A coding moth entry in a young fruitlet.

This article is the third in a series intended to help the apple industry transition insect pest management programs in apple to the use of new control technologies. This article focuses on control of the first coding moth generation.

Using pheromone mating disruption for coding moth control can be one of the most beneficial pest management decisions a grower can make. Several products are available that can reduce successful mating, thereby limiting the number of coding moth eggs that are deposited in the orchard. Fewer eggs result in a smaller population of coding moths that will need insecticide control.

Pheromones represent an additional cost to the grower. However, this cost is often offset by better coding moth control and a potential to decrease the number of supplemental insecticide applications. Researchers have observed that, even when coding moth pressure is high, pheromones plus supplemental insecticides provide better crop protection than insecticides alone. Most apple growers in Washington State are using some form of pheromone mating disruption for coding moth control. Mating disruption provides the foundation for a sustainable pest management program.

Strategies to control first-generation coding moth depend, in part, on the products that were used to control leafroller larvae of the overwintering generation. If a specific leafroller control product such as Success (spinosad), Proclaim (emamectin benzoate), or Bt (Bacillus thuringiensis) was used at petal fall, there would be no impact on coding moth since none of these products affect coding moth eggs.

However, if an insect growth regulator such as Esteem (pyriproxyfen), Intrepid (methoxyfenozide), or Rimon (novaluron) was used to control the overwintering leafroller generation, coincidental control of coding moth eggs would also be achieved. The destruction of coding moth eggs through the use of an insect growth regulator will delay the time when significant egg hatch begins and thereby allow growers to delay insecticide applications that target first-generation coding moth larvae.

If a specific leafroller control product was used in the petal-fall period—one that does not impact coding moth eggs—there is still an opportunity to delay the first insecticide treatment targeting coding moth larvae by applying oil (1% spray volume) just prior to the onset of the coding moth egg-hatch period, at 200 degree-days after biofix. Oil is a topical ovicide that kills coding moth eggs already deposited on foliage or fruitlets. The result of the insect growth regulator or oil application is that coding moth eggs that would begin hatching at 250 degree-days do not because they were killed by these products. The benefits of delaying coding moth larval control and strategies using this approach are discussed below.

Delayed application

Coding moth larvae find and enter the fruit within hours of hatching. The first sign that a coding moth larva has entered the fruit is a small pile of brown particles (referred to as frass) on the surface of the fruit, beneath which is the small larva (see photo).

Organophosphate insecticides kill coding moth larvae when the larvae come into contact with residues by crawling across them or when they consume the toxic residues. In contrast, the organophosphate alternatives, Assail (acetamiprid), Calypso (thiacloprid), Intrepid, and granulovirus, are effective when the coding moth larvae consume the residues. This means that excellent coverage of the foliage and fruit is crucial to the efficacy of these products.

Traditionally, larvicides have been applied at the very beginning of the coding moth egg-hatch period (250 degree-days) and then reapplied based on the expected residual life of the product. Many of the organophosphate alternative insecticides have a shorter residual life than the organophosphate products that they are replacing. To help compensate for this and to further optimize their efficacy as larvicides, using a strategy that delays their first application is recommended.

**TRANSLATION NOW to new pest controls**

**First-generation coding moth control.**

by Dr. Jay F. Brunner, Keith Granger, Mike Doerr, and Dr. Elizabeth Beers, Washington State University, Wenatchee

This yellow bars in this figure show the period of highest egg hatch rate. The green bars show the slowest period of egg hatch rate. Delaying the first cover spray provides the most active residues of the insecticide during the periods of highest biological activity.

**SOURCE:** WSU Tree Fruit Research and Extension Center, Wenatchee

**Delayed tank-mix strategy**

The colored bars indicate when each life stage is present in the orchard. The red bars indicate the life stages that are killed by the pesticide application. The red Xs represent larvae that do not need to be controlled, because an insect growth regulator (green arrow) killed the coding moth egg stage. Since coding moth eggs are killed by the petal fall ovicide treatment (1), the tank-mix can be delayed until 350 degree days.

The ovicide in the tank-mix kills any larvae that hatch and feed on residues (2). The larvicide in the tank-mix kills any larvae that hatch and feed on residues (3). Eggs that would have hatched after the larvicide residues are depleted do not, because they were destroyed by the ovicide in the tank-mix (4).

**SOURCE:** WSU Tree Fruit Research and Extension Center, Wenatchee

May 15, 2007 Good Fruit Grower
The added value of this approach may 15, 2007. The codling moth model predicts that egg hatch begins approximately 250 degree-days after biofix (see “Biological explanation: Traditional timing”). Egg hatch starts off slowly, with only 12 to 15 percent of all the eggs hatching in the first 10 to 15 days (the next 100 degree-days). The rate of egg hatch becomes more rapid after 350 degree-days, and most of the eggs hatch in the next 21 days. After this peak egg-hatch period, the rate of egg hatch slows, with the final 15 to 20 percent of the first-generation eggs hatching over about a two-week period.

A potential problem with the traditional (250 degree-day) larvicide application strategy is that the most active residues from the first application are present at a time when relatively few eggs are hatching, and the residues are weakest during peak egg hatch, when potential for fruit injury is the highest.

An ovicide (Esteem, Intrepid, Rimon, or oil) applied prior to the onset of egg-hatch eliminates eggs that would hatch in the period starting at 250 degree-days. As a result, the first larvicide application can be safely delayed until 350 degree-days. This delay places the most active larvicide residues in the orchard during the most active egg-hatch period (see “Biological explanation: Delayed timing”).

This strategy also shortens the period of time that control of larvae is necessary, which is important since the organophosphate alternatives generally have a shorter residual life than the organophosphates. A delayed application of Assail or Calypso at 350 degree-days followed by a second application in 14 to 17 days would be expected to provide control of the remaining portion of the first codling moth generation. Intrepid and granulovirus have a shorter effective residual life, and more frequent applications would be necessary with these products.

**Tank mixes**

One strategy that takes advantage of the multiple modes of action of the organophosphate alternatives is to combine two insecticides with different modes of action in the same tank. A tank mix of an ovicide (Esteem, Intrepid, or Rimon) and a larvicide (Assail or Calypso) can enhance codling moth control by killing both eggs and larvae with a single application. In this strategy, an ovicide (insect growth regulator or oil) is used prior to egg-hatch, at 100 to 200 degree-days (see “Delayed tank-mix strategy, ”). The larvicide in the tank mix kills any larvae that hatch and then feed on residues (see “Delayed tank-mix strategy, ”). The added value of this approach comes when eggs that would have hatched once the residues of the larvicide had been depleted do not because they were killed by the residual activity of the ovicide in the tank mix (see “Delayed tank-mix strategy, ”). The combined action of the ovicide and larvicide in the tank mix extends the period of control from this single application to cover the entire first generation under average conditions. Our experience indicates that this strategy is very effective even where codling moth pressure is high.

The final article in this series will cover control of summer leafroller and codling moth, as well as resistance management.

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