Indian J. Weed Sci. **38** (1 & 2) : 115-118 (2006)

Effect of pH on Degradation of Sulfosulfuron in Soil

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ABSTRACT

Growth of sorghum was more at low pH (5.1) soil than at high pH (8.1) soil at all concentrations of sulfosulfuron and incubation periods. Root dry weight per plant was 44% higher in low pH soil than under high pH soil. Visual phytotoxicity increased with increase in sulfosulfuron concentration and decreased with increase in incubation period in both the types of soil. After 120 days of incubation, GR 50 of sulfosulfuron increased approximately by 19.8 times in low pH soil as compared to only 7.8 times in high pH soil. Half life of sulfosulfuron was 28 days in high pH soil as compared to 11 days in low pH soil. After 120 days, 5 and 14% of the herbicide remained in low and high pH soil, respectively.

INTRODUCTION

Sulfosulfuron, N-(4, 6-dimethoxypyrimidin-2-yl)-3-[2-ethanesulfonyl-imadazo[1,2-a]pyridine-3-yl) sulfonylurea has been evaluated for selective control of isoproturon resistant population of *P. minor* and some broadleaf weeds in wheat (Malik and Yadav, 1997). The low dose requirement of sulfonylureas is also associated with their high persistence in soil. This can restrict their use in rotations where sensitive crops are included.

The degradation of sulfonylurea herbicides is affected by several soil and environmental factors like pH, temperature, organic matter, soil moisture, microbial activity, etc. (Sabadie, 1990; Vega *et al.*, 1992; Sarmah *et al.*, 1999). The degradation rates of sulfonylureas negatively correlated with pH (Joshi *et al.*, 1985; Streak, 1998). Soil pH may directly or indirectly influence the activity and detoxification of herbicide by affecting the ionic or molecular character of the chemical, ionic character of the soil colloid, the cation exchange capacity and capacity of microbial population to attack a herbicide (Corbin and Upchurch, 1967). The low organic matter content and high pH (>8.0) of soil in Haryana may favour the persistence of sulfosulfuron for a longer period. Thus, it is essential to know the effect of varying pH on dissipation of sulfosulfuron before making any sound recommendation for efficient weed control and to avoid residual toxicity to succeeding crop in rotation. The aim of the present investigation was to study the persistence of sulfosulfuron in different pH soil using sorghum as a test plant.

MATERIALS AND METHODS

The experiment was conducted in two phases i. e. Laboratory and Screen House of College of Agriculture, CCS Haryana Agricultural University, Hisar.

Prepration of Soil and Incubation Period

Two sets of 12 kg each, one of air-dried sandy loam high pH (8.1) Hisar soil with 61% sand, 18.7% silt, 20.2% clay and 0.34% organic carbon and other clay loam low pH (5.1) Palampur soil with 20.3% sand, 45.1% silt, 34.6% clay and 1.1% organic carbon, were prepared. Both the lots were divided into six parts of 2 kg each and were treated with sulfosulfuron to make concentration equal to 128

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ppb by addition of 8.0 ml of 16 ppm stock solution per 2 kg of soil. These admixed soil samples were then transferred to wide mouth steel containers and constant soil moisture was maintained by adding the water as and when needed to bring the soil to field capacity. Twelve steel jars covered with silver foil were placed in the incubators maintained at 25°C. After completion of respective incubation period, the jars were stored in deep freezer at -4°C in order to avoid further degradation of sulfosulfuron.

Bioassay Studies

After completion of the incubation period, sorghum (var. HC-136) was planted in pots (10 seeds/ pot) having treated soil (500 g/pot) at 5 cm depth on April 21, 2004. Two wicks of equal size alongwith cotton at bottom of each chilm shaped earthen pot were fixed before filling the pots with treated soil in such a fashion that it works like capillaries when these prepared pots were kept on wide mouth pitchers which were filled with water regularly as per requirement. Data on dry shoot weight per plant of sorghum were recorded on 30 days after sowing (DAS) and mean visual phytotoxicity per cent on sorghum plants, under different treatments in comparison to untreated control was subjected to probit analysis (Finney, 1971). GR_{50} (amount of herbicide required to cause 50% growth reduction) values were used for describing the degradation of sulfosulfuron in soil at various incubation periods.

RESULTS AND DISCUSSION

Dry Shoots Weight of Sorghum

Averaging the soil types over incubation periods and sulfosulfuron concentrations (Table 1) indicated that dry shoot weight of sorghum was significantly higher (320 mg/plant) in low pH soil than in high pH soil (266 mg/plant). When sulfosulfuron concentrations were averaged over incubation periods and soil types, there was significant decrease (810.5 to 23.9 mg/plant) in dry weight of sorghum shoots with increasing sulfosulfuron concentration from 0 to 64 ppb. As compared to untreated control, the per cent reduction in dry weight of shoot was 46, 55, 71, 84, 93 and 97 with 2, 4, 8, 16, 32 and 64 ppb of sulfosulfuron, respectively. Averaging incubation periods over sulfosulfuron concentrations and soil types showed that dry weight of shoot of sorghum increased significantly with corresponding increase in incubation period.

Visual Toxicity

The degradation of sulfosulfuron in high

Table 1. Residual effects of sulfosulfuron incubated for different periods in low and high pH soils on dry shoot weight (mg/plant) of sorghum (pot experiment, 2003-04)

Sulfosulfuron concentration	Incubation period (days)						Soil type		Mean
(ppb)	0	7	15	30	60	120	Low pH	High pH	
0	810.5	810.5	810.5	810.5	810.5	810.5	858.1	762.9	810.5
2	260.0	288.4	341.5	417.4	557.7	731.7	458.6	407.1	432.9
4	185.8	216.0	320.1	361.5	453.0	663.3	394.9	338.3	366.6
8	66.4	74.4	212.9	283.0	326.1	440.4	262.6	205.1	233.9
16	0.0	18.5	88.0	159.5	222.7	266.0	141.8	109.8	125.8
32	0.0	0.0	39.3	61.8	94.4	141.1	73.9	38.3	56.1
64	0.0	0.0	0.0	29.2	45.8	68.3	47.8	0.0	23.9
Mean	189.0	201.1	258.9	303.3	358.6	445.9	319.7	265.9	
	Conc.	Period	Conc. x Period		Soil		Soil x Conc.		
LSD (P=0.05)	0.5	0.5	1.3		0.3		0		

Table 2. Residual effects of sulfosulfuron incubated for different periods in low and high pH soils on visual phytotoxicity (%) of sorghum

Sulfosulfuron concentration (ppb)	Incubation period (days)						Soil type		Mean
	0	7	15	30	60	120	Low pH	High pH	
0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)	(0.5)
2	56.8	52.2	47.3	41.3	29.9	11.2	37.1	42.5	39.8
	(70.0)	(62.5)	(54.0)	(43.5)	(24.8)	(3.8)	(36.3)	(45.7)	(40.9)
4	63.4	59.3	49.3	46.4	37.7	24.7	45.2	48.5	46.8
	(80.0)	(74.0)	(57.5)	(52.5)	(37.3)	(17.4)	(50.3)	(56.0)	(49.7)
8	75.9	73.0	58.4	52.2	46.4	37.5	53.9	60.6	57.2
	(94.1)	(91.4)	(72.5)	(62.5)	(52.5)	(38.7)	(65.2)	(75.9)	(70.7)
16	90.0	83.5	69.4	60.1	56.5	50.3	64.8	71.9	68.3
	(100.0)	(98.7)	(87.6)	(75.2)	(69.6)	(59.2)	(81.8)	(90.3)	(86.3)
32	90.0	90.0	74.3	69.6	64.2	62.6	70.7	79.6	75.1
	(100.0)	(100.0)	(92.7)	(87.8)	(81.0)	(78.9)	(89.1)	(96.7)	(93.4)
64	90.0	90.0	90.0	80.8	76.7	76.7	78.1	90.0	84.0
	(100.0)	(100.0)	(100.0)	(97.4)	(94.7)	(94.7)	(95.7)	(100.0)	(97.0)
Mean	67.2	64.6	56.1	50.6	45.1	38.2	50.5	56.7	
	(85.0)	(81.6)	(68.9)	(59.8)	(50.1)	(38.2)	(59.6)	(69.9)	
	Conc.	Period	Conc. x Period	Soil	Soil x Conc.				
LSD (P=0.05)	0.21	0.19	0.51	0.11	0.29				

The data in parentheses are original, which have been subjected to arcsin transformation.

and low pH soil was assessed by an index of plant growth in terms of visual estimation of phytotoxicity percentage. The visual phytotoxicity of sorghum increased from 0-97% as sulfosulfuron concentration increased from 0-64 ppb (Table 2). The visual phytotoxicity decreased from 85 to 38.2% as the incubation period increased from 0-120 days. When soil types were averaged over incubation periods and sulfosulfuron concentrations, it was found that visual phytotoxicity was significantly lower in low pH soil than in high pH soil.

The rate of degradation of sulfosulfuron was faster in low pH soil as compared to high pH soil (Table 3 and Fig. 1). After 120 days of incubation amount of herbicide required to cause 50% growth reduction in sorghum increased by only 7.37 times in high pH soil as compared to approximately 19.8 times in low pH soil. The GR_{50} at this stage was 2.4 times higher in low pH soil as compared to that of high pH soil. The half-life of sulfosulfuron was 28 days in high pH soil, whereas the corresponding figure was only 11 days in low pH soil. The differences in residual bioactivity of sulfosulfuron in two soils might be attributed to differences in their pH values. This might be due to increased chemical hydrolysis in low pH acidic soil and the duration of sulfosulfuron activity in this soil was less as compared to high pH soil (Joshi *et al.*, 1985). Enhanced degradation of sulfonylurea herbicides

Table 3. GR_{50} values of sulfosulfuron in low and high pH soils after incubation at 25°C for different periods

Incubation periods (days)	GR_{50} (ppb)	
	Low pH soil	High pH soil
0	0.96	1.09
7	1.29	1.27
15	2.30	1.69
30	3.97	2.30
60	10.35	5.04
120	19.06	8.03

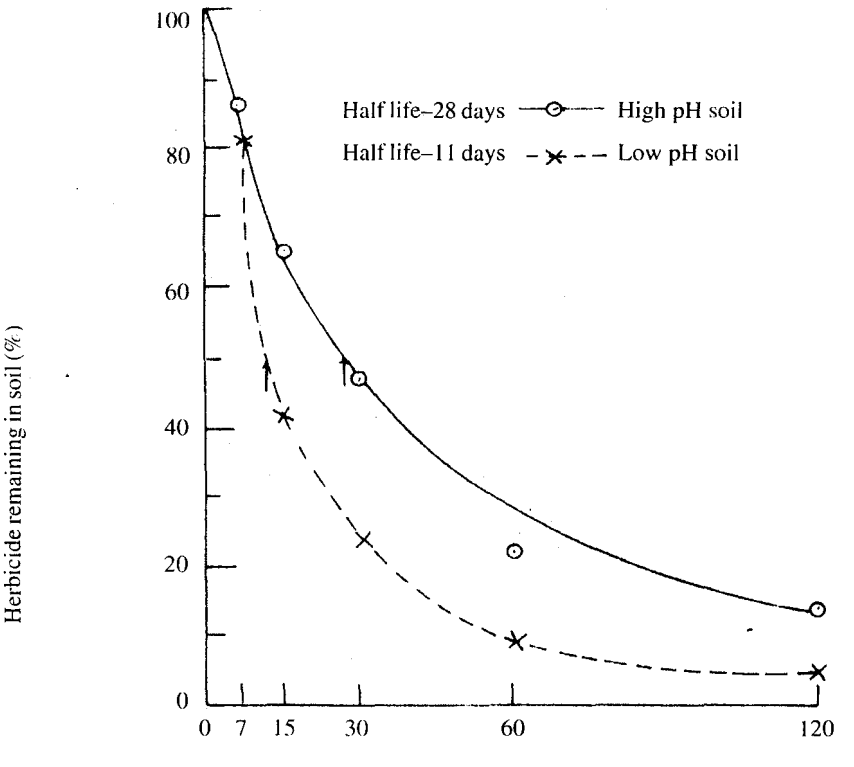

Fig. 1. Effect of soil pH on rate of degradation of sulfosulfuron. The arrow indicates half life of sulfosulfuron.

in low pH soil was less as compared to high pH soil as reported earlier by Walker *et al.* (1989) and Sarmah *et al.* (1998).

REFERENCES

Corbin, F. T. and R. P. Upchurch, 1967. Influence of pH on detoxification of herbicides in soil. *Weeds* **15** : 370-377.

Finney, D. J., 1971. *Probit Analysis, 3rd edn.* Cambridge University Press, Cambridge. pp. 373.

Joshi, M. M., H. M. Brown and J. A. Romesser, 1985. Degradation of chlorsulfuron by soil micro-organisms. *Weed Sci.* **33** : 888-893.

Malik, R. K. and Yadav, A. K. 1997. Potency of alternate herbicides against isoproturon-resistant little seed canary grass. Proc. 16th Asian Pacific Weed Sci. Soc. Conf., Session 4A. pp. 208-210.

Sabadie, J. 1990. Chemical acid hydrolysis of metsulfuron-methyl. Hydrolyse climique acids due to metsulfuron methyl. *Weed Res.* **30** : 413-419.

Sarmah, A. K., R. S. Kookana and A. M. Alston, 1998. Fate and behaviour of triasulfuron, metsulfuron-methyl and chlorsulfuron in the Australian soil environment–a review. *Aust. J. agric. Res.* **49** : 775-790.

Sarmah, A. K., R. S. Kookana and A. M. Alston, 1999. Degradation of chlorsulfuron and triasulfuron in alkaline soils under laboratory conditions. *Weed Res.* **39** : 83-94.

Streak, H. J. 1998. Fate of chlorsulfuron in the environment. I. Laboratory evaluations. *Pesticide Sci.* **53** : 29-51.

Vega, D., Beside, J. and Paulain, C. 1992. Chemical or microbial degradation of sulfonylureas in the soil. II. Metsulfuron methyl. *Weed Res.* **32** : 149-155.

Walker, A., E. G. Cotterill and S. J. Welch, 1989. Adsorption and degradation of chlorsulfuron and metsulfuron methyl in soils from different depths. *Weed Res.* **29** : 281-287.