

Codling Moth

Management in Apple

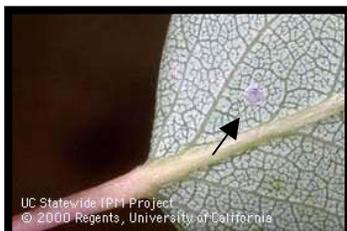


THE CODLING MOTH is the most serious insect pest of apple in the Midwest because the larvae feed inside the apple, leaving an unsightly hole that can promote internal rotting. Because growers have a low tolerance (<1%) for codling moth injury (more than one damaged fruit in 100 is usually considered unacceptable), control strategies usually consist of frequent applications of broad-spectrum insecticides throughout the growing season. However, codling moth can also be managed successfully using IPM techniques that include cultural controls, mating disruption, and well-timed applications of reduced-risk insecticides.



Causal Organism

The codling moth (*Cydia pomonella*) is found in most of the major fruit-producing regions of the United States. The adult is approximately one inch long with a mottled grayish brown body. It can be distinguished from other moths by coppery areas at the tips of the wings. Newly emerged larvae are white with black heads, and mature larvae are about 3/4 inch long with light pink bodies and brown heads.



Egg



Mature Larvae



Adult Moth

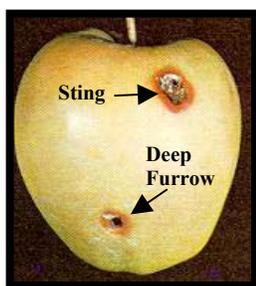
Ecology and Life Stages

The codling moth over-winters as a mature larva in a dense, silken cocoon found under loose bark or in debris underneath the tree. These larvae pupate in the spring and begin to emerge during the bloom or petal-fall stages of apple development. This emergence is often called the “first” or “spring flight”.

Eggs are laid primarily on leaf surfaces near the fruit. They hatch one to three weeks later, depending on the air temperature. Newly-hatched larvae usually enter the apple fruit through its calyx or sides, and feed on the flesh and seeds of the apples.

Full grown larvae burrow out of the apple and form silken cocoons in which to pupate. There are between two and three generations each year in the Midwest.

Damage



Larvae bore into the fruit and begin chewing their way to the core, where they feed on the seeds. They push their waste material (frass) out the entrance and exit holes; this type of damage is often referred to as a *deep entry*. Sometimes a larva will bore into the fruit a short distance, and then either die or move to another location to feed, leaving a little shallow hole called a *sting*. Small amounts of frass may or may not be present at sting sites.



Cultural Methods for Codling Moth Management:



Traditional codling moth control is achieved with regular, frequent sprays of organophosphate insecticides. Because these pesticides may pose human and environmental health risks, several new reduced-risk and Integrated Pest Management (IPM) options have been tested in the Midwest in recent years. There are several cultural techniques that can be used to reduce the number of insecticide applications necessary for control of the codling moth.

1. Pruning and Thinning. Pruning and thinning each spring can aid in codling moth control. These strategies allow for improved insecticide spray penetration and coverage. When every apple is thoroughly covered with the insecticide, the moths and larvae are more likely to come into contact with poisoned fruit surfaces, and the insecticide is more likely to come into contact with eggs.



2. Removal of Alternate Hosts. In addition to apple trees, pear and walnut trees can act as a refuge for codling moths. These trees should either be removed from sites near the orchard, or included in any codling moth treatments applied to the rest of the orchard. In addition, apples that will not be picked from young nursery trees should be removed early in the season.

Cultural Methods for CM Management, continued:

3. **Removal of Dropped Fruit.** Codling moth-infested fruit often drop from the tree early in the season. Raking and removing these apples from the orchard will prevent larvae maturing in these dropped apples. Picking infested apples off the tree is also an effective preventative measure, but is only practical in small orchards.

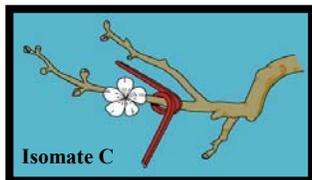


Mating Disruption:



Mating disruption is a relatively new codling moth control tactic that can be very effective in certain orchards. In this technique, the female sex pheromone of the codling moth is released in enormous quantities in the orchard, preventing the male moth from locating the female for mating. This technique is safe for non-target insects and doesn't leave pesticide residues on the fruit. The efficacy of mating disruption is conditional, however, and you should be aware of the following factors:

1. **Dispenser Choice and Rate.** There are several commercial products designed to release synthetic codling moth sex pheromone. In the most common type of dispenser, the pheromone is located in a reservoir from which it is released slowly into the orchard over several weeks (see diagram at left). These products usually require a rate of 200-400 dispensers per acre. Other products have a sprayable pheromone that can be applied via an airblast sprayer and typically last for 2 weeks before subsequent sprays are needed. There are also mechanical devices ('puffers') that will emit large quantities of pheromone into the orchard atmosphere, allowing air flow to distribute the pheromone.



2. **Orchard Choice.** Research has demonstrated that codling moth mating disruption is most effective in larger orchard blocks (>10 acres). In smaller orchards, mating disruption may not provide reliable control. Ideally, the orchard should also be relatively square and level, and the trees should be of approximately equal size. In addition, the area should also have a moderate to low codling moth population.

3. **Pheromone Traps.** Because mating disruption does not kill the moths, it is important to monitor the treated orchard regularly to be sure that control is occurring. The easiest way to monitor moth activity in



the orchard is through sex pheromone traps. In orchards under a regular spray program, pheromone traps loaded with a 1-mg lure and placed in the lower to mid-level of the canopy are sufficient for monitoring purposes. However, in mating disruption blocks the pheromone traps should be loaded with a 5- to 10- mg lure, and the traps should be placed in the upper canopy of the tree (no later than the bloom period). Use one trap for every 2-3 acres under mating disruption. A cumulative trap capture of more than 10 moths during the first generation suggests that mating disruption is not working (too high a moth population is present) and that supplemental insecticide sprays should be applied.

Mating Disruption, continued:

4. **Fruit Checks.** In addition to the use of sex pheromone traps to monitoring moth populations, it is also important to monitor fruit for codling moth damage throughout the season in orchards under mating disruption. This will allow you to make an “emergency” insecticide application if mating disruption does not suppress the moth population to economically acceptable levels. When the pheromone traps begin trapping moths in the spring, 20-25 trees from border rows and the center of the plot should be examined for stings and deep entries. If more than 0.5% of the inspected apples are damaged, an additional insecticide treatment should be applied.



5. **Timing.** Traps and dispensers should be placed in the orchard before the moths appear. Moths emerge in the spring just after petal fall, so dispensers should be deployed in the orchard no later than the bloom period. Degree day and biofix calculations (see below) can be used when deciding when to rate fruit.

Chemical Methods for Codling Moth Management:

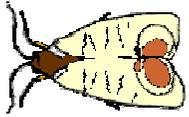
Well-timed insecticides are often the most effective method for managing codling moth. In fact, in orchards with very high populations of codling moth, insecticide use is the only method to achieve consistent control. Several lower-risk insecticides, such as insect growth regulators (IGRs) and other new products, have recently been labeled for use against codling moth. Efficacy trials conducted in Iowa and Missouri during 2001 and 2002 have demonstrated that many of these newer compounds can be successfully used to control codling moth, especially in orchards with low moth densities. In addition, the incorporation of these lower-risk compounds in rotation with other products help to slow the build-up of codling moth resistance to many insecticides.



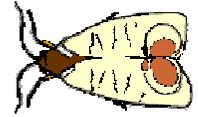
1. **Spray Timing by Degree Days and Trap Catches.** The key to the successful application of any codling moth insecticide is timing. The life stage and relative size of a codling moth population can be determined using the degree day model and pheromone traps. Pheromone traps should be checked twice per week to determine **biofix**, or the initial emergence of over-wintering first generation moths. Biofix occurs when there is an average of more than three moths caught in a trap over a 3- to 5-day period. For the rest of the season, these traps can be an effective way to monitor not only population cycles, but also the relative success of insecticide sprays.

Trap counts can be used in combination with degree-days (DD) to accurately pinpoint the stage of moth development. The degree day model is based on a developmental threshold of 50° F for moth development and works as follows: Begin calculating degree-days at biofix. Calculate the maximum and minimum temperatures for each day and fit them into the following equation: $[(\text{Max} + \text{Min})/2] - 50$. For example, on a day when the maximum temperature is 84° F and the minimum is 62° F, the total degree-day count would be 23 DD. The daily DD counts should be summed and accumulated as the season progresses.

Chemical Methods for CM Management, continued:



The codling moth developmental model (using degree-days) indicates that first generation (over-wintering) moths lay their eggs around 100 DD after biofix. By 250 DD after biofix, the eggs are beginning to hatch, and about half of the larvae have emerged. This is a time when many insecticides for codling moth control are first applied. The second flight of moths usually begins between 1,000 and 1,250 DD.



2. **Insect Growth Regulators.** The use of some insect growth regulators (IGRs) has been effective in managing codling moth. These compounds usually disrupt the pest insect's normal growth and development at an immature stage, and are not usually toxic to non-target organisms. Timing is often critical for the successful use of IGRs. For example, methoxyfenozide (trade name Intrepid) causes a premature lethal molt of caterpillars. It should be applied at the initiation of egg-laying (100-200 DD after biofix) and again two weeks later. Further sprays can be applied when pheromone trap catches indicate that they are necessary. Another IGR, pyriproxyfen (Esteem), mimics the juvenile hormone and suppresses embryogenesis. It can be used to control first generation codling moth and should be applied at 100 DD following biofix and again 14 days later.



3. **Reduced Risk Insecticides.** Besides IGRs, there are several other reduced-risk insecticides that have also been tested for codling moth control. Some examples of these types of pesticides include acetamiprid (trade name Assail) and spinosad (trade name SpinTor).

4. **Other Insecticides.** The codling moth spray schedule used by most commercial Midwest growers is a 2-week alternation of organophosphates, such as azinphos-methyl (trade name Guthion) and phosmet (trade name Imidan). However, the use of Guthion has been severely restricted on apple, and Imidan is facing similar restrictions. Furthermore, there have been several reports of codling moth resistance to Guthion in the Midwest. Nevertheless, azinphosmethyl and phosmet continue to be the most commonly used insecticides for codling moth. This is because other broad-spectrum insecticides, such as synthetic pyrethroids and carbamates (Danitol and Sevin, respectively), that are also labeled for codling moth, may be harmful to beneficial insects and/or are labeled for limited use in the orchard.



An understanding of the biology and population dynamics of codling moth is very important to the successful management of this pest in your orchard, especially when using IPM tactics that depend on accurate pest monitoring (e.g. mating disruption and IGRs). Well-timed applications of appropriate insecticides can be combined with cultural strategies in an IPM program for safe, effective codling moth control.



More Information:

- For diagnosis of codling moth damage to your apples, fill out the “plant disease identification form” available at your county extension office or online at

www.extension.iastate.edu/Publications/PD31.pdf (Iowa)

<http://plantclinic.cropsci.uiuc.edu/dffecrops.pdf> (Illinois)

<http://agebb.missouri.edu/pdc/> (Missouri)

<http://www.entomology.wisc.edu/entodiag.html> (Wisconsin)

- Then send this form and a plastic-wrapped apple in a sturdy box to:

**IOWA STATE
UNIVERSITY**



Plant Disease Clinic
323 Bessey Hall
Dept. Plant Pathology
Iowa State University
Ames, IA 50011

Plant Clinic
University of Illinois
1401 W. St. Mary's Rd.
Urbana, IL 61802

**UNIVERSITY OF
WISCONSIN
MADISON**

Insect Diagnostics Clinic
Dept. Entomology
Univ. Wisconsin-Madison
1630 Linden Drive
Madison, WI 53706-1598



Plant Diagnostic Clinic
42 Agriculture Building
University of Missouri
Columbia, Missouri
65211

- For more information on codling moth, see the Midwest Apple IPM web page at:

www.public.iastate.edu/~appleipm

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... And justice for all

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