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Persistence and degradation of pyrazosulfuron-ethyl in soils of Karnataka

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SUMMARY

Persistence of pyrazosulfuron-ethyl was studied in three different soils (Shimoga, Mandya and Chamrajanagar) of Karnataka under three moisture regimes (maximum water holding capacity, half maximum water holding capacity and submergence). The persistence of pyrazosulfuron-ethyl indicated a close correspondence to first order exponential degradation kinetics in soils and mainly influenced by soil organic matter and moisture. Faster disappearance was noticed under submergence followed by maximum water holding capacity and half maximum water holding capacity in all soils. Persistence of pyrazosulfuron-ethyl was lower in Shimoga soil followed by Chamarajanagar and Mandya under all moisture regimes. Half lives for pyrazosulfuron-ethyl under half maximum water holding capacity, maximum water holding capacity and submergence ranged from 74.6 to 85.5, 57.7 to 62 and 42.9 to 53.8 days, respectively.

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KEY WORDS : Persistence, Degradation, Pyrazosulfuron-ethyl, Maximum water holding capacity, Submergence

Pyrazosulfuron-ethyl (Ethyl 5- [(4, 6-dimethoxy-pyrimidin-2-yl carbamoyl) sulfamoyl]-1-methylpyrazole-4-carboxylate) is a newly introduced selective pre-emergence sulfonylurea herbicide effective against most annual grasses and broad-leaf weeds in crops like paddy, wheat, maize and some of vegetables.

Persistence of Pyrazosulfuron-ethyl in soils is influenced by various factors like soil moistures, organic matter content and microbial activity. A number of field studies conducted to know the fate of pyrazosulfuron-ethyl in soil.

The fate of any herbicide depends on its properties and that of soils to which it is applied, the present study undertaken to determine the persistence of pyrazosulfuron-ethyl in soils under three different moisture conditions namely maximum water holding capacity, half maximum water holding capacity and submergence.

EXPERIMENTAL METHODS

Surface soil samples from 0-15 cm depth were collected from Shimoga (sandy loamy *Ultic haplustalfs*), Mandya (sandy clay loam *Typic rhodustalfs*) and Chamrajanagar (sandy clay loam *Typic Paleusterts*). The data on physical and chemical properties of these soils are presented in Table A.

Pyrazosulfuron-ethyl (technical purity-99% obtained from Sigma- Aldrich Labor chemikalien GMBH chemicals) was used in the present investigation.

Persistence of pyrazosulfuron-ethyl was studied in soils under three moisture regimes namely maximum water holding capacity, half maximum water holding capacity and submergence. Twenty gram of each soil samples were weighed in to 50 ml test tubes and the herbicide rate of application 10 $\mu g\ g^{-1}$ in acetone medium. After thoroughly mixing soil with herbicide, the moisture level was maintained at half maximum water holding capacity, maximum water holding capacity and submergence. Submergence was achieved by maintaining two centi meter water column over the soil surface. The weight of each test tube was recorded for periodic adjustments of water content. Test tubes were incubated in incubator. Duplicate tubes were removed for estimation

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Table A : Physical and chemical properties of incubated soils

Sr. No.	Parameters	Shimoga	Mandya	Chamarajanagar
1.	Particle size distribution			
	Sand (%)	72.9	65.0	56.8
	Silt (%)	9.4	12.1	14.6
	Clay (%)	17.7	22.9	28.6
	Textural class	Sandy loam	Sandy clay loam	Sandy clay loam
	Taxonomical class	*Ultic haplustalfs*	*Typic rhodustalfs*	*Typic Paleusterts*
2.	pH (1:2.5 soil and water)	5.6	6.9	8.3
3.	EC (dS m^{-1})	0.29	0.23	0.35
4.	Organic matter (g kg^{-1})	10.3	12.9	13.4
5.	CEC (c mol kg^{-1})	14.4	19.3	23.7
6.	Bulk density (mg/m^3)	1.34	1.22	1.26
7.	Available N (kg ha^{-1})	225.3	260.4	243.5
8.	Available P_2O_5 (kg ha^{-1})	13.6	18.7	21.9
9.	Available K_2O(kg ha^{-1})	124.8	140.6	176.3
10.	MWHC (%)	34.2	36.8	39.5

of pyrazosulfuron-ethyl residues at periodic intervals.

Extraction and analysis of pyrazosulfuron-ethyl were carried out as per the method of Kang *et al.* (2006). The contents of the test tubes were quantitatively transferred to 100 ml centrifuge tubes extracted twice with 50 and 25 ml volumes of methanol by using mechanical shaker then centrifuge and filtered under suction. The extract was transferred to 500 ml of separating funnel. Add 250 ml de-ionized water and 50 ml saturated sodium chloride solution and 1 ml of 6 N HCl were added and pyrazosulfuron-ethyl residues was quantitatively re-extracted twice with 50 ml and 25 ml of dichloromethane. Shaken for 30 seconds and layers were allowed to separate and bottom layer of solution was collected. The aqueous layer was further extracted twice with hexane, each time with 25 ml. The pooled hexane was passed through anhydrous sodium sulphate and evaporated to dryness by using rotary flash evaporator. The residue was dissolved in acetonitrile evaporated to dryness and finally the volume was made up to 5 ml by repeated washing with acetonitrile. A suitable aliquot of the cleaned up sample was injected into high performance liquid chromatography (HPLC) with the help of micro-liter syringe for quantitative residue analyses.

Per cent recovery of pyrazosulfuron-ethyl in soils under different moisture regimes ranged from 87.1 to 91.2 per cent.

EXPERIMENTAL FINDINGS AND ANALYSIS

It was found that increase in moisture content increased the disappearance of pyrazosulfuron-ethyl, disappearance was most rapid under submergence followed by maximum water holding capacity moisture level and half maximum water holding capacity conditions. In half maximum water holding capacity the degradation pyrazosulfuron-ethyl was very less obviously due to low moisture content. Since the degradation of pyrazosulfuron-ethyl was mainly microbial, moisture becomes a limiting factor and this has been reflected in higher persistence and half lives compared to maximum water holding capacity and submergence condition (Table 1).

Table 1 : First order rate constants (k_{deg} day^{-1}), determination coefficients (r^2) and half lives ($t_{1/2}$) for pyrazosulfuron-ethyl degradation in soils at different moisture regimes

Moisture regimes	k_{deg} (days)	r^2	$t_{1/2}$ (days)
Shimoga			
Half MWHC	0.009	0.989	74.6
MWHC	0.012	0.986	57.7
Submergence	0.016	0.992	42.9
Mandya			
Half MWHC	0.008	0.993	85.5
MWHC	0.011	0.992	62.0
Submergence	0.013	0.980	53.8
Chamarajanagar			
Half MWHC	0.009	0.990	78.9
MWHC	0.012	0.990	59.0
Submergence	0.015	0.996	46.9

Half lives for pyrazosulfuron-ethyl under half maximum water holding capacity, maximum water holding capacity and submerged ranged from 74.6 to 85.5, 57.7 to 62.0 and 42.9 to 53.8 days, respectively (Table 1). These result suggested soil anaerobiosis as major factor responsible for degradation of pyrazosulfuron-ethyl.

Earlier workers Yadav *et al.* (1997) reported that the residual toxicity of metsulfuron-methyl after 120 days of its application was more at low soil moisture than at high moisture level.

Degradation of pyrazosulfuron-ethyl was faster in Shimoga soil followed by Chamarajanagar and Mandya soils under all moisture regimes. However, the difference in the persistence of pyrazosulfuron-ethyl among the soils was less, though the soils belong to different textural classes and with different soil properties. The persistence and degradation variation shows relation with organic matter, chemical process in soil and also effect on microbial activities (Albanis *et al*., 2002). The lower persistence of pyrazosulfuron-ethyl in Shimoga soil may be due to low pH compared to other two soils. Zheng *et al.* (2008) and Xu *et al.* (2009) reported that the hydrolysis rate was pH-dependent and increased with varying pH from neutral. The hydrolysis of pyrazosulfuron-ethyl was much faster in acidic or basic media than under neutral conditions and the abiotic degradation occurs much faster at low pH than at basic and neutral pH conditions.

Data on persistence of pyrazosulfuron-ethyl as monitored by residue analysis indicated an initial rapid degradation followed by slower rate of loss in all the soils under all moisture regimes.

Present study proved that pyrazosulfuron-ethyl degradation is favoured under flooded condition and is mainly depends on moisture and microbial activity of the soil.

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