

Residual Toxicity of Lambda-Cyhalothrin on Apple Foliage to *Amblyseius fallacis* and the Tarnished Plant Bug, *Lygus lineolaris*

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The residual toxicity of lambda-cyhalothrin on leaves from a treated apple orchard to a mite predator, *Amblyseius fallacis* (Garman), in the laboratory, declined to one-third of its original level within 3 weeks. The absence of *A. fallacis* on apple trees during the pink bud stage coupled with the results of this study pave the way for the development of integrated pest management strategies where key pre-bloom pests, such as the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), may be controlled with lambda-cyhalothrin with little if any toxic effects to the predator later in the season. Two years of field testing indicated that 10 g a.i./ha of lambda-cyhalothrin applied at pink was very effective against the tarnished plant bug.

KEY WORDS: Lambda-cyhalothrin toxicity; *Amblyseius fallacis*; *Lygus lineolaris*.

INTRODUCTION

Lambda-cyhalothrin is a third generation pyrethroid. It is a contact, residual, and stomach-poisoning insecticide, with repellency properties. It has no fumigant or systemic activity. For several years now, it has been used to control a wide range of arthropod pests found on field and vegetable crops.

Graham and Gaylor (7) reported significantly fewer nymphs of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), on cotton treated with this compound (as Karate 1 EC formulation) in Alabama. Similar results were reported with the same formulation on cotton from Louisiana in 1989 (10). More recently, significant reductions of tarnished plant bug on alfalfa treated with Karate 1 EC were reported from Wisconsin (11). Very little work has been published on the activity of lambda-cyhalothrin in pome and small fruits. Excellent control of winter moth, *Operophtera brumata* (L.); apple sucker, *Psylla mali* (Schmidberger); rosy apple aphid, *Dysaphis plantaginea* (Passerini); codling moth, *Cydia pomonella* (L.); and pear psylla, *Psylla pyricola* Foerster, was reported from Britain with the 5 EC formulation of PP321 (13). The same study also reported moderate control of woolly apple aphid, *Eriosoma lanigerum* (Hausmann); European red mite, *Panonychus ulmi* (Koch); and apple rust mite, *Aculus schlechtendali* (Nalepa). In China, PP321 (2.5 EC) provided effective control of an armored scale pest that attacked citrus in 1988 (8), and of thrips that attacked apple in 1989 (12). More recently, good control of hickory

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shuckworm, *Cydia caryana* (Fitch), and of the pecan nut casebearer, *Acrobasis nuxvorella* Neunzig, was reported with Karate 5 EC on pecan trees in Mexico (2). The post-bloom use of pyrethroids is strongly discouraged in apple orchards of eastern Canada and the northeastern United States, because pyrethroids are persistent and toxic to native mite predators (5). In Quebec, a maximum of two sprays is recommended, one at pink and one at petal fall to control such pests as the tarnished plant bug and various fruit worms.

In this study we report the residual toxicity of a 50% lambda-cyhalothrin formulation at different intervals after treatment to *Amblyseius fallacis* (Garman), and the most effective time to apply this insecticide to control the tarnished plant bug. *A. fallacis*, hereafter referred to as *Af*, is one of the more important predatory mites in the region. Determination of the residual toxicity of lambda-cyhalothrin to *Af* will allow us to develop strategies to use this pesticide in orchards with minimal impact on this predator.

MATERIALS AND METHODS

The field work was conducted at the Agriculture and Agri-Food Canada Experimental Orchard at Frelighsburg, Quebec. Data about solar radiation and the number of days with maximum sunlight at Frelighsburg are recorded in Table 1. A block of high density dwarf *Malus domestica* Borkhauser 'Jersey Mac' (0.72 ha) apple trees was used from 1986 to 1988. It consisted of three separate plots (I, II, III). Each plot was 0.24 ha, separated from the adjacent plot by a 8-m-wide passageway, and divided into a treated and a non-treated sub-plot of equal size. The treated sub-plot was sprayed at pink in plot I, pink + petal fall in plot II and at petal fall only in plot III. Lambda-cyhalothrin (Matador[®]50 EC),* a product of ICI Agrochemicals, was applied at 10 g a.i./ha with a Swanson airblast sprayer Dual 200 (Swanson Sprayer Mfg., Clarksbourg, Ontario, Canada). The sprayer was calibrated to deliver 560 l/ha at 1034 kPa (150 psi) pressure.

Toxicological tests

Leaf samples from the treated and untreated sub-plots of plots I, II and III were used for toxicological studies. For this purpose, ten leaves of approximately equal size were picked at shoulder height (1.5 m) from flower/fruit clusters in each of the sub-plots at different time intervals. The exact dates for collection are reported within parentheses in Figure 1. In the laboratory, 16 24-h-old female adult *Af* were exposed to the leaves as described by Bostanian and Belanger (5). Twenty-four h after the mites had been exposed to lambda-cyhalothrin-treated leaves in a growth chamber, percent mortality was calculated (1). The growth chamber was set at 20°C and 80% r.h. The check was comprised of untreated apple leaves sprayed with tap water.

Efficacy tests

At harvest, 1150 to 1500 apples from each of the treated and untreated sub-plots of plots I, II and III were examined for tarnished plant bug injury; percentages of injured fruit were calculated for each of the plots. Confidence intervals for these percentages were calculated according to equation No. 6 in Bailey (4).

*Mention of this proprietary compound does not imply its endorsement as an official recommendation by the authors or Agriculture and Agri-food Canada.

RESULTS AND DISCUSSION

When lambda-cyhalothrin was applied only once, at pink, against tarnished plant bug, it was diluted by the lush growth in early spring. In that respect, leaf samples (96 leaves each) indicated that on the average the surface area of leaves collected at petal fall in 1987 was 1.75 times greater than the surface area of leaves collected at pink. In 1988, this factor increased to 1.81 (6). Hence, 3 weeks after such a treatment in 1986, we noted $39.8 \pm 2.5\%$ mortality of *Af*. In 1987, a pink treatment resulted in $8.6 \pm 1.1\%$ mortality of *Af* after one month, and in 1988 the mortality rate of this predacious mite could not even be determined, as it was within the natural mortality rate (13.4%).

The toxicity data of lambda-cyhalothrin to *Af*, when this pesticide was applied to trees at pink + petal fall, or only at petal fall, are summarized in Figure 1. In 1986 toxicity decreased, resulting in reduced mortality so that the 25% mortality was noted after 16 days with a single treatment at petal fall and 25 days later with two treatments (pink + petal fall). The 50% mortality occurred 12 days after a single treatment and 20 days after two treatments. In 1987, the rate of dissipation was even more rapid. This resulted in reduced mortality so that a single treatment at petal fall caused 25% mortality at 12 days, and 14 days after two treatments (pink + petal fall). The 50% mortality was noted 3 days after a single treatment and 5 days after two treatments. The toxicity data for 1988 were by and large similar to those of 1986. Thus, a single treatment at petal fall caused 25% mortality at 17 days and at around 22 days after two treatments (pink + petal fall). The 50% mortality was noted 10 days after a single treatment and 14 days after two treatments. These results were obtained with one and at most two early season applications of lambda-cyhalothrin to apple trees. On the other hand, unacceptable levels of *Af* mortality were recorded when this pesticide was applied three times in apple orchards throughout the summer (9). However, such a use pattern is alien, as it was never endorsed by the manufacturers of pyrethroids or government advisory services in Canada and the United States.

Unlike lambda-cyhalothrin, earlier pyrethroids were very persistent. For example, in English apple orchards, permethrin, cypermethrin, fenvalerate and deltamethrin applied at pink were incompatible with integrated mite management programs based on *Typhlodromus pyri* (Scheuten) as the key predator (3). In Quebec, following a petal fall treatment, residues of permethrin, cypermethrin and fenvalerate on the foliage were highly toxic to *Af* for at least 6 weeks post-treatment, when these phytoseiids were exposed in the laboratory to field-treated leaves (5).

The discrepancy of dissipation rates between 1987 and the other years can be partially explained by rainfall. In 1987, 105.4 mm of rain was recorded during the 3 weeks following the treatment. In 1986 and 1988, 45.3 mm and 81.9 mm of rain were recorded for the same period of time. This additional rain in 1987 may have helped to dissipate the pesticide from the foliage. The number of days with maximum sunlight is reported in Table 1. The level of solar radiation was higher in 1987 than in the 2 other years. This additional energy also may have contributed to the faster dissipation of this compound in 1987. Finally, the decrease in residual toxicity of lambda-cyhalothrin as summarized in Figure 1 follows the same pattern as its dissipation from apple foliage as measured by gas chromatography (5). In the latter study, lambda-cyhalothrin residues on apple foliage were found to be one-half their initial concentration after only 10 days.

Fig. 1: Toxicity of cyhalothrin residues (10 g a.i./ha) on 'Jersey Mac' apple foliage to *Amblyseius fallacis* at different dates after treatment. The treatments were as follows: A – 1986: pink, 9 May; petal fall, 29 May; 1987: B – pink, 4 May; petal fall, 3 June; 1988: C – pink, 16 May; petal fall, 31 May. Corrected percent mortality was calculated according to Abbott (1) (n = 160 adult mites per date). Arrows indicate dates of observations.

TABLE 1. Number of days with maximum solar radiation at Frelighsburg, Quebec (1986–1988)

Solar radiation (kJ m ⁻² h ⁻¹) No. of days	1986 (28 days) 29 May to 25 June			1987 (26 days) 31 May to 25 June			1988 (23 days) 31 May to 21 June		
	<1900	2000– 3000	>3000	<1900	2000– 3000	>3000	<1900	2000– 3000	>3000
		5	21	2	7	2	17	0	22

TABLE 2. Effect of cyhalothrin applied at 10 g a.i./ha on tarnished plant bug, *Lygus lineolaris*, infesting ‘Jersey Mac’ apple trees, Frelighsburg, Quebec

Plot no.	Treatment stage(s) and date	Number of apples examined	% Injured fruit (95% confidence interval)	
			Treated	Control
<i>1987</i>				
I	Pink, 4 May	1150	0.6 (1.34-0.20)	5.6 (7.25-4.13)
II	Pink + petal fall, 4 May & 3 June	1150	0.7 (1.46-0.25)	6.6 (8.42-5.05)
III	Petal fall, 3 June	1200	7.2 (8.99-5.57)	8.5 (10.46-6.77)
<i>1988</i>				
I	Pink, 16 May	1500	1.4 (2.23-0.79)	9.8 (11.64-8.13)
II	Pink + petal fall, 16 May & 31 May	1500	1.5 (2.39-0.90)	10.5 (12.43 - 8.81)
III	Petal fall, 31 May	1400	8.5 (10.30-6.89)	10.1 (12.00 - 8.32)

Commercially acceptable tarnished plant bug control (not exceeding 1.5% injured fruit) was obtained in 1987 and 1988 with lambda-cyhalothrin applied at pink and pink + petal fall (Table 2). Closer examination of Table 2 suggests that the petal fall treatment in the pink + petal fall regime did not reduce further the number of apples injured by this pest. Moreover, an application at petal fall only (plot III) was totally ineffective (Table 2). As a result of a frost during bloom, there were not enough apples in 1986 to evaluate the timing of lambda-cyhalothrin treatments in that year.

Field observations from Ontario and Quebec apple orchards show that *Af* overwinter in the debris and ground cover near the tree base. Moreover, in early spring they feed and reproduce on phytophagous mites in the ground cover. Eventually, around mid-July, adult *Af* climb the trees and react to spider mite infestations. The absence of *Af* on apple trees during the pink bud stage, coupled with the results of this study, pave the way for the development of integrated pest management strategies where key pre-bloom pests, such as the tarnished plant bug, may be controlled with lambda-cyhalothrin with little if any toxic effects to the predator later in the season.

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