulfonylurea herbicides on growth, development and yield of wheat and residual effects of sulfonylurea herbicides on following *Kharif* crops grown in sequence.

MATERIALS AND METHODS

The present investigation was carried out at Punjab Agricultural University, Ludhiana during the years 2003-04 and 2004-05. A pre-sowing irrigation to the field was given then ploughed twice with cultivator followed by cross planking to attain fine seedbed. One meter distance was maintained between the plots by having paths between them. All four sides of the plots were protected by soil boundaries (bunds) raised to a level of 40 cm height and 30 cm width. Wheat variety '*PBW 343*' was sown with seed rate of 100 kg/ha having spacing of 22.5 cm. The experiment was laid out in randomized block design for wheat crop with six different herbicide treatments and unsprayed control. The herbicide sulfosulfuron (1-(4,6-dimethoxypyrimidin-2-yl)-3-(2-ethylsulfony-limidazo [1,2-a]pyridin-3-ylsulfonyl) urea was applied at recommended dose (25 g/ha of sulfosulfuron 75% w/w WG formulation) as one treatment, second treatment was applied at 37.5 g/ha of sulfosulfuron 75% w/w WG formulation and last was double the recommended dose (50 g/ha). Similarly mesosulfuron (Methyl2-(3-(4,6-dimethoxypyrimidin-2-yl) ureidosul-fonyl)-4-methanesulfonamido-methyl benzoate) + iodosulfuron (Methyl 4-iodo-2-(3-(4-methoxy-6-methyl-1, 3, 5-triazin-2-yl) ureidosulfonyl benzoate) was applied as 12, 18 and 24 g/ha and the unsprayed control. Seven different plots each with a dimension of 7.25 x 5.00 m (net plot size) were prepared and these treatments were replicated four times. Both the herbicides were applied 35 days after sowing of wheat. After wheat harvest, the above-described dimensioned plots were sub-divided and the succeeding crop of maize was taken. All the data were collected from the center rows of each plot to minimize the border effects. All the weeds were removed manually from the succeeding *Kharif* crop of maize as no herbicide was applied to this crop. The sowing of maize was done in June.

The soil was loamy send with pH 7.4. However, it was high in available P_2O_5 (25.7 kg/ha) and medium in available K_2O_5 (222.3 kg/ha). The soil profile (0-90 cm) had 16.56 and 5.81 cm moisture content at 0.3 bar and 15 bar, respectively.

The experimental data were subjected to analysis using CPCS1, software developed by Cheema and Singh (1991). All the comparisons were made at 5% level of significance.

RESULTS AND DISCUSSION

Effect on maize crop

At harvest, the plant height (Table 1) was significantly more in unsprayed control than all other treatments applied to wheat. The plant height was significantly less at higher dose of both the herbicides than the lower dose. The per cent reduction in height was 2.91, 5.35 and 8.07 in sulfosulfuron applied doses of 25, 37.5 and 50 g/ha, respectively and 3.28, 4.75 and 7.13 in mesosulfuron + iodosulfuron 12, 18 and 24 g/ha, respectively over unsprayed control. All doses of mesosulfuron + iodosulfuron and sulfosulfuron were at par with each other. Though, maize crop has been reported very sensitive to sulfosulfuron (Singh and Walia 2005) but in a loamy sand soil, leaching of the herbicide to lower layers may also to some extent be able to nullify the adverse effect when the rainfall is frequent and more than the normal. The data indicated that higher dose of both the herbicides led to residual toxicity to the succeeding maize crop as the height was significantly reduced at all doses.

The dry matter accumulation (Table 1) was not significant at harvest in 2004 whereas it differed significantly in 2005. At harvest, dry matter accumulation was significantly more in unsprayed control than rest of the treatments. The per cent reduction in DMA was 4.03, 5.94 and 6.66 in sulfosulfuron at 25, 37.5 and 50 g/ha, respectively and 4.95, 4.04 and 3.72 in mesosulfuron + iodosulfuron at 12, 18 and 24 g/ha), respectively over unsprayed control.

The grain and straw yield (Table 1) was not significant during 2004. During 2005, the grain yield was significantly affected by different herbicide treatments applied to wheat. The significantly higher grain yield was obtained in unsprayed control than all other treatments. Significant reduction in grain yield was recorded where sulfosulfuron was applied at double dose 50 g/ha on wheat than 37.5 and 25 g/ha however, at later two doses, the grain yield was at par. The per cent reduction in grain yield was 11.45, 10.74 and 26.89 in sulfosulfuron at 25, 37.5 and 50 g/ha, respectively and 11.52, 16.0 and 15.01 in mesosulfuron + iodosulfuron applied at 12, 18 and 24 g/ha, respectively over unsprayed control. All the doses of mesosulfuron + iodosulfuron applied to wheat were at par with each other in case of maize grain yield but significantly less than unsprayed control. Similar trend was observed in straw yield during 2005.

The effect of herbicides applied to wheat on succeeding crop of maize was evident on growth characters and yield (Table 1) during 2005 whereas in 2004, plant height and dry matter at all stages of maize was not affected significantly. This might be due to differ-

Table 1. Residual effect of sulfonylurea herbicides applied to wheat on growth and yield of maize

Treatment	Emergence (m^2)		Plant height (cm)		Dry matter (g/plant)		Grain yield (t/ha)		Straw yield (t/ha)	
			At harvest		At harvest					
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
Sulfosulfuron 25 g/ha	7.65	7.28	188.6	155.2	175.8	156.2	4.75	3.64	5.69	4.44
Sulfosulfuron 37.5 g/ha	7.98	7.43	187.1	151.3	174.8	153.1	4.84	3.66	5.71	4.57
Sulfosulfuron 50 g/ha	7.52	7.27	185.7	147.0	176.0	151.9	4.69	3.00	5.92	4.12
Mesosulfuron + iodosulfuron 12 g/ha	7.18	7.46	186.3	154.6	178.2	154.7	4.54	3.63	5.71	4.64
Mesosulfuron + iodosulfuron 18 g/ha	7.65	7.38	185.3	152.3	175.2	156.1	4.48	3.45	5.75	4.60
Mesosulfuron + iodosulfuron 24 g/ha	7.50	7.43	186.4	148.5	175.5	156.7	4.43	3.49	5.55	4.56
Control (unsprayed)	6.89	7.55	189.8	159.9	174.7	162.7	4.79	4.11	5.84	5.12
LSD (P=0.05)	NS	NS	NS	4.61	NS	3.10	NS	0.32	NS	0.31

ence in rainfall received at different stages of the crop growth in both the years. The rainfall received from April to June was 137 mm and 54.2 mm in 2004 and 2005, respectively, however in July rainfall was more in 2005, but the earlier status of rainfall was more responsible for the residual effect in 2005 as the reduced rainfall presumably left the soil dry for long time and might have resulted in slow dissipation rate of the herbicides (Vicari *et al*. 1994). Again in August, rainfall was more in 2004 (+45.7 mm departure from normal rainfall in 2004) than 2005 so this might have enhanced the movement of the herbicide to lower surface (Junnila *et al*.1994) and thus no residual effect was observed on the crop. So the crop like maize can not be safely grown in rotation after wheat, as significant effect on the growth and yield was recorded.

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