

Managing codling moth with a granulovirus

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Many apple growers in Pennsylvania continue to do battle with the internal fruit feeding complex, the codling moth (CM) *Cydia pomonella* and the oriental fruit moth (OFM) *Grapholita molesta*. The year 2006 was the first time since 1998 that CM, rather than OFM, was responsible for the majority of rejected loads of fruit destined for Pennsylvania processors from eastern U.S. growers.

Most growers continue to rely upon insecticides as their principal control tool for this pest complex, but more and more growers are adding sex pheromone mating disruption to their management toolbox.

Among the new tools available to control CM is a naturally occurring virus that was identified in 1964 in Mexico on infected CM larvae. Because of its high selectivity toward this pest, it is called the codling moth granulovirus (CpGV). It does show some activity on a couple of closely related species (such as OFM), but it is noninfectious toward beneficial insects, fish, wildlife, livestock and humans.

Mode of action

Each CpGV particle is naturally microencapsulated within a protein occlusion body

(OB) that protects it to some degree from degradation. These viral OBs are extremely small, 400 x 200 nanometers (4,000 OBs placed end to end are approximately 1/16-inch long). Depending on the product, a single ounce of the aqueous suspension concentrate can contain up to 3 trillion OBs.

These extremely tiny particles must be ingested by the larvae to be effective – there is no contact activity with CpGV.

It only takes a couple of these OBs to cause death in a young larva. Once the larva ingests the virus, the OBs dissolve in the alkaline gut of the larva, rapidly releasing the viral particles. The virus rapidly penetrates the gut lining, causing the virus to replicate numerous copies of itself, which then rapidly spread to other organs within the larva. This multiplication causes the larva to stop feeding within a few days and become sluggish and discolored as the virus moves throughout the insect's body. Upon death, the larvae "melt," spreading billions of the viral OBs that can be ingested by other CM larvae. Each OB is capable of causing a new infection.

Products

In Pennsylvania, there are two products

that are currently available for use by fruit growers: Cyd-X (CertiS USA) and Carpovirusine (Arysta LifeSciences Inc.). The label use rate for Cyd-X is 1-6 fluid ounces per acre, and the label rate for Carpovirusine is 6.8-13.5 fluid ounces per acre.

Both products can be used right up to the day of harvest, and they both have a four-hour re-entry window. The products should be refrigerated until use because

warm temperatures (more than 90° F) degrade the OBs. Also, these products are certified for use in organic orchards.

We have been researching both products at the Penn State Fruit Research and Extension Center during the last few years, and we have achieved much success in substantially reducing CM populations, especially where CpGV was integrated with some form of pheromone mating disruption for CM.

There are a number of opportunities for using CpGV in a CM management program. Before using a CpGV product, there are a number of important points to understand:

1. The virus must be ingested by the larva, thus timing and coverage are extremely critical.

2. The virus breaks down rapidly in an orchard environment due to both UV rays from the sun and rainfall. Thus, spray intervals should not be stretched for more than seven to nine days.

3. The feeding larva causes some injury to the fruit, commonly referred to as a "sting" – injury less than 1-2 mm in depth – before the virus eventually kills the larva.

Timing

Since CpGV is most active against young larvae and these larvae usually penetrate the fruit within 24 hours of hatching, it is very important to have the virus present when egg hatch begins (approximately 230-250 degree days following biofix, which is defined as the first sustained adult capture in a monitoring pheromone trap).

If CpGV is intended as the primary control tactic for CM, then the first application should be timed to coincide with the beginning of egg hatch. Depending on the length of the egg hatch period, three to five applications – each spaced about seven to nine days apart – will be necessary to cover the timeframe. In some apple orchards in Pennsylvania, we have observed egg hatch to extend over a longer period than what is normally predicted by the CM developmental model. Under

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these conditions, it may be prudent to apply an insecticide with ovicidal activity (Esteem, Intrepid or Rimon) at approximately 75-150 degree days (DD), then start the CpGV applications at about 300-350 DD and repeat the applications every seven to nine days (about every 125-150 DD) following this initial application.

Since the virus rapidly breaks down in the orchard environment, it is our experience that frequent applications of a lower rate is a better approach than high rates applied at longer spray intervals.

Target first generation

The CpGV must replicate itself within the larva to be effective, and allowing the larva to continue to feed for a few days will cause some shallow feeding damage ("stings") to a fruit.

If you are trying to decide when to use a CpGV product, I recommend that you might want to restrict your use of the product to the first generation. If "stings" or deep entries do occur in the small fruits during June from the first generation larvae, these fruit often fall from the tree or can be thinned off. At this time of the season, the fruit on the

tree are still small and canopy volume is still not complete, allowing more thorough coverage of the fruit.

Tank mixing and spraying

CpGV products are compatible with most fungicides and insecticides sprayed on apples. However, since CpGV is sensitive to high alkaline conditions, it should not be mixed with copper fungicides or lime sulfur. In addition, it is recommended to use a buffer to neutralize the spray mix if the pH is above 9 or below 5. Larry Gut, an entomologist at Michigan State University, has cautioned Michigan growers to avoid tank-mixing CpGV with the neonicotinoid insecticides Assail and Calypso, since these compounds have some anti-feeding activity that may interfere with the larva ingesting the virus.

Since UV light can rapidly break down the virus particles, it is also recommended that growers avoid applying the virus

during periods of intense sunlight. If rain is forecast soon, try to wait until after the rain to make the application.

Alternate row middles?

Many growers in Pennsylvania commonly apply their pesticides using the alternate row middle method of spraying. We have used CpGV successfully with ARM sprays, but the studies have always



been conducted with pheromone mating disruption for CM as a basic component of the program. Thus, my recommendations for applying CpGV using the ARM approach are given using the following guidelines:

- Since the virus must be consumed, thorough coverage is critical, thus ARM sprays must provide some coverage on the unsprayed side of the trees.
- Depending on the size of the tree, water volumes of at least 50 to 100 gallons per acre should be used.
- Dependent upon pest pressure and

weather conditions, ARM intervals should not stretch beyond five to seven days.

- This method of applying CpGV should only be used with some form of CM mating disruption.

Options for use

Either make the first application at the beginning of egg hatch (230-250 DD after biofix); or use an ovicidal insecticide at 75-150 DD, then begin virus applications at 300-350 DD.

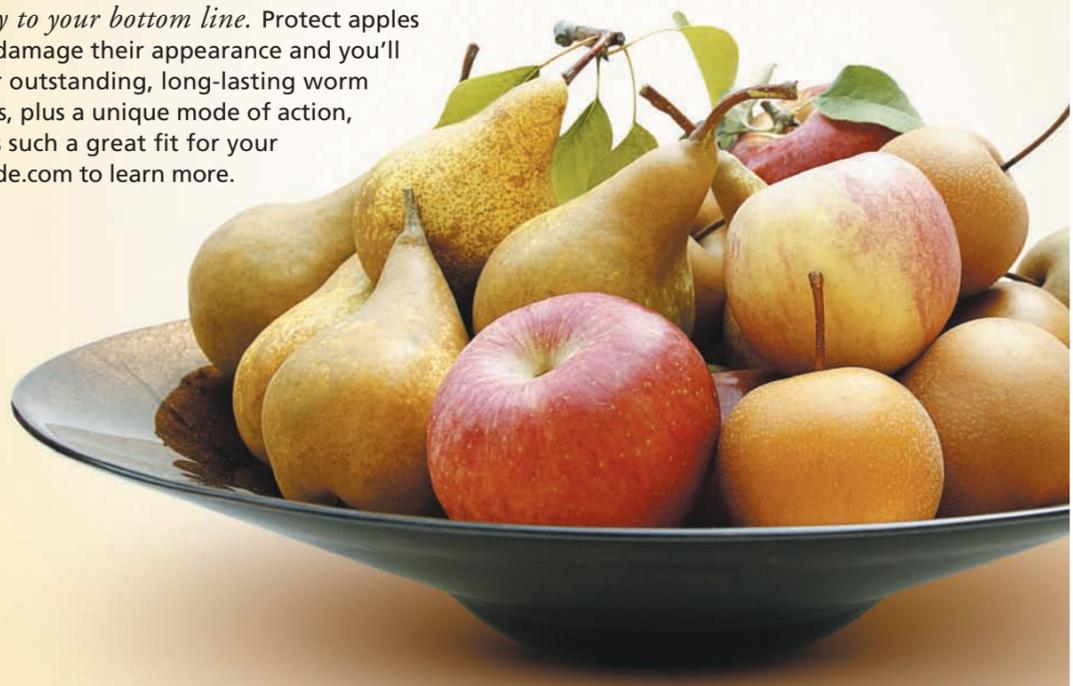
Repeat applications every seven to nine days, or every 125-150 DD. Use a higher rate of CpGV for the first application, and repeat applications at lower rates for subsequent applications. Apply three to five applications for first brood, depending on the length of the adult flight and egg hatch period.

Use it primarily for first-brood CM control. For more effective control, combine with CM mating disruption, especially where CM populations are high and/or fruit injury from CM was present last season. **FGN**

For more information about using a granulovirus for CM management, e-mail Larry Hull at lah4@psu.edu.

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