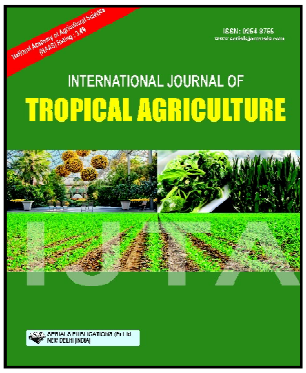

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Dissipation of Synthetic Pyrethroid in Sandy Soil under Laboratory Conditions

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Abstract: Dissipation of Synthetic pyrethroid that is bifenthrin in sandy soil was investigated under laboratory conditions. Commercial Formulation of bifenthrin available as Talstar 10% EC was applied @ 25 and 50 g a.i./ha in pot under field capacity moisture in laboratory.. Samples drawn periodically were analyzed on GC-ECD. The residues of bifenthrin in both the doses dissipated almost 85 % in 15 days. Half-life period values were 3.01 and 2.81 days in soil at single and double doses, respectively. The values of correlation coefficient for degradation kinetics in soil were -0.9832 to -0.9773 for T_1 and T_2 doses, respectively.

Keywords: Bifenthrin, Residues, Dissipation, Half-life

INTRODUCTION

Pesticides of different chemical structures are used worldwide in agriculture for saving crop sufferers and increasing crop productivity. The main problem linked to over use of pesticide is the contamination of soil. Several scientists reported effect of pesticides in soil (Frampton *et al.* 2006; Coupe *et al.* 2005; Willian and Mueller 1994; Balasubramanya and Patil 1980). Integrated pest management (IPM) programs were introduced in order to minimize sole dependence on chemical control of pests because of undesirable side effects on the environment. Generally, IPM programs have not been practically developed for most of the crops in India. Once the pollutants enter into the environment, it may persist and enter into food chain by bioaccumulation. Soil pH has an influence on the rate of dissipation of the pesticide (Sabadie 1990). Bifenthrin (2-Methyl-3-phenyl phenyl methyl (1*S*, 3*S*)-3-(Z)-2-chloro-3,3,3-triflouroprop-1-enyl 2,2-dimethylcyclopropane-1-carboxylate;

Fig. 1) is a third generation pyrethroid. It is an effective insecticide against stored grain pests and various insect pests of cotton, vegetables and fruit crops (Ali and Karim 1994; Chinniah and Ali 2000; Reddy and Rao 2002, Gupta *et al.* (2009). Bifenthrin has low potential to volatilize into air when applied to dry soil but somewhat higher potential when applied to wet soils. Thus it may be found in air attached to soil particles. Also it has low water solubility but correspondingly strong affinity to bind to soil therefore found in runoff sediments (Gan *et al.* 2005). Suspended soil particles contaminated with bifenthrin can increase the toxic concentration in water bodies. The present study was undertaken to determine the dissipation of bifenthrin in sandy soil under laboratory condition.

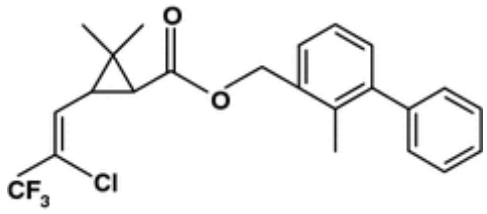

Figure 1: **Chemical structure of bifenthrin**

MATERIALS AND METHODS

For laboratory experiment, sandy soil was collected from the untreated plots of village of Patuwas (Bhiwani) Haryana, India. Soil after drying was sieved through 2 mm sieve before use to remove the debris. The quantity of the insectiside required per pot (4 kg of soil) was calculated based on the soil weight of plough depth (i.e. 2 million kg soil per ha.). Soil was treated with two doses equivalent to field doses, single dose (T_1: 25 g a.i.ha^{-1}) and double dose (T_2: 50 g a.i.ha^{-1}) and packed in separate pots in triplicate for each dose and control for each treatment. The pots were kept at field capacity moisture level of 1/3 bar tension. The moisture content in pot was checked periodically (3–5 days interval) and the required amount of water was added to maintain the desired moisture content throughout the experimental period. Samples of soil from each treatment were drawn and analyzed periodically after 0 (1 h after treatment), 1, 3, 7, 15 and 30 days after treatment. From each pot, a thoroughly mixed soil sample was taken with steel auger and quartered to a required size (15 g) and analyzed for degradation studies.

Extraction and clean-up was carried out as per method of Kumari *et al.* (2008). Ground, sieved and dry representative (15 g) of soil mixed with charcoal and florisil (0.3 g each) and 10 g of anhydrous sodium sulphate. The mixture was packed compactly in a glass column (60 cm × 22 mm) in between two layers of anhydrous sodium sulphate. Residues were eluted with 125 mL of hexane:acetone (9:1 v/v) at flow rate of 2–3 mL/min. The eluate was concentrated on flash evaporator and made the final volume to 2 mL for GC analysis.

The final extracts were analyzed on Shimadzu 2010 gas chromatograph (GLC) equipped with capillary column, HP-I (30 m × 0.32 mm × 0.25 µm film thickness of 5% diphenyl/95% dimethyl polysiloxane) and electron capture detector (ECD). The operating parameters of the instrument were: Oven temperatures ratio 1:10. Under these operating conditions the retention time of bifenthrin was found to be 18.480 min. (°C) 150 (5 min) → 8°C min^{-1} → 190 (2 min) → 15°C min^{-1} → 280° (10 min), injection port 280°C and detector 300°C. Flow rate of nitrogen (carrier gas) was 60 ml/min; through column was 2 ml/min and split The retention times observed for bifenthrin was 18.480 min. The percent recoveries of bifenthrin in soil were found to be consistent and more than 80% (Table 2). Therefore, the results are presented as such without applying any correction factor. Limit of detection was 0.001 and limit of determination/quantitation 0.005 mg kg^{-1}.

RESULTS AND DISCUSSION

The residue data and statistically analyzed data obtained from two treatments [25 g a.i. ha^{-1} (T_1) and

50 g a.i. ha^{-1} (T_2)] are given in Table 3. The residue data in Table 3 (Fig. 2) revealed that at T_1 , average initial deposits on 0 day (1 h after treatment) were 0.038 mg kg^{-1} which dissipated to 0.035, 0.029, 0.020, 0.014 and 0.007 mg kg^{-1} in 1, 3, 5 , 7 and 15 days, respectively. The per cent dissipation was recorded to be 33.89, 49.15, 62.71 79.66 and 88.13 respectively in this period. At T_2, the initial residues were found to be 0.062 mg kg^{-1}on 0 (1 h) day. After 1 day of treatment, the residues declined to 0.058 mg kg^{-1} indicating per cent dissipation of 34.16. The residues further declined to 0.044 mg kg^{-1}, 0.023 mg kg^{-1}, 0.020 mg kg^{-1} and 0.013 mg kg^{-1} after 3, 5, 7 and 15 days of treatment indicating 34.16, 50.03, 63.36, 80.83 and 89.16 per cent dissipation, respectively.

Statistically analyzed data (Table 3) showed that with increase in duration, significant reduction (CD=0.002; $p \geq 0.05$) in residue levels was observed. Double dose showed significantly more residues at the end of study period as compared to single dose (CD=0.002; $p \geq 0.05$). Plot of log [Residues (mg kg^{-1}) x 10^3] and time (in days) were also plotted to study the degradation kinetics of bifenthrin residues dissipation in soil (Fig. 2). The residue half life values were 3.01days and 2.85 days in soil at T_1 and T_2 doses, respectively. The values of correlation coefficient for degradation kinetics in soil were -0.9832 to -0.9773 for T_1 and T_2 doses, respectively.

Table 1
Physical properties of soil

Soil type	*Sand (%)*	*Silt (%)*	*Clay (%)*	*pH*	*EC (dSm^{-1})*	*O.C.*	*N ($kg\ ha^{-1}$)*
Sandy	28	24.3	42.0	7.85	0.21	0.92	90

Table 2
Recovery of bifenthrin from soil

Substrate	*Level of fortification ($mg\ kg^{-1}$)*	*Recovery (%) (mean ± SD)[a]*
Soil	0.10	88.00± 1.56
	0.25	90.50 ± 2.40

[a]Each value is mean ± SD of three replicate determinations

Table 3
Dissipation of bifenthrin in Sandy soil

Days	*Single dose (25 g a.i. ha^{-1})*		*Double dose (50g a.i. ha^{-1})*	
	Average Residues ($mg\ kg^{-1}$) ± SD*	*% Reduction*	*Average* Residues ($mg\ kg^{-1}$) ± SD*	*% Reduction*
0(1h)	0.038±0.003	-	0.062±0.003	-
1	0.035±0.003	33.88	0.058±0.003	34.16
3	0.029±0.003	49.15	0.044±0.003	50.03
5	0.020±0.003	62.71	0.023±0.003	63.36
7	0.014±0.003	79.66	0.020±0.003	80.83
15	0.007±0.002	88.13	0.013±0.002	89.16

Average ± SD of three replicates; BDL 0.007 mg kg^{-1}

For regression equation, [Residues (mg kg^{-1}) x 10^3] is taken

CD ($p \geq 0.05$) for days = 0.002, for dose = 0.002, for days x dose = 0.003

The results are in agreement with Chauhan *et al.* (2012) reported that the residue half - life values of bifenthrin in soil as 2.02 days and 2.10 days at 25 and 50 g a.i. ha^{-1} doses, respectively. Recovery of bifenthrin in soil ranged between 92.6% and 93.8% at 0.5 and 1.0 µg g^{-1} and the DT_{50} (disappearance time for 50 % loss) of bifenthrin at the level of 10 µg g^{-1} in sterile and non sterile soil were found to be 330 and 147 days, respectively reported by Sharma and Singh (2012).

CONCLUSION

Average recoveries at 0.10 and 0.25 mg kg^{-1} levels were 88.00 and 90.50 percent respectively. Bifenthrin dissipated up to 7 days in single dose and 15 days for double dose. Very low amount of bifenthrin were detected in soil which indicated that insecticide is safe for soil health.

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