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Abstract - The purpose of this study was to determine the leaching behaviour of pyrethroids. Now days pyrethroids are applied largely in India, creating the need to evaluate potential leaching of pyrethroids. Thus leaching of bifenthrin and λ -cyhalothrin in sandy loam soil was evaluated under laboratory conditions with simulated rainfall of 300 mm. Bifenthrin was applied at 2 and 4 µg while λ -cyhalothrin was applied at 2 and 4 µg on soil columns, respectively. Maximum concentration of bifenthrin and λ -cyhalothrin was recovered from 0-5 cm depth in the soils. Results indicated the low mobility of both the insecticides under saturated moisture condition that may be significant in terms of ground water contamination Now a days pyrethroids .

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I. Introduction

Pesticides are one of the major technological developments of twentieth century, whether natural or synthetic, they have toxicological significance and pose potential risk when persist in the environment. As they are the most important component of any pest management strategy.The indiscriminate use of pesticides has given rise to many problems viz. persistence of toxic residues in the environment, development of resistance in insect pests and resurgence of pests.Soil, an important component of the environment, act as a sink for the pesticides used in agriculture. Such treatments may suppress soil micro-flora and hence affect soil properties. The pesticides present in soil sometimes act as a source of contamination for succeeding crop also. From soil, the pesticides residues can reach to water bodies by leaching and runoff. The main processes potentially affecting the ultimate fate of pesticides in soil are retention by soil materials (involving adsorption /desorption processes), transformation processes (biological and chemical degradation), and transport (through soil, atmosphere, surface water, or ground water) (Saltzman and Yaron 1986; van der Hoff and van Zoonen 1999).

Bifenthrin,((2-methyl-1,1-biphenyl-3-y1)-methyl-3-(2-chloro-3,3,3-trifluoro-1-propenyl)-2,2-dimethylcyclo propanecarboxylate and λ-cyhalothrin, (S)-α-cyano-3-phenoxy benzyl-(Z)-(1R, 3R)-3-(2-chloro-3, 3, 3-trifluoro prop-1-enyl)-2, 2 dimethyl cyclopropane carboxylate, are the member of synthetic pyrethroid family. These groups are characterized by greater photostability and greater insecticidal activity than previous pyrethroids (Morky and Hoagland 1989). Being non-polar in nature their solubility is less in water but have strong tendency to bind to soil (Linde, 1994). It gives rapid knockdown activity to control of a wide spectrum of insects pests like aphids, thrips, lepidopteran larvae, coleopteran larvae and adults in cereals, ornamentals, potatoes, vegetables, cotton and other crops. Despite of their extensive use, very little is known about their leaching behaviour in Indian soil. Since ground water is the main source of drinking and irrigation water thus to assess the risk of ground water contamination by both the insecticides, this experiment was carried out to generate information on the leaching behaviour of both the insecticides in sandy loam soil at different doses under laboratory conditions.

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II. Material and Method

a) *Chemicals*

All the solvents used for this study were of analytical grade. All the solvents were redistilled before use in glass apparatus and their suitability was ensured by running reagent blanks along with actual analysis. The stock solution of both the insecticide prepared at concentration of 1000 µgml^{-1} in GLC-grade analysis; and further diluted to prepare working standards.

b) *Sample processing*

The leaching experiment was carried out in Residue Laboratory in the Dept. of Entomology CCS Haryana Agricultural University, Hisar. For the experiment, soil was collected from Research Farm of the University and used after drying, grinding and sieving. From the bulk soil samples nine sub-samples of 1.58 kg each were used for filling in plexi glass column (90 cm x 5 cm i.d). Characteristic of soil was as follows:

Commercial bifenthrin and λ-cyhalothrin formulation (2.5EC) was used in leaching experiment. The column was sequentially filled with soil up to the height of 60 cm in triplicate along with blank. Before packing, filter paper was kept at the perforated distal end of the column to allow only the passage of leachate. Filter paper disks were placed on top of the each column to assist uniform dispersion of the water across the column surface. At the bottom of the columns, a funnel with flask was kept to collect the leachate. Before the application, both the insecticides were dissolved in deionized water and simultaneously applied to the last 5cm of the soil in the column at the dose of 2 and 4 µg bifenthrin and λ-cyhalothrin (2 and 4 µg). After application of both the insecticides, the columns were irrigated with 98ml of water daily for six days (equivalent to 300mm rain) at the time interval of 24 hrs. After six days, when addition of water was completed, the soil columns were allowed to drain for 36 hrs. Columns were then cut into two equal halves and the soil was sampled in 5cm segments and was used for analysis of residues.

III. Extraction and Clean up

Extraction of both the insecticides from soil was performed as described by Kumari et al. (2008).Water samples (leachates) were extracted by liquid-liquid partitioning with hexane: dichloromethane (85:15 v/v) by adding 5% Sodium chloride solution. Soil samples were air dried and sieved through 2 mm sieve and extracted by using column chromatography. A representative sub-soil of 15 g mixed with 0.3g each of activated charcoal and florisil was filled in a long glass column (60 cm x 22mm i.d.) between two layers of anhydrous sodium sulphate. The residues were eluted with 125 ml of hexane: acetone (9:1v/v). The organic layer was concentrated on rotary vacuum evaporator and final volume was made to 2ml in n- hexane.

The residues of both the insecticides were quantified on Shimadzu 2010 gas chromatograph (GC) equipped with fused capillary column, SPB-5 of 30m × 0.32 mm i.d, 0.25 µm film thickness of polysiloxane (5% diphenyl /95% dimethyl) and electron capture detector (ECD). The operating parameters of GC were: carrier gas flow, 60ml min^{-1} , injector temperature 280 ^{0}C , oven temperature programme was 150 ^{0}C (5 min) increasing @ 8 ^{0}C min up to 190 ^{0}C (2 min.), further increased @ 15^{0}C min^{-1} up to 280 ^{0}C (10 min) with split ratio 1: 10. The retention times observed for bifenthrin was 18.480 min and for λ-cyhalothrin was 19.427 min.

IV. Result and Discussion

Residue data of both the insecticides i.e bifenthrin and λ-cyhalothrin at different soil depths are given in Table 2 and 3, respectively. The results showed that the insecticides leached up to the depth of 15 cm at 300 mm rainfall condition. The highest concentration of both the insecticides was found at 0-5 cm depth in both the application rates and it was higher at T_2 dose as compared to T_1. Bifenthrin was retained between 89-92 per cent in 0-5 cm core of soil and only 0.54-1.07 per cent residues were retained in 10-15 cm core of soil at single and double dose, respectively showing very low mobility of bifenthrin.

Retention of λ-cyhalothrin in soil cores was comparatively more than bifenthrin in both the doses. The retention was 94.41 – 95.91 per cent in the core of soil 0-5 cm at respective doses. Retention was quite low i.e 0.55-0.57 per cent in 10-15 cm soil core, showing immbobility of λ-cyhalothrin in soil. Among the two insecticides, the mobility of λ-cyhalothrin was found to be less than that of bifenthrin which can be attributed to low solubility (0.005 mg L^{-1}) of λ-cyhalothrin in water whereas solubility of bifenthrin in water is 0.1mg L^{-1}. None of the fractions contained residues of any insecticides in both the doses. Hence both the insecticides are seems to be safe for ground water. Manoj and Gajbhiye (2007) reported similar results i.e mobility of bifenthrin in soil was low. Its residues remained with in top 15 cm and more than 99 percent of residues were recovered from top 0-10 cm layer.

Tariq et al; (2006) observed the highest concentrations of λ -cyhalothrin in the top 0–10 cm layer. Gupta and Gajbhiye (2002) reported that the residue of β-cyfluthrin was recovered more than 99 percent from 0-5 cm depth. The possibility of its leaching to ground water is negligible because of its immobility. Hill and Inaba (1991) also reported the similar results that λ- cyhalothrin did not leach out of the top 2.5 cm of soil after application of 102 cm of water, i.e., 2 times the annual rainfall). No residues were detected in any leachate. No leaching was found by Sakata et al; (1986) in case of cypermethrin in all the three types of soils. Hence the results of the present studies have been well corroborated by the findings of other researchers.

V. Acknowledgements

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Table1 : Physical properties of soil.

Soil type	Sand (%)	Silt (%)	Clay (%)	pH	EC (dSm^{-1})	O.C.	P_2O_5 ($kg\ ha^{-1}$)
Sandy loam	28	24.3	42.0	7.6	2.0	0.67	15

Table 2 : Leaching behaviour of bifenthrin in sandy loam soil.

Soil Column Depth (cm)	Residues ($mg\ kg^{-1}$)*	
	Single dose (2 μg) ±SD	Double dose (4 μg) ±SD
0-5	1.62±0.005	3.44±0.015
5-10	0.19±0.011	0.26±0.008
10-15	0.01±0.003	0.04±0.001

* Average residues of three replicates
Leachate contained no residues

Table 3 : Leaching behaviour of λ-cyhalothrin in sandy loam Soil.

Soil Column Depth (cm)	Residues ($mg\ kg^{-1}$)*	
	Single dose (2 μg) ±SD	Double dose(4 μg) ±SD
0-5	1.69±0.301	3.52±0.211
5-10	0.09±0.007	0.13±0.030
10-15	0.01±0.001	0.04±0.006

* Average residues of three replicates
Leachate contained no residues

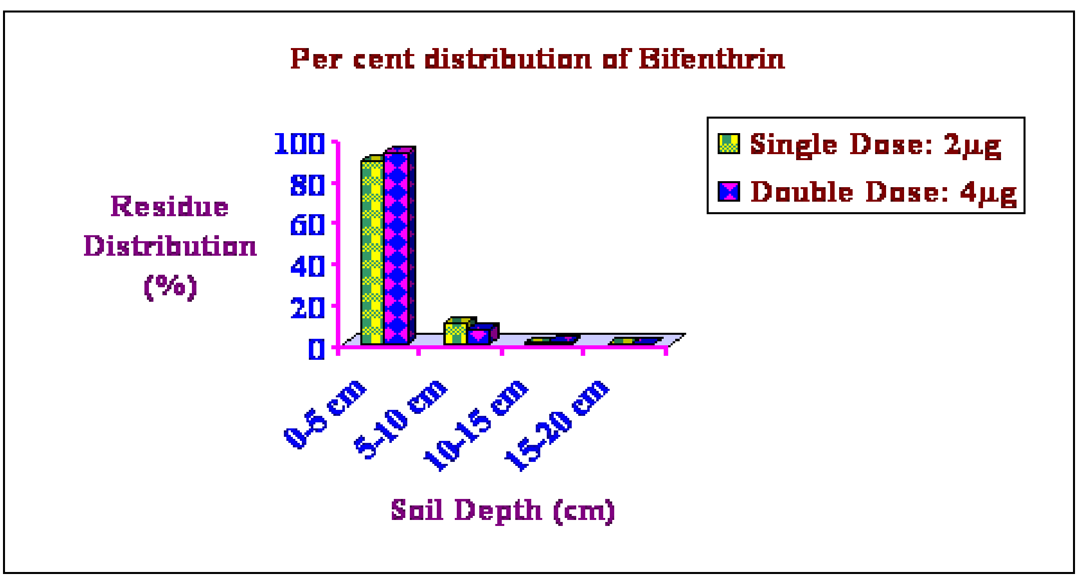

Figure 1 : Distribution of bifenthrin at different soil depths at two doses.

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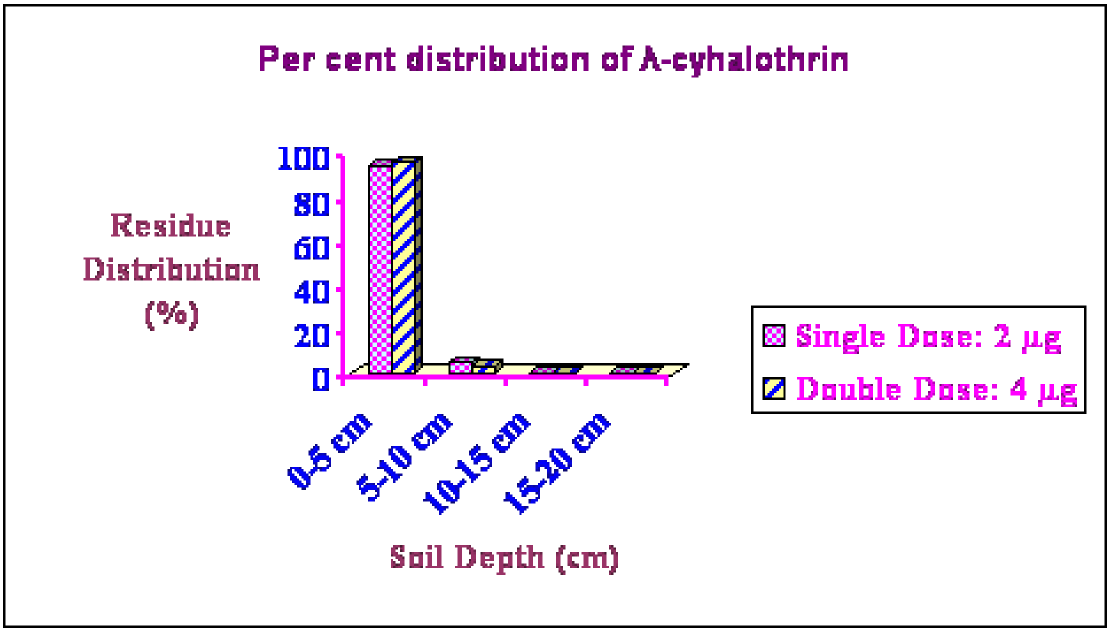

Figure 2 : Distribution of λ-cyhalothrin at different soil depths at two doses.