

Dissipation pattern of the herbicide Pyrazosulfuron- ethyl in Alluvial and red lateritic soils of West Bengal

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ABSTRACT

The sulfonylurea herbicide pyrazosulfuron- ethyl [Ethyl 5- (4, 6- dimethoxy pyrimidine- 2- yl carbamoyl sulfamoyl) -1 - methyl pyrazole- 4- carboxylate] is a systemic herbicide absorbed by roots and leaves and translocates to the meristem. Dissipation of pyrazosulfuron- ethyl follows first order kinetics in both the alluvial and red lateritic soils of West Bengal under laboratory condition when applied @ 10 μ g (T₁) and 20 μ g (T₂) of the active ingredient per gram of soil. About 80% of the initial concentration of the herbicide in soil was dissipated by 30 days which further increased to more than 95% by 60 days. The rate of dissipation of pyrazosulfuron- ethyl was found to be similar (DT₅₀ ~ 15 days) for both the soils.

Key words: Pyrazosulfuron- ethyl; Herbicide; Residues; Soil

Pyrazosulfuron- ethyl is a systemic herbicide for the control of various annual and perennial broad- leaved weeds and sedges in the rice field. It is used as a pre or post emergent herbicide and was found to be effective at very low doses i.e. less than 10 g. a. i./ ha for 12 major weeds of rice (Suzuki *et al.*, 1990). In addition, pyrazosulfuron- ethyl shows a high degree of selectiveness in its action. The selective action of pyrazosulfuron ethyl on growth and acetolactate synthase activity between rice and *Cyperus serotinus* was studied by Kobayashi *et al.* (1991). The results revealed that root and shoot growth were suppressed more markedly in *C. serotinus* than in rice after three weeks of application @ 41-41.4 g/ha of pyrazosulfuron ethyl. Since the herbicide shows high safety to grass, so it can be used to control other grasses in Lawn (Yamamoto *et al.*, 1996). However no systematic work has been delineated to study the dissipation pattern of pyrazosulfuron- ethyl in soils for impact assessment in different agro- ecological region. Therefore, the present study has been carried out to understand the dissipation behaviour of pyrazosulfuron- ethyl in two different soils of West Bengal under laboratory condition.

MATERIALS AND METHODS

i) Collection of soils

The experiment was conducted during October, 2002- April, 2003 in the laboratory of Department of Agricultural Chemicals. Two types of soils were collected from i) Kalyani block farm, B. C. K. V., Nadia, (Alluvial Soil) and ii) Regional Research Station, Jhargram, Midnapur (Red & Lateritic soil). The soils were air dried, grinded and passed through a 20 mesh sieve. The physico- chemical properties of the soils were determined by various standard methods as shown in Table-1.

ii) Application of the herbicide in soil

Analytical grade of pyrazosulfuron- ethyl (99.5% purity) was obtained from M/S Excel Crop Care Ltd., Mumbai. A stock solution of this pyrazosulfuron- ethyl (100 ppm) was prepared in HPLC grade acetonitrile for application to both the soils @ 10 ppm (T₁) and 20 ppm (T₂). The moist condition of both the soils were maintained by determining the initial moisture level and then adding the calculated amount of water so that the moisture level remains at 80% of the moisture holding capacity. Three replicate sets of each treatment were maintained in 250 ml conical flasks,

under laboratory condition keeping one such replicated set as untreated control (T_0). Soil samples were withdrawn for residue analysis at 0, 3, 7, 15, 30 and 60 days after application of the pesticide.

iii) Extraction and clean up

The soil samples collected from each treatment replicates were taken in 100 ml of acetonitrile: water (8: 2 v/v) and kept for 1 hr followed by mechanical shaking for one and a half hour more. The extracts were then filtered in Buchner funnel through Whatman No 1 filter paper with the same washing solvent (2x 25 ml). The filtrates were then concentrated in rotary vacuum evaporator at $\sim 40^\circ\text{C}$.

The concentrated extract of each replicate was transferred to 1L separatory funnel after adding 200 ml saturated NaCl and the diluted extracts were then partitioned with 200 ml dichloromethane (100+ 50+ 50). The organic layers were collected by passing over anhydrous Na_2SO_4 . The extract was then evaporated to dryness in the rotary vacuum evaporator at $\sim 40^\circ\text{C}$.

Finally for each sample, the residue was dissolved in HPLC grade acetonitrile for estimation using High Performance Liquid Chromatography (HPLC).

iv) HPLC analysis

HPLC, Model Jasco Japan PU 1575 coupled with UV- VIS detector equipped with Chemito 5000 Data processor was used for the residue analysis. The HPLC operating parameters are given in Table 2.

v) Method validation study

To establish the reliability of the analytical method and to ascertain the efficiencies of extraction and clean up steps used for the analysis of residues, recovery experiment was carried out for the two types of soil samples after fortification with standard solution of pyrazosulfuron- ethyl. The samples were analyzed in triplicate. The average recovery was found to be more than 88% for both the soils in each treatment dose. The method, therefore, was quite satisfactory and adopted for the present study.

RESULTS AND DISCUSSION

The results on the residue content of pyrazosulfuron- ethyl in soil and its dissipation with time in alluvial and red lateritic soils are summarized in Table 3 and 4 respectively. The initial residue obtained in the range of 8.62- 9.44 ppm in T_1 and that for T_2 it was found 18.05- 18.73 ppm in soil. The residue was found to dissipate by 6.6- 8.3% within 3 days in alluvial soil while this value was much higher (13.8- 22.8%) in lateritic soil. However the dissipation of the herbicide in both the soil was comparable by 15 days (39.2- 41.5% in alluvial and 35.5- 37.0% in lateritic soil). The dissipation increased progressively with time and the calculated rate was almost equal ($b = -0.025$) in both the soils over the period of 60 days (Table 3 and 4). The nature of dissipation of pyrazosulfuron- ethyl followed first order kinetics in both the cases as the log values of the residues when plotted against days produced straight line (Fig. 1 and 2).

The initial higher rate of dissipation observed for pyrazosulfuron- ethyl in lateritic soil of Jhargram in comparison to the alluvial soil of Kalyani might be predominately due to pH induced degradation of the herbicide. The degradation of Chlorsulfuron, a sulfonylurea herbicide has also been reported to proceed slowly as the pH of the soil increases from 6.02 to 7.02 (Joshi *et al.*, 1985). However, in addition to pH there are some other soil factors viz. soil texture, temperature, moisture content which also influences the rate of degradation of sulfonylurea herbicides in soil (Rao, 2002). The coarse texture of the lateritic soil under study (sand 54.02%) was not favorable for faster degradation in comparison to the relatively light textured alluvial soil (sand 35.10%). Moreover, higher organic matter content in the alluvial soil (0.71%) in comparison to the lateritic soil (0.31%) might have favored more microbial population in the former favoring microbial degradation of the herbicide in the alluvial soil (Aislabie, 1997). These complimentary factors like lower pH in lateritic soil but light texture, higher CEC and organic matter content in alluvial soil might be responsible for almost similar rate of dissipation in two soils with time.

Table 1 Physico- chemical properties of two soils under study

Properties	Kalyani soil (Alluvial soil)	Jhargram soil (Lateritic soil)
a) pH	8.10	6.01
b) Organic matter (%)	0.71	0.31
c) CEC (meq/100g of soil)	12.70	7.80
d) EC (dsm^{-1})	0.38	0.31
e) Percentage of sand	35.10	54.02
f) Percentage of silt	32.50	14.18
g) Percentage of clay	31.40	30.00

Table 2 HPLC operating parameters

Column	:	250 x 4.6 mm; Thermo Hypersil ODS, 5 μ (RP C ₁₈)
Mobile phase	:	0.01 (M) H ₃ PO ₄ buffer : Acetonitrile (1 : 1 v/v)
Flow rate	:	2 ml/min
Detector wave length (λ_{max})	:	230 nm
Retention time of pyrazosulfuron ethyl	:	5.14 min
Limit of quantification	:	0.01 ppm

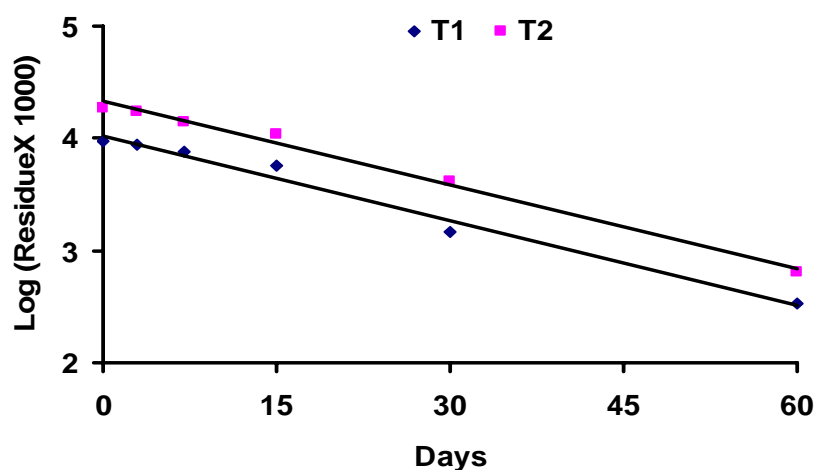
**Fig. 1 Linear plot of dissipation of Pyrazosulfuron Ethyl in Alluvial soil**

Table 3 Persistence and Dissipation of Pyrazosulfuron- Ethyl in Alluvial and Lateritic soil

DAT	Residues in ppm* (% Dissipation)				Regression equation		Half- life (days)	
	Single Dose (T ₁)		Double Dose (T ₂)		Alluvial soil	Lateritic soil	Alluvial soil	Lateritic soil
	Alluvial soil	Lateritic soil	Alluvial soil	Lateritic soil				
0	9.44 (-)	8.62 (-)	18.73 (-)	18.05 (-)				
3	8.66 (8.26)	6.65 (22.85)	17.50 (6.57)	15.55 (13.85)	T ₁ : Y= 3.025- 0.0252X	T ₁ :Y= 2.952- 0.0250X	11.94	12.04
7	7.59 (19.60)	6.09 (29.35)	13.96 (25.47)	14.27 (20.94)				
15	5.74 (39.19)	5.43 (37.01)	10.96 (41.48)	11.64 (35.51)				
30	1.47 (84.43)	1.26 (85.38)	4.12 (78.00)	3.61 (80.00)	T ₂ : Y= 3.325- 0.0247X	T ₂ : Y= 3.313- 0.0249X	12.19	12.09
60	0.34 (96.40)	0.29 (96.64)	0.64 (96.58)	0.62 (96.57)				

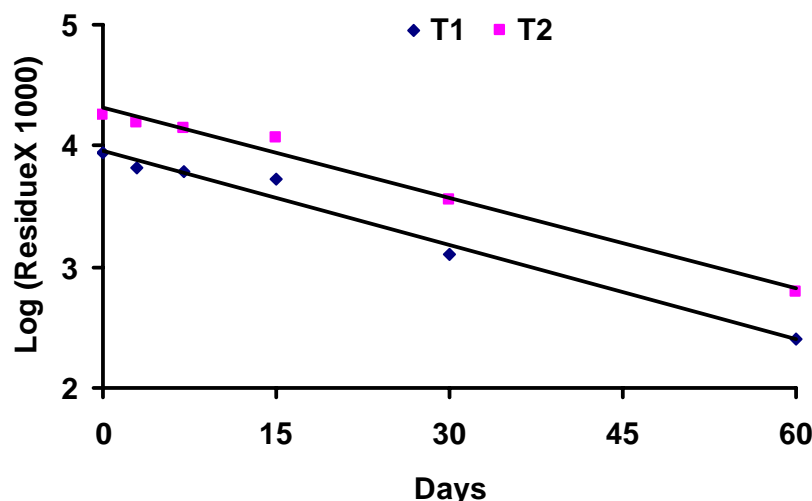


Fig. 2 Linear plot of dissipation of Pyrazosulfuron Ethyl in Lateritic soil

The calculated DT_{50} values for two soils with two doses did not differ statistically and were found to be in the range of 11.9- 12.2 days very similar to those reported for pyrazosulfuron- ethyl in earlier studies (Tomlin, 1997).

The study reveals the residual behavior of the new generation herbicide pyrazosulfuron- ethyl. Such type of information is helpful for recommendation of the chemical in a particular type of soil for weed control. Moreover, the findings are also useful for safety assessment of the agro-ecosystem.

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