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Residual effect of wheat applied sulfonylurea herbicides on succeeding crops as affected by soil pH

Tarundeep Kaur* and Lall Singh Brar
Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab 141 004

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ABSTRACT

Study was conducted at Punjab Agricultural Univeristy, Ludhiana to find the residual effect of sulphonylurea herbicdes, applied on wheat on the suceeding crops. The application of sulfonylurea herbicides proved quite effective against *Phalaris minor* in wheat crop without causing any toxicity to the crop. These herbicides being persistent in nature did not have same residual toxicity to most of the crops grown in succession except in mung and maize where growth and development was adversely affected. The other crops like rice and cotton grew well and did not exhibit any toxicity due to various sulfonylurea herbicides *viz*., sulfosulfuron and mesosulfuron + iodosulfuron. fresh weight of maize was significantly more in normal pH soil than high pH soil which indicates that herbicides persist longer in high pH soil and cause 8.1% reduction in fresh weight of maize in high pH soil.

Key words: *Kharif* crops, pH, Residue, Sulfonylurea herbicides, Wheat

Sulfonylurea herbicides are widely used in wheat. These herbicides break down slowly in alkaline soils and are very mobile in water under high pH conditions and can cause damage to following sensitive crops. Sulfonylurea herbicides persists longer as soil pH increases (Burkhardt and Fay 1985). Saha and Kulshreshtha (2002) reported that sulfosulfuron degraded at a faster rate in acidic (pH 4.0) than in alkaline condition (pH 9.2) and least in neutral. Sulfosulfuron can persists in soil at phytotoxic concentrations for more than one year after application, especially at low temperatures and high pH and cause damage to sensitive crops such as lentil, sorghum and sunflower grown as rotational crops after winter wheat (Kelly and Peeper 2003). Walker and Welch (1989) reported that sulfonylurea herbicides degrade faster in low pH soils than in high pH soils as degradation rate of chlorsulfuron and metsulfuron-methyl were negatively correlated with soil pH and suggested that the risk of residue carry-over will be greater in alkaline soils where degradation rates may be slow. High pH soils also provide a less favorable environment for hydrolysis (Hemmemda *et al*. 1994). Under alkaline soils, these herbicides cannot have significant mobility which could lead to the increased persistence of residues over a longer period of time (Sarmah *et al*. 1999). Amarjeet *et al*. (2003) also reported the faster rate of chlorsulfuron degradation in low pH soil than high pH soil. So there may be risk of residue carry-over in alkaline soils. Keeping these things in mind, the experiment was conducted to assess the efficacy of the sulfonylurea herbicides applied to wheat with respect to different pH levels and to study the effect on the crops grown in rotation.

***Corresponding author:** tarundhaliwal@pau.edu

MATERIALS AND METHODS

The experiment was carried out at the Student's Research Farm, Department of Agronomy, PAU, Ludhiana during the years 2003-04 and 2004-05. The pot experiment was laid out in split plot design with four different herbicide treatments and unsprayed control. The herbicide sulfosulfuron was applied at 25 and 37.5 g/ha. Similarly mesosulfuron + iodosulfuron was applied at 12 and 18 g/ha and the unsprayed control. Both the herbicides were applied 35 days after sowing of wheat as per treatment. Twenty seeds of *Phalaris minor* were sown in all the wheat sown pots and later on thinned to ten plants and ten plants of wheat were retained. The treatments were replicated four times. The high pH soil (pH 8.9) was taken from Bathinda district of Punjab and normal pH soil (pH 7.4) was taken from PAU, Ludhiana. The soil was put in five iron rectangles (grills) having each box measuring 9"x 4". After wheat harvest, the succeeding crops of summer mung (*Vigna radiata* L.), *Kharif* mung (*Vigna radiata* L.), maize (*Zea mays* L.), rice (*Oryza sativa* L.) and cotton (*Gossypium arboreum*) were taken. The sowing of cotton was done in mid April and of rice and maize was done in June and of *Kharif* mung in July. Fresh weight of whole above ground portion of the plants was taken in all the *Kharif* crops.

RESULTS AND DISCUSSION

The height of *Phalaris minor* was statistically similar at two different pH soils (Table 1) during both the years. Both the doses of sulfosulfuron (25 and 37.5 g/ha) were at par with each other at harvest during both the years. During 2004-05, *P. minor* height was significantly less where mesosulfuron + iodosulfuron was applied at higher dose (18 g/ha) than its lower dose (12 g/ha). The height variation didn't indicate any consistency and hence not conclusive. *P. minor* height was significantly more in unsprayed control than rest all the other herbicide treatments due to susceptibility of this weed to herbicides. The interaction effects were not significant during both the years. The results were in line with Walia *et al.* (2002).

The wheat plant height did not differ significantly in different pH soils during both the years (Table 1). The plant height was at par where sulfosulfuron was applied at 25 and 37.5 g/ha in wheat during both the years. Higher dose of mesosulfuron + iodosulfuron (18 g/ha) resulted in significantly less height than its lower dose (12 g/ha) at harvest. This might be due to toxic effect of herbicide (Shukla *et al.* 1998, Chandi 2004). The interaction effects were not significant during both the years.

Significantly fewer yields were obtained in unsprayed crop (Table 1) than all other treatments which though were at par with each other during Ist year. On an average of two years, the per cent increase was 11.2, 14.6, 11.0 and 4.45 in sulfosulfuron at 25 and 37.5 g/ha and in mesosulfuron + iodosulfuron at 12 and 18 g/ha over unsprayed control, respectively,. Again significantly less grain yield was obtained in unsprayed than all other treatments in IInd year. Similar trend was recorded in the IInd year except where mesosulfuron + iodosulfuron was applied at 18 g/ha as this part of the experiment being low lying remain at its disadvantage. Straw yield also maintained the same trend during both the years. The interaction effects were not significant during both the years.

Effect on *Kharif* crops

The fresh weight of summer and *Kharif* mung was not affected significantly in both pH soils during both the years (Table 2), though significant differences were recorded in case of herbicide treatments during IInd year in both the crops. The residual effects were conspicuous as per cent reduction in fresh weight of summer mung was 14.1, 17.4, 12.3 and 5.3 g/ha in sulfosulfuron at 25 and 37.5 g/ha and in mesosulfuron + iodosulfuron at 12 and 18 g/ha, respectively, over unsprayed control and 16.7, 21.5, 15.8 and 16.7 per cent reduction in *Kharif* mung, respectively. This might be due to the rainfall pattern as the less rainfall was received in April, May and June in 2005 as compared to 2004. So, less rainfall left the soil dry and favoured the persistence in the soil. Fresh weight was significantly more where no herbicide was sprayed than sprayed plots in both the crops. All doses of both the herbicides were at par in respect of accumulating fresh weight. Fresh weight was not affected significantly in different herbicide treatments in *Kharif* mung during 2004. The interaction effects were not significant during both the years. Singh and Walia (2005) also reported residual effect of sulfosulfuron on mung crop.

No significant difference in the fresh weight of maize was recorded in two different pH soils and herbicide treatments during 2004 (Table 2). During 2005, fresh weight of maize was significantly more in normal pH soil than high pH soil which indicates that herbicides persist longer in high pH soil and cause 8.1%

Table 1. Effect of different treatments on plant height of *Phalaris minor,* and growth and yield of wheat

Treatment	*Phalaris minor* height at harvest (cm)		Wheat plant height at harvest (cm)		Grain yield (t/ha)		Straw yield (t/ha)	
	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Soil pH								
High pH (8.9)	74.5	74.2	71.7	68.6	15.4	15.4	42.1	42.7
Normal pH (7.4)	76.1	74.2	72.7	687.0	15.6	15.8	43.1	40.4
LSD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Herbicide dose								
Sulfosulfuron 25 g/ha	74.8	72.35	73.8	72.1	15.7	16.3	43.0	42.7
Sulfosulfuron 37.5 g/ha	73.1	68.6	73.1	69.9	16.5	16.4	43.6	42.6
Mesosulfuron + iodosulfuron 12 g/ha	73.9	73.8	72.1	70.1	15.8	16.1	43.2	42.5
Mesosulfuron + iodosulfuron 18 g/ha	71.8	71.4	73.4	65.6	15.6	14.4	43.2	39.4
Control	83.0	85.1	68.4	64.0	13.7	15.0	40.1	38.1
LSD (P=0.05)	4.6	3.71	2.39	3.25	1.66	0.93	2.33	2.89

Table 2. Residual effect of different herbicides applied to wheat on fresh weight of summer and *Kharif* mung, maize, rice and cotton in high and normal pH soil

Treatment	Summer mung (5 plants)	*Kharif* mung (5 plants)		Maize (g/plant)		Rice (g/plant)		Cotton (g/plant)	
	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year	Ist year	IInd year
Soil pH									
High pH (8.9)	23.32	35.20	24.25	34.15	22.56	41.73	30.34	33.36	23.13
Normal pH (7.4)	24.29	34.45	24.30	35.32	24.55	40.47	29.69	33.87	23.92
LSD (P=0.05)	NS	NS	NS	NS	0.84	NS	NS	NS	NS
Herbicide dose									
Sulfosulfuron 25g/ha	23.41	35.78	23.75	34.26	23.44	40.24	28.79	33.31	23.13
Sulfosulfuron 37.5 g/ha	22.51	34.01	22.38	34.74	22.57	40.66	30.37	34.99	23.78
Mesosulfuron + iodosulfuron 12 g/ha	23.88	35.06	24.00	34.43	23.63	41.24	30.32	33.15	23.54
Mesosulfuron + iodosulfuron 18 g/ha	21.98	34.18	23.75	35.18	22.50	40.24	29.88	33.39	23.57
Control	27.24	35.10	28.50	35.06	25.63	40.07	29.62	33.25	23.52
LSD (P=0.05)	2.67	NS	3.33	NS	3.07	NS	NS	NS	NS

reduction in fresh weight of maize in high pH soil. This might be due to slower rate of degradation in high pH soil which provided a less favourable environment for hydrolysis (Hemmemda *et al*. 1994). This indicates that there may be risk of residue carry over in alkaline soils. Similar findings were also reported by Walker and Welch (1989), Amarjeet *et al.* (2003). Similarly significant reduction in fresh weight was observed in different herbicide doses as compared to unsprayed control. The percent reduction was 8.5, 11.9, 7.8 and 12.2 in sulfosulfuron at 25 and 37.5 g/ha and in mesosulfuron + iodosulfuron at 12 and 18 g/ha respectively, over unsprayed control. The reduction in fresh weight indicates that maize is a sensitive crop for sulfonylurea application to wheat on alkaline pH soil. The interaction effects were not significant during both the years. This might due to toxic effect of herbicide on the crop (Yadav *et al*. 2004, Singh and Walia 2005). Fresh weight of rice and cotton was not significant with respect to all herbicide treatments and different pH soils during both the years (Table 2). Singh *et al*. (2003) also reported that mesosulfuron + iodosulfuron at 15.0+3.0 and 30.0+6.0 g/ha applied in wheat had no residual effect on the succeeding crop of transplanted rice. Yadav *et al*. (2004) also reported that sulfosulfuron applied at 25 g/ha to wheat caused no residual toxicity to cotton.

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