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Dissipation of sulfosulfuron from wheat field and detection of its residues in wheat grains and straw

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ABSTRACT

Persistence of sulfosulfuron applied at 25 g/ha in *rabi* 2006-07 in wheat crop was determined in soil, wheat grains and straw. Soil samples treated with sulfosulfuron were collected at 1, 15, 30, 60, 90 and 120 days after herbicide application and were analyzed for herbicide residues. Wheat grains and straw were sampled at the time of harvest. HPLC coupled with PDA detector was used to detect sulfosulfuron residues. Sulfosulfuron degraded rapidly in soil and was not detected in soil, wheat grains and straw at harvest. Half-life of sulfosulfuron was found 14.40 days.

Keywords: Sulfosulfuron, Residues, HPLC, Soil, Wheat grains and straw

In India wheat is the second most important food crop in terms of production after rice. It gets infested heavily with annual grassy weeds *viz*. *Phalaris minor* Retz and *Avena ludoviciana* Dur. Sulfonylurea herbicides are relatively new class of chemical compounds that function by inhibiting the action of acetolactate synthetase (ALS) enzyme, affecting plant growth, and eventually killing the plant (Koepe and Brown 1995, Meister 1997, Brown 1990, Ware and Whitacrle 2004). Sulfonylurea degrades faster in warm, moist, low organic and low pH soil (DuPont 1998). Sulfonylurea possess a wide range of sensitivity among different plants (Peterson *et al*. 1994). Sulfonylureas are active at very low concentrations and can cause a problem with plant vigor in some crop rotations even when only one per cent or less of the originally applied material remains. Some of sulfonylurea herbicides have demonstrated residual phytotoxicity to rotation crops such as corn, sunflower, sugar beet and dry bean (Anderson and Humburg 1987, Curran *et al.* 1991, Sondhia 2007, Sondhia and Singhai 2008). The sulfonylureas are meristematic inhibitors with both foliar and soil activity, which control broadleaf weeds better than grasses.

Sulfosulfuron provides very good control of *P. minor* and partial control of broad leaved weeds, since sulfosulfuron is very effective in low doses and residual toxicity can affect the succeeding crop, hence residues of sulfosulfuron in soil, wheat grains and straw were analyzed by HPLC method utilizing photodiode array detector.

MATERIALS AND METHODS

Field dissipation study

A field experiment was conducted in *rabi* 2006-07 at the farm of National Research Centre for Weed Science, Jabalpur, in a randomized block design with three replications. Sulfosulfuron (75% WG) at 25 g/ha was used in wheat crop as post-emergence herbicide and residue analysis was carried out in residue laboratory of National Research Centre for Weed Science. Jabalpur. Samples were randomly taken from each treated and untreated plots at 1, 15, 30, 60, 90 and 120 days after application of herbicide, from a depth of 0-20 cm using a soil auger. Replicated samples were bulked together from each plot, air-dried, powdered and passed through a 3 mm sieve to achieve uniform mixing. Pebbles and other unwanted materials were removed manually. The soil contains clay 35.47%, silt 12.45%, sand 52.09%, nitrogen 300 kg/ha, available phosphorus 40 kg/ha and potassium 300 kg/ha with organic carbon 0.80%, EC 0.35 mmhos/cm and pH 7.2.

Collection of wheat grains and straw samples

500 g of representative wheat grains and straw samples were collected at harvest from sulfosulfuron treated and untreated plots. The straw samples were cut in small pieces and air-dried. Wheat grains and straw samples were then ground on mechanical grinder and used for residue analysis.

Analytical methods

Analysis was done using high-performance liquid chromatography (HPLC). Extraction was done as described by Sondhia *et al*. (2007). Soil (25 g), wheat grains and straw samples (25 g) each were extracted with 50 and 70 ml of acetonitrile: water (50:50%), respectively (repeated thrice). After extraction, cleanup was done on column packed with anhydrous sodium sulfate, activated charcoal and florisil. Elutes were collected and concentrated to approximately 10 ml and passed through 0.45 µm filter. Analysis was performed on a Shimadzu HPLC, coupled to PDA detector. The method makes use of Phenomenix C-18 (ODS) column (250 x 4.6 mm) and acetonitrile: water (70:30 v/v) as mobile phase at a flow rate of 1 ml/min at 230 nm. 20 µl of the aliquot was injected into the column by using micro syringe. Using these conditions sulfosulfuron was eluted at 2.28 min. The time of dissipation of 50% (DT_{50}) of the highest concentration was calculated from the equation $DT_{50} = 0.693/k$.

Sulfosulfuron reference analytical standard of 99.9% purity was obtained from Merck, Germany. All the other chemicals and solvents used in the study were of analytical grade and all the solvents were glass distilled prior to use.

RESULTS AND DISCUSSION

Sulfosulfuron residues at 1, 15, 30, 60, 90 and 120 days in soil is presented in Table 1. The initial concentration of sulfosulfuron in the soil was found 0.510 µg/g, which degraded to 0.058 µg/g and 0.018 µg/g by 15 and 30 days, respectively. There was a progressive decline in the concentration of sulfosulfuron so that after the 60 and 90 days the concentration level goes down to 0.017 and 0.003 µg/g, respectively. After 120 days residues were found below the detection limit in the soil.

Table 1. Detection of sulfosulfuron residues in the soil of wheat crop

Days	Residue (µg/g)
0	0.510 ± 0.050
15	0.058 ± 0.003
30	0.018 ± 0.020
60	0.017 ± 0.001
90	0.003 ± 0.001
120	<0.001
R^2	0.99
Half-life (days)	14.40

Dissipation of sulfosulfuron residues during predetermined intervals *viz*., 1, 15, 30, 60, 90 and 120 days as determined by HPLC in soil is presented in Fig. 1. Under the field condition rapid dissipation of sulfosulfuron residues during initial period was noticed and by 15, 30 and 90 days approximately 88.67, 96.47 and 99.41 % sulfosulfuron was dissipated from the surface soil (0-20 cm) and approximately 100% dissipation was achieved by 120 days (Fig. 1) in the soil and hence, no residue was detected after 120 days (Fig. 1). Half-life of sulfosulfuron under field conditions was found 14.40 days. Sondhia *et al*. (2007) and Ramesh and Maheswari (2004) also reported rapid dissipation of sulfosulfuron in the field conditions. Decrease in the concentration of the herbicide with passage of time in soil is compensated by the increased microbial activity thereby increasing the rate of degradation (Johnson and Simsm 1993, Sondhia. 2005).

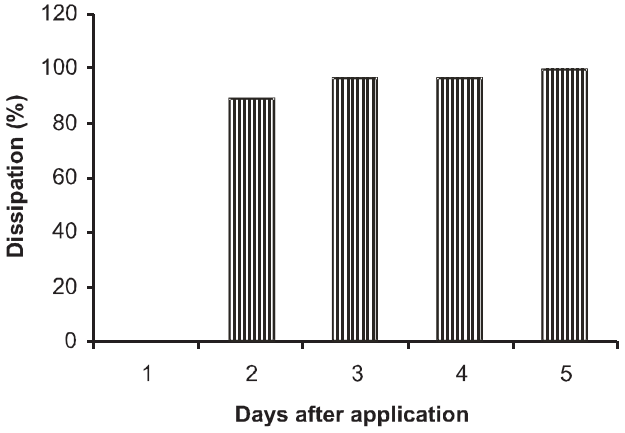

Fig. 1. Dissipation of sulfosulfuron residues from soil of wheat field

The soil was rich in clay content (35%) that might favored degradation of sulfosulfuron in the soil so that by 90 and 120 days sulfosulfuron degraded completely and hence, no residue was detected at harvest. Residues of sulfosulfuron were not detected in wheat grains and straw samples collected at harvest. The data generated here clearly indicated rapid degradation of sulfosulfuron residues in soil.

Although some authors suggested a potential risk of sulfonylurea herbicides (Fletcher *et al*. 1993, Peterson *et al*. 1994, Fahl *et al*. 1995) which are active at very low rate of application. But on the basis of above experiment it appears that sulfosulfuron represents an interesting alternative to other less environment friendly herbicides for weed control in wheat crop. Low half-life of

sulfosulfuron in the soil shows its instable and degradable character so that it is unlikely to occur at significant concentration in soil, wheat grains and straw at 25 g/hadose.

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