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The Biopesticide Company

CYD-X®

BIOLOGICAL INSECTICIDE

For Use on Apple, Pear and Walnut Crops

CYD-X® is an aqueous suspension concentrate biological insecticide from Certis USA. It contains a naturally occurring virus that infects and kills larvae of the codling moth (*Cydia pomonella*). The scientific name for this beneficial virus is *Cydia pomonella* granulovirus or CpGV. It is also known as the codling moth granulosis virus.

Always read and carefully follow label directions.

Mode of Action

Each CpGV particle is naturally microencapsulated within a protein occlusion body (OB) that protects it to some degree from degradation. Each OB measures about 400 x 200 nanometers, meaning 4,000 OBs placed end to end would span only about 1/16".

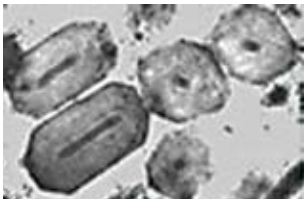

Photo: BBA, Darmstadt

Granulovirus OBs.

A codling moth larva must ingest OBs in order to become infected with the virus. The highly alkaline environment of the larval digestive tract (where pH can be as high as 10) dissolves the OBs and releases the virus, which penetrates the cells lining the mid gut. Once inside, the viral DNA "hijacks" the nucleus of the cell, causing it to replicate numerous copies of the virus which rapidly spread the infection to other organs. Within a few days the infected larva stops feeding, becoming sluggish and discolored as its internal organs fill with virus. Upon death the larva "melts," its fragile outer skin disintegrating to release the liquefied remains of its internal organs, containing billions of new virus OBs. Each of these is capable of initiation a new infection if ingested by another codling moth larva feeding at that site or wherever OBs have been deposited by raindrops, gravity, or by spraying CYD-X.

Laboratory studies have determined that a dose of 1 or 2 OBs is all that is required to cause a lethal infection in half of the codling moth larvae tested. A single ounce of CYD-X biological insecticide contains nearly one trillion OBs. Of course, not every OB in a CYD-X spray will be ingested by a codling moth larva, but the extremely virulent nature of CpGV toward its host means that it is effective at very low use rates.

Transmission of CpGV

CpGV occurs naturally in codling moth populations, but usually at levels too low to prevent damaging outbreaks in commercial orchards. The virus can persist for years in protected environments such as soil and leaf litter on the orchard floor or in tree cavities. Rainfall, wind, cultivation, movement of animals and birds, and other physical forces can move OBs into areas such as foliage or fruit where they can be ingested by codling moth larvae to begin another cycle of infection. However, the most effective way to initiate CpGV infection is to spray the virus onto the tree in much higher amounts than would otherwise occur naturally.

Once CpGV infection has occurred within a larval generation, there are several ways it can be maintained within the codling moth population. Horizontal transmission occurs when larvae become infected by ingesting virus released into the environment when diseased larvae die. Sometimes infection occurs too late and at too low a dose to kill a larva outright, even though the virus has entered the host cells. A female that survives this sublethal infection may transmit the virus to her offspring, a process known as vertical transmission. In some cases a latent infection can occur, in which the virus lies dormant in the host until stress brought

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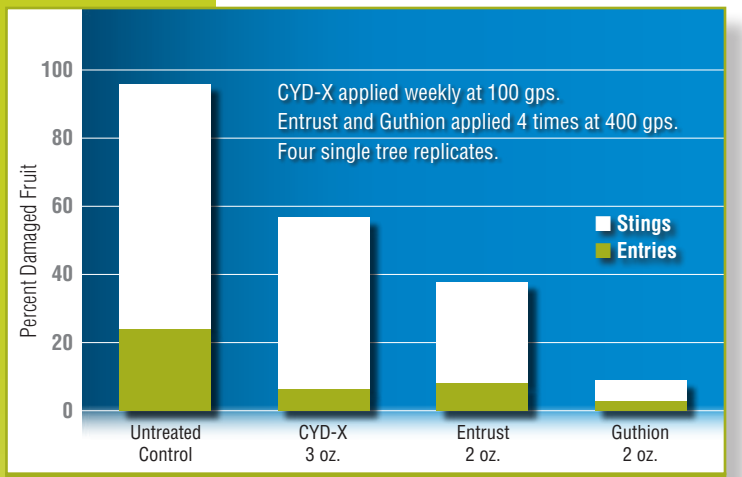
on by overwintering, overcrowding, lack of food, or insecticide exposure causes an outbreak of virus that kills the host. Latent virus can kill host insects even years after initial infection.

Host Specificity

CpGV is highly specific to the codling moth. Under artificial conditions in the laboratory, CpGV can also infect two species related to the codling moth: the pea moth *(Cydia nigricana)* and the false codling moth *(Cryptophlebia leucotreta)*. Neither of these species is found in North America. Similar studies have also suggested that CpGV can infect larvae of the oriental fruit moth *(Grapholita molesta)*, but the evidence is not strong enough to expect that CYD-X or any other CpGV product will also control OFM.

CpGV is noninfectious toward beneficial insects, fish, wildlife, livestock, or humans.



CYD-X was as effective as Entrust and Guthion in preventing codling moth larvae from entering fruit. Superficial feeding damage occurred in the form of stings, which are less serious when inflicted early.

Trial conducted by Dr. H. Riedl, Oregon State Univ., Hood River, OR (2003).

Production and Formulation

CYD-X biological insecticide is produced by infecting mass-reared codling moth larvae with CpGV from a "seed stock." The virus-killed larvae are harvested from the growth medium and homogenized in water to ensure complete release of the OBs. The resulting suspension is filtered and diluted to its final concentration with water and glycerol, which retards spoilage by microbes that would otherwise grow in the rich "bug soup."

CYD-X contains only CpGV in a homogenate of virus-killed larvae, glycerol, and water. CYD-X is listed by both the Organic Materials Review Institute (OMRI) and the National Organic Program (NOP) for use in organic orchards.

Choosing an Application Rate

The label recommended application rate for CYD-X is 1 to 6 fl. oz. (30 to 180 ml) per acre. This equates to 1 to 6 trillion OBs per acre.

In most cases, apply 3 fl. oz. CYD-X per acre in sufficient water to obtain thorough coverage of the orchard canopy without excessive runoff, which could carry the virus off the tree. At 100 gallons of spray per acre, this is equivalent to 1 to 1½ teaspoons of CYD-X per 5 gallons of water. Actual application volume will depend on the type of spray equipment used, but concentrated sprays are usually more effective for applying CYD-X than are dilute sprays.

CYD-X can be applied at lower label rates (1 or 2 fl. oz. per acre) if codling moth pressure is low or frequent applications are planned.

Always plan to apply CYD-X at least twice during each larval generation targeted. Multiple sprays at low rates (1 to 3 oz.) and short intervals are likely to provide better control than a single spray at a high rate (4 to 6 oz.) One economical strategy is to use a high rate (4 to 6 oz.) for the initial spray to initiate a virus outbreak in the larval population, with subsequent sprays at reduced rates (1 to 3 oz.) to maintain the level of infection.

See the next section for more information on spray timing.

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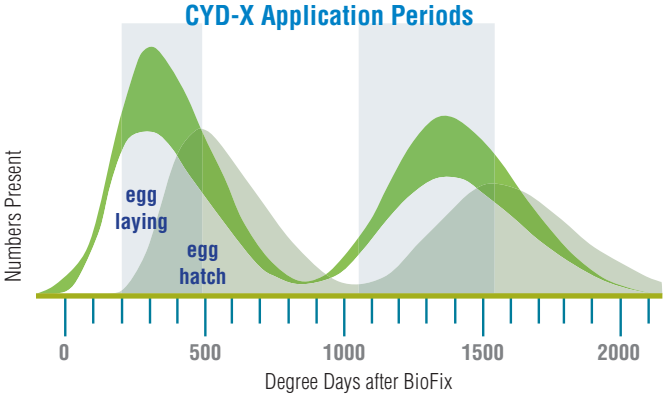
Timing of CYD-X Applications

Target Small Larvae

Upon hatching, codling moth larvae wander in search for a spot to penetrate fruit, usually within a day or two after hatching. They may drink water droplets and feed on foliage if no fruit are available. But most don't eat until after they enter the fruit, and typically do not ingest the skin of the fruit when making an entry hole. Since CpGV must be ingested by the larva to be effective, and may take several days to kill it, optimal use of CYD-X requires the virus to be present wherever and whenever small larvae are wandering on foliar or fruit surfaces seeking a penetration site. Virus picked up on the larva's body and mouthparts will contaminate its feeding site, and infect the larva when it starts to feed. CYD-X applications should therefore coincide with egg hatch and this early wandering phase of newly hatched larvae.

CYD-X Application Periods



CYD-X sprays should be timed so that young larvae will become contaminated with the virus as they search for feeding sites. If using temperature models to predict codling moth development, the initial spray against the first larval generation should be applied around 250 degree days after codling moth biofix. Otherwise, apply CYD-X in the first and second cover sprays. If targeting the second generation, start at approx. 1100-1200 DD (4th or 5th cover spray, depending on weather).

When Targeting First Generation

CpGV must replicate within the host larva in order to be effective, so CYD-X is slower to kill larvae compared to many chemical insecticides having a toxic mode of action. Virus-infected larvae may still cause superficial "sting" damage where they attempt to enter the fruit, but they usually die before causing the deeper entry wounds that make fruit unacceptable for harvest. Initial CYD-X applications can be targeted against the first summer generation of larvae; a low level of early and superficial damage can be tolerated in most orchards and in many cases will be taken care of by thinning. Establishment of CpGV infection in the first generation may also carry over into later generations, making them easier to control with other tactics.

When targeting larvae of the first summer generation (late May to mid-June), make the first application of CYD-X at the beginning of egg hatch, or shortly thereafter. If using a degree day model to predict codling moth development, then the first CYD-X application should be around 250 degree days after codling moth biofix, assuming a base temperature of 50° F. Make a second application after 7 sunny days (two cloudy days should be counted as 1 sunny day). Third and fourth applications may be required under conditions of unusually high codling moth pressure, sustained egg laying, or prolonged sunny weather. If you can only make two applications, it may be more effective to hold the second spray until peak egg hatch.

Second and Later Generations

The second summer generation of larvae can cause more severe damage directly to fruit intended for harvest. Although CYD-X will infect and kill many of these larvae, it will not prevent them from damaging the fruit before they die. Unless the orchard is certified organic, or codling moth pressure is already low, in most cases it is better to rely on fast-acting chemical insecticides to prevent damage to fruit. CYD-X can be still be included in a chemical spray program against second and later larval generations to combat resistance and reduce overwintering success. Codling moth larvae resistant to chemical insecticides are still susceptible to the virus.

If using a degree day model to predict codling moth development, CYD-X applications directed against

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- Meets National Organic Program (NOP) standards.
- Organic Materials Review Institute (OMRI) listed.

the second generation should begin by about 1200 degree days after codling moth biofix, just before predicted egg hatch. Depending on weather and location, it may be more convenient to simply continue spraying lower rates of CYD-X at regular intervals of 7 - 14 days from the end of the first generation through the beginning of the second.

First generation CYD-X applications should correspond roughly with first and second cover sprays, second generation with fourth and fifth cover sprays. However, weather conditions, local topography, quality of monitoring, and other factors influence how accurately degree day models can predict actual codling moth development in any given orchard. Consult your University Cooperative Extension Service, crop consultant, or other local pest management professional for information on monitoring of codling moth in your orchards.

Using Cyd-X With Pheromone Mating Disruption

CYD-X can be used in combination with codling moth mating disruption as a means of overall population management. CYD-X can be used to prevent establishment of larval infestations by immigration of codling moths from bordering nondisrupted or abandoned orchards, or to treat areas unsuitable for mating disruption due to size, shape, slope, wind, or other factors.

Storage and Handling

For best results, CYD-X should be refrigerated when not in use. Bioactivity of the virus can be degraded by exposure to high temperatures (>90°F) for long periods. Always store CYD-X in its original bottle in a cool, dry place, out of direct sunlight. Shake well before use. CYD-X can also be frozen for extended storage without harm.

pH Sensitivity

Water used for mixing the spray should be at or near neutral pH (7) before adding CYD-X. Highly alkaline conditions (pH>9) will prematurely degrade the protein occlusion body, reducing bioactivity and stability of the virus. Buffer the water in the spray tank if pH is above 9 or below 5, or if it contains materials such as lime sulfur or foliar fertilizers that may create pH extremes.

Spray CYD-X as soon as possible after mixing. Do not delay more than a few hours between mixing and spraying, especially if pH is not neutral.

Use of Spray Adjuvants

Because of the way it is made, CYD-X contains natural compounds derived from host larvae that can provide some protection from the UV rays in sunlight. Additional protection, as well as enhanced spray deposition and rainfastness, may be obtained by using certain adjuvants with CYD-X. Pinolene or related stickers, latex, methylated seed oils, humic acid, and powdered skim milk have been used with some degree of success, but Certis USA cannot guarantee performance of any adjuvant from another company.

Refer to the adjuvant label or see your dealer for more information on a specific adjuvant.

In many cases, performance of CYD-X is more likely to be improved by addition of a feeding stimulant such as sugar or molasses (which also acts as a sunscreen) at a rate of 5 pounds per acre. Larvae will then ingest virus more quickly as they feed preferentially on spray droplets, reducing the time of exposure of the virus to sunlight and increasing the rate of infection.

Exposure to sunlight can be reduced and effectiveness of the virus increased by spraying CYD-X in the late afternoon or early evening. Avoid spraying in intense sunlight.

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