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Dissipation of Lambda-Cyhalothrin on Tomato (*Lycopersicon esculentum* Mill.) and Removal of Its Residues by Different Washing Processes and Steaming

S. Jayakrishnan,[1] A. K. Dikshit,[1] J. P. Singh,[2] D. C. Pachauri[3]

[1] Division of Agricultural Chemicals, Indian Agricultural Research Institute, New Delhi 110012, India
[2] Division of Entomology, Indian Agricultural Research Institute, New Delhi 110012, India
[3] Division of Vegetable Crops, Indian Agricultural Research Institute, New Delhi 110012, India

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Lambda-cyhalothrin, a 1:1 mixture of the (Z)-(1R, 3R), S-ester and (Z)-(1S, 3S), R ester of ∝-cyano-3-phenoxybenzyl-3-(2-chloro-3,3,3-trifluoroprop-1-enyl)-2,2-dimethylcyclopropanecarboxylate, has a very high activity against a wide range of chewing and sucking insect pests, particularly lepidoptera, coleoptera and mites in fruits, vegetables, cereals, maize, cotton, wheat, pulses, oilseeds and in public health as a vector control agent (Davey et al. 1992; Roberts et al. 1993; Dikshit et al. 2000; Mathirajan et al. 2000).

In India lambda-cyhalothrin is registered for use in plant protection practices but public health considerations have to be taken into account for the residue levels not higher than the maximum permissible intake in order to ensure safety. From the environmental and food safety viewpoint, the persistence of lambda-cyhalothrin in animals, soil, water and plants has been studied. (Hill and Inaba 1991; Dikshit et al. 2000; 2001). Since it is used at various stages from flowering to fruiting stages for the control of insect pests, the chemical may reside and remain in the edible parts till maturity and ripening stages of the tomatoes. Therefore an attempt has been made to predict its total dietary intake from consumption of tomato and to study consumer risk assessment by generating food chemical concentration data (residues) from residue field trials conducted for two crop years.

MATERIALS AND METHODS

The tomato seedlings (var. Pusa Sheetal) were transplanted on raised beds (4.5 × 0.5 m^2) during 2001 while var. Pusa Ruby was transplanted in the normal plots (5 × 4 m^2) in the year 2002 at the experimental farm of Indian Agricultural Research Institute, New Delhi, India. The plant spacing was 45×45 cm^2 for both the years. Lambda-cyhalothrin, (Karate 5 EC, Syngenta Crop Protection India Limited, New Delhi, India) was sprayed at the rate of 15 and 30 g active ingredient per hectare (ai ha^{-1}). The insecticide was sprayed on the tomato crop when some fruits had set in. Twenty days later, a second spray was given. The fluid rate was 500 L ha^{-1} for both the sprays. All the treatments were in

Correspondence to: A. K. Dikshit

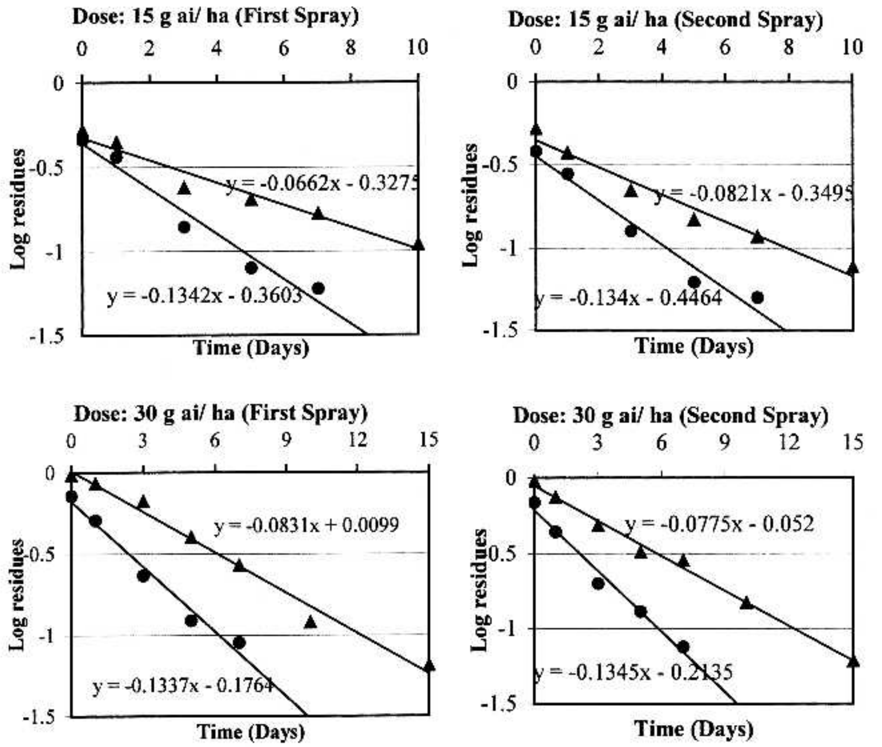
Randomized Block Design and taken in three replicates including untreated control.

For determining rate of decline of lambda-cyhalothrin and its concentration in tomato fruits to assess dietary intake and consumer risk, the fruit samples (500 g) were collected randomly on 0 d (1 hr after insecticide spray), 1, 3, 5, 7, 10, 15 and 20 d from both the trials/ sprays.

The fruit samples were cut into small pieces, mixed and a sub sample of 50 g was taken for further analysis. Based on the results and performance of the recovery experiments, the optimum conditions suited were adopted for the analysis of field samples as per the method of Jayakrishnan (2002).

The efficiency of extraction, cleanup and determinative steps were checked by fortifying the tomato fruits. Untreated tomato fruits (50 g) were spiked separately with 5, 25 and 50 μg of lambda-cyhalothrin and kept 24 hr. Next day fortified samples were extracted with acetone and the extracts were liquid- liquid partitioned by dichloromethane. The organic extracts were cleaned up by column chromatography using Florisil (10 g). The cleaned extracts obtained after the above chromatographic separations were quantified by gas liquid chromatography (GLC). The GLC (Hewlett Packard 5890 A) conditions were: Ni^{63} electron capture detector; HP-1 megabore column (methyl silicon gum, 10 m x 0.53 mm, 2.65 μm film thickness); oven and injector temperature 250°C; detector temperature 300°C; N_2 flow 30 mL min^{-1}. This method gave highest average recovery (96%) of the pesticide when compared to other methods where average recoveries varied from 49 to 93%. The better recovery by Florisil can be attributed to the fact that it is less reactive than alumina or silicagel in retaining the insecticide where as low recoveries from charcoal were due to its high adsorptive power.

The extent of removal of lambda-cyhalothrin residues from 0, 3 and 5 d contaminated samples was seen from only second spray of first year trial. For this purpose, contaminated fruits were washed separately with water, saline water (1.5% NaCl in water), citrus water (5 ml acid lime juice in 95 ml of water). For each process, samples were washed for 5 min in a dish containing 2L of the above wash solution. The washed fruit samples were taken out and estimated for presence of insecticide residues. Similarly for washing + steaming process, samples were washed with water and then steamed for 5 min and the resultant mass was determined for residues. Further, the analytical data was interpreted for the dissipation rate kinetics, half-life and safety factors such as Theoretical Maximum Daily Intake (TMDI) and Processing Factor (PF) with respect to Maximum Permissible Intake (MPI) in order to arrive at risk assessment to human health.



▲, First year; •, Second year

Figure 1. Dissipation rate kinetics of lambda-cyhalothrin on tomato.

RESULTS AND DISCUSSION

The initial deposit of lambda-cyhalothrin on tomato fruits was 0.385 to 0.526 mg kg^{-1} and 0.690 to 0.958 mg kg^{-1} from 15 and 30 g ai ha^{-1} treatments from both the trials. The reported concentration declined with time and reached non-detectable after 7-10 d. Residues dissipated at the half-life of 3.6-4.5 d and 3.7-3.9 d from first and second spray, respectively from first year trial. There was no significant difference in dissipation pattern (Figure 1) between the two treatments suggesting that the dissipation of lambda-cyhalothrin was independent of dose of insecticide. The residue concentration data fitted to a first order rate kinetics and the dissipation rate constants ranged from 0.0662 to 0.1345 day $^{-1}$(Figure 1).

The TMDI from residues for all the treatments was found to be lower (0.0385 to 0.0958 mg $person^{-1}$ day^{-1}) than the MPI of 0.25 mg $person^{-1}$ day^{-1} (Tomlin 2000). The TMDI has been arrived at considering recommended consumption of vegetables as 100 g for leafy or fruit vegetables other than roots and tubers (Anonymous 1999) and MPI has been calculated on the basis of ADI value of lambda-cyhalothrin 0.005 mg kg^{-1} body weight (Tomlin 2000) and the average body weight of an Indian person as 50 kg. Tomato fruits are normally harvested at an interval of 3 d and first picking is normally done after 3 d of spray of insecticide. Considering this, the TMDI from 3 d residues will be much less than the MPI or to that of 0 d residues. This further encompasses more margin of safety (MOS). In view of this a minimum of 3 d waiting period for harvest of fruits after insecticide application is recommended to achieve maximum safety and minimum risk to consumers.

The data on the processing effect by culinary procedures are presented in Table 1. Washing of 0 d contaminated tomato fruits with tap water dislodged 39 and 42 percent residues from 15 and 30 g ai ha^{-1} treatments from first year experiment. Tomato samples when washed with citrus solution did not yield significant reduction of residues over tap water washing. Hence, washing the samples with citrus solution will not be economical and meaningful. Washing of samples with saline water removed 44 and 46 percent from both the treatments in case of 0 d contaminated samples. Washing of 3 or 5 d contaminated samples with tap water, citrus solution or brine water did not remove residues to the same extent to that of 0 d samples. However, washing followed by steaming gave best results and removed 60-79 percent residues. This can be recommended as the best method to remove the lambda-cyhalothrin residues from tomato fruits.

Table 1. Effect of some culinary processes on removal of lambda-cyhalothrin from tomato: Second application

Time (days)	Dose[a]	Residues (mg kg^{-1})[b]				
			Washed with			
		Unwashed	Water	Citrus solution	Saline solution	Washing + Steaming
0	15	0.526±0.005[c]	0.321±0.010 (39)[d]	0.309±0.007 (41)	0.294±0.013 (44)	0.209±0.008 (60)
	30	0.950±0.028	0.553±0.015 (42)	0.542±0.009 (43)	0.516±0.011 (46)	0.363±0.010 (62)
3	15	0.233±0.004	0.162±0.004 (30)	0.154±0.004 (34)	0.148±0.008 (36)	0.071±0.006 (70)
	30	0.484±0.005	0.319±0.010 (34)	0.312±0.010 (36)	0.302±0.009 (38)	0.142±0.008 (71)
5	15	0.148±0.003	0.112±0.011 (24)	0.110±0.006 (26)	0.103±0.012 (30)	0.035±0.006 (76)
	30	0.324±0.003	0.238±0.012 (27)	0.234±0.006 (28)	0.218±0.010 (33)	0.068±0.010 (79)

[a]Dose in g ai ha^{-1}; [b] Results are expressed as average of three replicates and only from one experiment; [c] Standard deviation; [d] Figures in parentheses denote the percent removal/ reduction.

To conclude, the lambda-cyhalothrin at the experimented doses (15 and 30 g ai ha^{-1}) that were effective in managing tomato fruit borer did not present the residue problem in fruits. A waiting period of 3 d for harvest of the fruits after insecticide application and PF ensures large margin of safety.

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