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Effect of Temperature on Persistence of Sulfosulfuron in Sandy Loam Soil

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ABSTRACT

The dry weight of sorghum shoot (test plant) increased significantly with each successive increase in temperature level from 15-35°C and incubation period from 0-120 days. Whereas increase in concentration of sulfosulfuron (0 to 64 ppb) caused significant reduction in dry weight of sorghum shoot. At 120 days of incubation, the GR_{50} (Growth reduction 50%) at 35°C was approximately 2.5 times higher than at 15°C. The half life of sulfosulfuron was 46, 28 and 11 days at 15, 25 and 35°C, respectively.

INTRODUCTION

Phalaris minor is the dominant weed found intensively in rice-wheat cropping system and it alone affects wheat yield upto 40%. To control isoproturon resistant population of *P. minor*, alternate herbicides such as sulfosulfuron, clodinafop and fenoxaprop have been recommended (Malik and Yadav, 1997). Of these, sulfosulfuron (25 g ha^{-1}) provides 60-70% control of broadleaf weeds in addition to grassy weeds.

Temperature is one of the most important factors influencing the rate of degradation of sulfonylurea herbicides which increase with increase in temperature (Vega *et al.*, 1992). Both chemical and microbial degradation are enhanced by warmer temperatures (Beyer *et al.*, 1988). At temperature below 25-27°C, the contribution of microbial factors towards degradation exceeds that of chemical hydrolysis (Bondarev *et al.*, 1990).

It may be possible to develop prescription for safe recropping of the treated area by quantitative estimates of rate of persistence under a range of temperatures prevailing during the season. Sorghum is more sensitive to sulfosulfuron than other **kharif** crops. The aim of the current investigation was to study the persistence of sulfosulfuron under different temperature conditions using sorghum as test plant.

MATERIALS AND METHODS

Thirty- six kg air-dried sieved sandy loam soil having 61% sand, 18.7% silt, 20.2% clay and 0.34% organic carbon with a pH of 8.1 was taken. Two kg of this soil was treated with 8.0 ml of 16 ppm stock solution of sulfosulfuron giving an initial concentration of 128 ppb. Thus, total 18 lots of 2 kg each (6 lots for each temperature 15, 25 and 35°C) comprising six incubation periods (0, 7, 15, 30, 60 and 120 days) were prepared. These soil samples were transferred to steel jars (15 cm x 10 cm) and covered with silver foil were placed in each of three incubators maintained at 15, 25 and 35°C. Each jar was weighed accurately before keeping in the incubator and constant soil moisture was maintained by adding distilled water as and when needed to bring the soil to field capacity. The jars were removed from incubators after completion of the desired incubation period and were stored in deep freezer at -4°C in order to avoid further degradation of sulfosulfuron.

Pot Bioassay

In order to maintain uniformity, an equal quantity of absorbent cotton and two wicks of equal size after sterilizing in boiling water and drying were

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placed in the bottom of conical pot (10 x 8.5 cm) in such a way that above cotton portion of wicks remained in pot and below cotton portion of wicks went down to the wide mouth water filled pitchers placed below pots. Thus, the wicks served as capillaries as the water was supplied from below. Soil samples removed from deep freezer after completion of all incubation periods were dried in shade for 24 h and soil was well pulverized by crushing with a pestle and mortar. Each 2 kg soil (128 ppb concentration) of desired incubation period was mixed with fresh untreated 2 kg soil. Out of this 4 kg soil, 2 kg soil (64 ppb concentration) was used to fill four pots of 500 g each to be used as four replications and remaining 2 kg soil was used for further dilution with untreated soil in order to get the concentrations of 32, 16, 8, 4 and 2 ppb, respectively. Untreated control was maintained for comparison by filling four pots with fresh untreated soil for each treatment. These pots were kept on wide mouth pitchers with their wicks in the water. Ten seeds of sorghum (HC-136) were sown at 5 cm soil depth on April 21, 2004 just after filling the pots. Moisture content in the pots was maintained at constant by placing the pots on wide mouth pitchers which were filled with water regularly. The data on shoot dry weight, visual phytotoxicity (0-100 scale) were recorded on 30 days after sowing (DAS). The average of three plants was taken for analysis. The data were analyzed using three factor completely randomized design. The data on mean visual phytotoxicity were subjected to arcsine transformation and from these values probit regression analysis was made to find out GR_{50} values and half-life of sulfosulfuron. Half-life of sulfosulfuron was calculated from herbicide (%) remaining in the soil after a particular period which was calculated as :

$$\text{Herbicide (\%) remaining in the soil after 't' days} = \frac{GR_{50} \text{ after 0 day}}{GR_{50} \text{ after 't' day}} \times 100$$

The herbicide remaining in the soil was plotted against the incubation period to obtain the curves for different situations.

RESULTS AND DISCUSSION

The dry weight of sorghum shoot increased significantly with each corresponding increase in the temperature level. The relative increase in shoot dry weight was 5 and 32% at 25 and 35°C as compared to 15°C (Table 1). Similarly, the increase in shoot dry weight at different incubation periods as compared to zero day incubation was 18, 53, 78, 114 and 149% at 7, 15, 30, 60 and 120 days of incubation, respectively. The shoot dry weight decreased significantly with increasing concentration of sulfosulfuron. The

Table 1. Dry shoot weight (mg plant^{-1}) of sorghum as influenced by residues of sulfosulfuron in soil incubated for varying periods at different temperatures

Sulfosulfuron concentration (ppb)	Incubation period (days)						Temperature (°C)			Mean
	0	7	15	30	60	120	15	25	35	
0	762.9	762.9	762.9	762.9	762.9	762.9	762.9	762.9	762.9	762.9
2	217.8	279.8	346.9	425.4	564.2	701.5	379.2	407.1	481.4	422.6
4	156.6	201.8	302.8	357.2	471.3	636.7	306.7	338.3	418.1	354.4
8	37.4	89.2	216.6	291.4	344.8	402.2	184.9	205.1	300.7	230.3
16	8.4	49.2	113.4	181.2	219.8	256.3	106.5	109.8	197.7	138.0
32	0.0	15.3	47.7	71.2	128.2	130.3	38.3	38.3	119.6	65.4
64	0.0	4.0	24.0	24.4	37.8	53.0	0.0	0.0	71.7	23.9
Mean	169.0	200.3	259.2	301.9	361.3	420.4	254.1	265.9	336.0	
	Conc.		Period		Conc. x Period		Temp.		Temp. x Conc.	
LSD (P=0.05)	0.8		0.7		1.8		0.5		1.3	

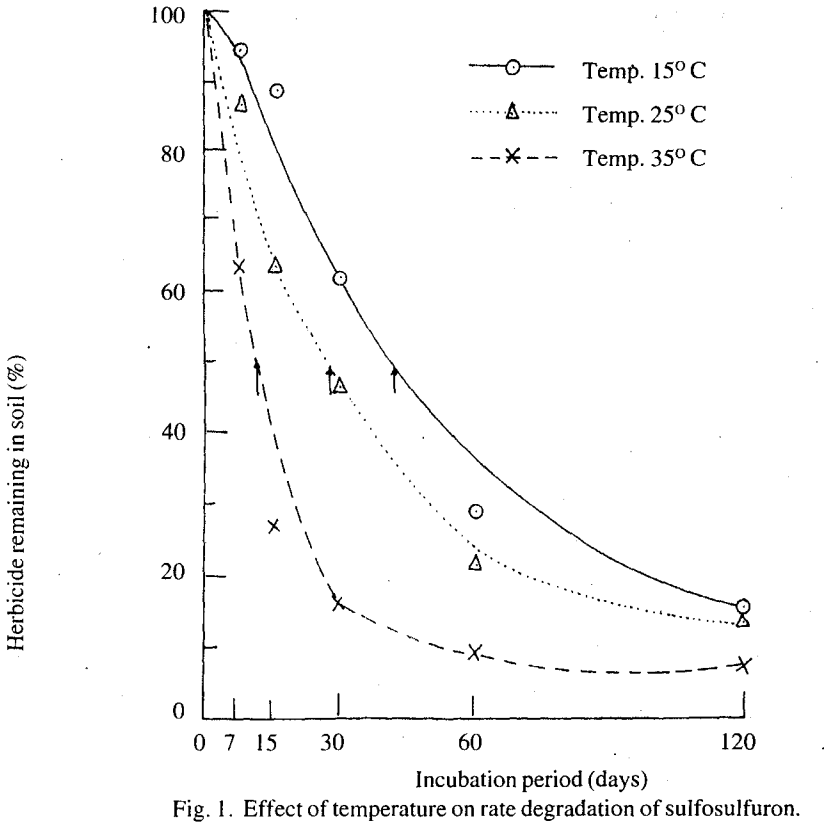

Fig. 1. Effect of temperature on rate degradation of sulfosulfuron.

Table 2. GR_{50} values of sulfosulfuron residues in soil incubated for different periods at various temperatures

Incubation periods (days)	GR_{50} (ppb)			Herbicide (%) remaining in soil		
	15°C	25°C	35°C	15°C	25°C	35°C
0	1.09	1.09	01.09	-	-	-
7	1.12	1.27	01.70	97	86	64
15	1.24	1.69	03.98	88	64	27
30	1.76	2.30	06.73	62	47	16
60	3.81	5.04	11.57	29	22	09
120	7.20	8.03	16.30	15	14	07

relative decrease in shoot dry weight was found to be 45, 53, 70, 82, 91 and 97% with 2, 4, 8, 16, 32 and 64 ppb sulfosulfuron, respectively, as compared to untreated control.

The GR_{50} values increased as the temperature increased from 15 to 35°C at all incubation periods. Likewise, the GR_{50} increased with increase in incubation period at each temperature level (Table 2). At 120 days of incubation, the GR_{50} at 35°C was approximately 2.26 times higher than that at 15°C. Thus, it can be concluded that degradation of sulfosulfuron was faster at 35°C than 15°C. The half life of sulfosulfuron also decreased with increasing temperature which was observed to be 46, 28 and 11 days at 15, 25 and 35°C temperature (Fig.1), respectively. Similarly, Punia *et al.* (1996) and Amarjeet *et al.* (2004) also reported decreased half life of tribenuron-methyl and chlorsulfuron, respectively, as the temperature increased.

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