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Persistence and dissipation of lambda cyhalothrin in/on mango (*Mangifera indica*)

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ABSTRACT

A study was conducted during 2004 to evaluate persistence of lambda cyhalothrin residues in mango (*Mangifera indica* L.) fruits. Repeated spray application of lambda cyhalothrin (Karate 5 EC, used for control of mango leaf hopper) at the recommended dose of 0.5 and double the recommended dose 1.0 ml/litre, resulted in the initial deposit of 0.86 and 1.6 mg/kg, respectively. The residues dissipated steadily and after 20 days of spraying 0.05 and 0.09 mg/kg were recovered from the fruit peel. In the fruit pulp maximum of 0.034 and 0.044 mg/kg lambda cyhalothrin was recovered after 5 days, following treatment at recommended and double the recommended dose, respectively. The residues in the peel remained up to 20 days and in the pulp 7 days. Lambda cyhalothrin residues in mango peel dissipated at the half-life of 4.8 days and the safe pre-harvest interval was 4 and 8 days taking the maximum residue limit value as 0.5 mg/kg.

Key words: Half-life, Lambda cyhalothrin, Mango hopper, Persistence, Pre-harvest interval

Mango (*Mangifera indica* L.), is the leading fruit crop of India, that occupies 22% of the total area under fruit crops comprising 1.2 million ha, with a total production of 11 million tonnes (NABARD 2003). Leaf hopper is a serious insect pest of mango and it appears on the inflorescence and significantly reduces the fruit yield from 25 to 60%. Traditional insecticide like monocrotophos gives effective to control mango hopper (Sahoo and Samanta 2006). Carbaryl (0.15%) along with endosulfan (0.07%) significantly reduced the hopper population, and also gave high yield (Samanta *et al.* 2008). But as per earlier results treatment of these insecticides resulted in high deposit of 15.95–50.77 mg/kg of carbaryl and 0.95–2.60 mg/kg of monocrotophos on mango fruits following treatment at 0.05–0.2% and 0.05–0.1%, respectively (Sachan and Singh 1994).

Lambda cyhalothrin [1-cyano-3-phenoxybenzyl-3-(2-chloro-3-3-3-trifluoroprop-1-inyl)-2,2,-dimethyl cyclopropane carboxylate] is a potent synthetic pyrethroid, used for control of a variety of insect pests of fruits (Gyi *et al*. 2003) and vegetables (Tripathy *et al*. 2005). This insecticide has been found to give good control of mango hopper, [*Idioscopus niveosparsus* (Leth.)] at a concentration level of 0.5 ml/litre (0.003%) (Verghese 2000). It was also found to be effective and comparable with standard, but more toxic pesticides like monocrotophos. It is therefore essential to generate information on its persistence and dissipation on mango as no such information is available.

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MATERIALS AND METHODS

Repeated spray application of lambda cyhalothrin (Karate 5 EC) was given at recommended (0.5 ml/litre) and double the recommended dose (1.0 ml/litre) to mango trees at Bengaluru during January–May 2004. The first application was given at flowering stage, the second application at lime size of the mango fruits. The third (last) application was given 1 month before harvest and analysis of the samples was carried out after that.

Treated mango fruits were sampled at periodic intervals of 0 (1 hr), 1, 5, 7, 10, 15, 20, 25 and 30 days after the last spray. Harvest time residues were also evaluated following treatment at flowering and lime size of the mango fruits.

The extraction and clean-up of the samples were carried out as per the method developed by Awasthi (1985) after necessary standardization to get satisfactory recoveries. Mango fruit samples (2 kg) were cut into small pieces and representative 50 g portions (in triplicate) were extracted with 100 ml of hexane + acetone (1:1, v/v) by blending. The extract was filtered through Buchner funnel under vacuum and the process was repeated twice with 75 ml of solvent. The extracts were diluted with water and the hexane layer collected, dried over anhydrous sodium sulphate and concentrated. The concentrated extracts were passed through a chromatographic column with 10 g florisil and eluted with 100 ml of hexane + acetone (9:1, v/v), which was concentrated and volume made

up to 10 ml in n-hexane for analysis by GLC.

The residues of lambda cyhalothrin in n-hexane were estimated by GLC (Varian 3800) equipped with an electron capture detector (ECD) and fitted with a capillary column (fused silica 30 m × 0.25 mm id). The column, injector and detector temperatures were maintained at 260, 280 and 300°C, respectively. The carrier gas (UHP grade nitrogen) flow rate was 15 ml/min. Under these parameters, the retention time of lambda cyhalothrin was 16.62 min. The limit of detection was 0.02 ng and the limit of determination was 0.005 mg/kg. The recovery test was carried out at 0.1 and 0.5 mg/kg levels for fortification of lambda cyhalothrin in acid lime showed that the recovery ranged between 90.2 to 92.0%. The residue data was subjected to statistical analysis according to Hoskins (1961) to compute the residual half-life ($t_{1/2}$) and safe pre-harvest interval.

RESULTS AND DISCUSSION

Mango whole fruit samples treated with lambda cyhalothrin spray at the recommended and double the recommended dose of 0.5 and 1.0 ml/litre were analyzed immediately after the application and an initial deposit of 0.86 and 1.60 mg/kg, respectively was detected (Table 1). Subsequently, peel and pulp samples were analyzed separately. Residues of lambda cyhalothrin mostly remained on the fruit peel which dissipated steadily and reached a low level of 0.05 and 0.09 mg/kg by 20 days. The treated fruits were analyzed up to 30 days, but residues reached below detectable limit by 25 days. In the fruit pulp lambda cyhalothrin residues were detected 1 day after application and reached a maximum of 0.034 and 0.044 mg/kg after 5 days, following treatment at recommended and double the recommended dose. The residues in mango pulp dissipated further and reached below detectable level after 7 days. The residue data on the peel was subjected to statistical analysis as per Hoskins (1961) for computing half-life and safe pre-harvest interval. The residues of lambda cyhalothrin on mango dissipated at the half life of 4.8 days. The maximum residue limit (MRL) value of lambda cyhalothrin on mango is not fixed either by PFA (Prevention of Food Adulteration Act) or Codex Alimentarius Commission (Joint FAO/WHO Food Standards Programme). However, a value of 0.5 mg/kg has been prescribed by the Japan Food Chemical Research Foundation (http://www.m5.ws001.squarestart.ne.jp/foundation/fooddtl.php?f_inq=11600) and the same is being endorsed by India for export of mangoes. Based on the persistence study and MRL value of 0.5 mg/kg the safe pre-harvest interval was calculated. The pre-harvest interval following treatment at recommended and double the recommended dose is 3.38 and 7.63 days (Table 3). The time taken for the residues to reach below detectable level was worked out as 25 and 29 days, respectively. Pre-harvest interval of lambda cyhalothrin on mango pulp has not been calculated as the residues at all times were below the maximum residue limit value of 0.5 mg/kg.

Table 1 Residues of lambda cyhalothrin in/on mango

Days after application	Treatment of Karate 5 EC (ml/litre)	Residues of lambda cyhalothrin recovered* (mg/kg)	
		Mango peel	Mango pulp
0	0.5	0.86**	
	1.0	1.60**	
1	0.5	0.72	0.020
	1.0	1.38	0.036
5	0.5	0.41	0.034
	1.0	0.73	0.044
7	0.5	0.29	0.014
	1.0	0.55	0.020
10	0.5	0.16	BDL
	1.0	0.28	BDL
15	0.5	0.10	BDL
	1.0	0.18	BDL
20	0.5	0.05	BDL
	1.0	0.09	BDL
25	0.5	BDL	BDL
	1.0	BDL	BDL
30	0.5	BDL	BDL
	1.0	BDL	BDL

*Average of 3 replicates; **Residues were evaluated only on the whole fruit BDL, Below detectable limit (0.005 mg/kg)

Table 2 Harvest time residues of lambda cyhalothrin in mango

Treatment spray given at	Dose of application (ml/litre)	Residues recovered (mg/kg)	
		Peel	Pulp
Flowering	0.5	BDL	BDL
	1.0	BDL	BDL
Lime size	0.5	BDL	BDL
	1.0	BDL	BDL
Flowering + lime size	0.5	BDL	BDL
	1.0	BDL	BDL
Flowering + lime size + 1 month before harvest	0.5	BDL	BDL
	1.0	BDL	BDL

BDL, Below detectable limit (0.005 mg/kg)

Harvest time residues on mango samples were also evaluated where only 1 and 2 spray applications were given. No residue of lambda cyhalothrin was detected in the fruits at harvest (1 month after the last spray) whether single spray application, 2 or 3 spray applications were given (Table 2).

Persistence study of lambda cyhalothrin on several vegetable crops has already been reported, though little information is available on its persistence on fruit crops. In an earlier study (Singh *et al.* 2007) lambda cyhalothrin residues degraded on okra with a half-life of 2.92 and 2.86 days and the residues were below detectable levels (<0.009 mg/kg) in 15 days. Lambda cyhalothrin persisted on brinjal

Table 3 Rate of residue decay and safety constants of lambda cyhalothrin on mango

Rate of application (ml/litre)	Regression equation	Regression co-efficient	Half-life (days)	Pre-harvest interval (days)
0.5	Y = 2.9086 – 0.0619 X	–0.99	4.86	3.38
1.0	Y = 3.1798 – 0.06301 X	–0.99	4.78	7.63

for 7 days when treated with Karate 2.5 and 5.0 EC and the prescribed pre-harvest interval was 4–5 days from both the treatments (Ahuja *et al.* 2006). In another study (Singh and Singh 2003) on the persistence and dissipation of lambda cyhalothrin on chickpea, treatment at 25 and 50 g ai/ha resulted a deposit of 0.335 and 0.462 mg/kg and the residues on grains at harvest was below detectable level.

In the present study lambda cyhalothrin treatment has resulted in the deposit of most of the insecticide residues on the mango fruit skin and penetration to the fruit pulp has been very low. Even on the fruit skin the residue deposit is much lower than other traditional insecticides like monocrotophos and carbaryl. In very recent study (Anitha Kumari *et al.* 2009) this insecticide is found to be effective against mango hopper at a concentration of 0.003%. Based on this study lambda cyhalothrin treatment for control of hopper can be recommended to get residue-free mangoes at harvest.

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