

FINAL REPORT FOR 1999-2000

TITLE: Management of Leafrollers in Apple

PRINCIPAL INVESTIGATORS: Alan L. Knight, Yakima Agricultural Research Laboratory, ARS

CO-INVESTIGATORS: Steve Cockfield, Scientific Methods

FUNDING HISTORY:	Funding in 1995-1996 (Year Initiated):	\$ 22,998
	Funding in 1996-1997 (2 nd Year):	\$ 29,000
	Funding in 1997-1998 (3 rd Year):	\$ 29,500
	Funding in 1998-1999 (4 th Year):	\$ 46,000
	Funding in 1999-2000 (5 th Year):	<u>\$ 31,000</u>
	Total Project Funding:	\$158,498

SIGNIFICANT FINDINGS:

Sublethal exposure to Bt endotoxins causes severe retardation in larval development. Inclusion of this delay into a predictive phenology model improved the prediction of pupation and adult emergence.

Sex pheromones can be used effectively in combination with the use of insecticides to manage OBLR populations. Current sprayable formulations are short-lived. The Isomate CM/LR dispenser is effective but runs out of pheromone before the end of the season. New dispensers being developed are effective.

Aerosol puffers when placed internally in the orchard at 1 per hectare and integrated with border treatments of hand-applied dispensers are effective.

A three year area-wide program effectively managed both codling moth and obliquebanded leafrollers using the Isomate CM/LR dispenser plus reduced use of insecticides.

OBJECTIVES:

Evaluate the effects of Bt endotoxin ingestion on leafroller larval development and develop and then validate a predictive phenology model for leafroller emergence and egg hatch following spring Bt spray applications.

Evaluate the effectiveness of various hand-applied sex pheromone dispensers, sprayables, and puffers for mating disruption of leafrollers.

Evaluate the adoption of a sex pheromone-based area-wide management program for both codling moth and the obliquebanded leafroller.

PROCEDURES:

Field studies were typically conducted in replicated 20-40 acre orchards in the Brewster region. Orchards were treated with various mating disruption systems including hand-applied dispensers, sprayables, and aerosol devices. Orchards were monitored with traps and both larval sampling and fruit inspections. Emission rates of the various hand-applied dispensers were monitored throughout the season.

Laboratory studies with either Bt or sex pheromone components were conducted with the Yakima OBLR strain under controlled temperature and light conditions.

RESULTS AND DISCUSSION:

The first year of the project focused on both the use of *Bacillus thuringiensis* sprays and both hand-applied dispensers (Hamaki-con and Isomate CM/LR dispensers) and sprayables to manage leafrollers. Various field and laboratory studies were conducted that evaluated the influence of larval ingestion of Bt endotoxins on subsequent rate of development and pupal weight. A predictive phenology model for leafrollers was developed which included the delay in larval development following sublethal ingestion of Bt endotoxins. We also surveyed eight endotoxins and reported that the most active toxins are the ones currently being used in the Bt products available to growers. Other studies demonstrated the importance of temperature on the effectiveness of Bt sprays and led to the development of a set of recommendations on how growers can optimize their use of these products. Studies with the pheromone dispensers and sprayable formulations were conducted in 10 - 40 acre replicated blocks and the results were encouraging. Moth catches were reduced > 90% and orchards treated with leafroller pheromone had similar levels of fruit injury as untreated blocks but were treated with \$80 per acre less insecticide. The CM/LR dispenser performed well but was found to run out of pheromone late in the season. The sprayable formulation was found to work best at a rate of 24 g per acre and lasted only three weeks.

Studies conducted during the second year of the project again focused on the Bt-phenology model and the use of sex pheromones to disrupt leafrollers. The Bt-model was validated for OBLR and was found to significantly improve the prediction of pupation and adult emergence in orchards treated with Bt sprays in the spring. The CM/LR dispenser was evaluated in three 20 acre orchards and fruit injury was reduced 64% compared with orchards treated with similar numbers of insecticide sprays but without leafroller pheromone. Also during 1997 six 40 acre orchards were split and treated either with 200 or 400 Isomate CM/LR dispensers per acre for codling moth and obliquebanded leafroller. Moth catches and fruit injury did not differ between treatments. The evaluation of the sprayable formulation in 20 acre orchards demonstrated that multiple applications of this formulation were not effective in managing seasonal leafroller populations.

From 1998 to 2000 a 450 areawide project was conducted with 12 growers who treated their orchards with the Isomate CM/LR dispenser for disruption of both codling moth and obliquebanded leafrollers (OBLR) for three years. Orchards were treated with 200 dispensers per acre and supplemental sprays of *Bacillus thuringiensis* or spinosid were applied for leafrollers. Results were compared with 150 orchards in the Brewster Areawide Management program treated with Isomate-C+ plus insecticides only for leafrollers. Moth catches of codling moth and obliquebanded leafroller were reduced > 95% during the study. Fruit injury for both codling moth and leafroller were reduced > 60% and the number of insecticide sprays for codling moth and leafrollers was decreased by nearly two sprays per season.

Aerosol puffers were evaluated in four 40 acre orchards for OBLR in 1998, three orchards in 1999 and nine orchards were treated with dual canister in 2000. In all cases orchards were treated with 16 puffers placed one per hectare and the perimeter of the orchards were treated with the hand-applied dispensers for leafrollers and/or codling moth. Moth catches and fruit injury varied widely among blocks yet mean moth catches and percent fruit injury did not differ from surrounding orchards treated with Isomate products during all three years. Also during 1999 we evaluated several operational settings of the aerosol puffers to determine how best to release the pheromone. The use of 15 minute intervals for sprays releasing 7.5 mg of pheromone for 12 hours each day (3 pm to 3 am) was found to work the best.

Laboratory studies showed that the levels of E11-14:AC present as a contaminant with the pheromone component, Z11-14:AC does not significantly reduce disruption of mating for *Pandemis pyrusana* at levels from 0.25 - 6.0% in the formulation.

CONCLUSIONS:

Effective use of Bt insecticides is dependent upon minimizing sublethal larval exposures. Factors such as, the formulation's array of endotoxins, field temperature, larval age, spray rate, and time to resumption of larval feeding should be considered in optimizing the use of Bt insecticides.

The use of various methods to disperse leafroller sex pheromone can be an effective tool to manage populations especially when integrated with a reduced- use of insecticides.

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Abstracts for 10 posters presented at the annual Washington Horticultural Association meeting are published in their Proceedings.