UW Extension Ashland/Bayfield County
Research Bulletin
No. 8
Date: Dec 2009

Using Pheromone Disruption to Control Codling Moth in Bayfield Apple Orchards

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Introduction

Codling moth is one of three major insect pests of apples in the Bayfield fruit growing region. The female adult moths (Photo 1) lay their eggs on or near developing apples and the larvae tunnel into the apple and become the classic worm in the apple. Apples attacked by codling moth are unfit for sale (Photos 2, 3). There are two generations per year in WI with a peak flight in late-June and again in mid-August in the Bayfield area. Producing #1 apples requires managing codling moth, usually with a conventional or organic chemical spray program.

A Two-Step Control Program

In cooperation with the Bayfield apple growers, a two-step codling moth control program is underway to help growers reduce the number of spray applications for codling moth.

Step 1: Removing Abandoned Apple Trees to Reduce Codling Moth Populations

The first step is to reduce the overall population of codling moth in the region. Blocks of unmanaged apple trees serve as breeding grounds for the moths and these moths can fly into nearby managed orchards and cause major problems. With funding through a federal SARE grant, blocks of abandoned orchards adjacent to commercial orchards have been removed over the last two years (Photo 4) and have resulted in reduced codling moth pressure (Photo 5).

Step 2: Using Mating Disruption to Prevent Egg-Laying

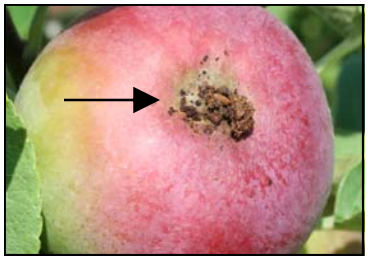
Mating disruption can be an effective method for controlling codling moths and is used extensively in other apple producing regions. To test whether it would work in Bayfield where the blocks of trees are smaller, a mating disruption trial was conducted in 2009 at three orchards.

To lay eggs, female moths must first mate with male moths. To find each other, the female moths emit a pheromone plume that the male moths follow to find the female. With mating disruption, pheromone emitters (Photo 6) are placed throughout the orchards, which saturate the orchard with pheromone. The males can't find the females, and no eggs are laid. The pheromone that is used is specific to codling moths and doesn't disrupt other lepidopteran insects that use pheromones.

For the Bayfield trial, just prior to bloom, the emitters were placed in the three orchards at a rate of 400 emitters per acre. The emitters are thin tubes that can be wrapped around branches or twisted into a loop and hung on branches. Because most codling moth mating activity occurs in the top third of the tree it is important to place the emitters as high up in the tree as possible. Table 1 shows the time and costs of deploying the pheromone disruption at the three orchards. Orchards 1 and 2 are high-density blocks with small trees and Ochard 3 has full-sized trees requiring a stick or ladder to hang the emitters.

▲ **Photo 1.** The codling moth female lays the eggs and the larvae tunnel into the apples.

▲ **Photo 2.** The larvae tunnel through the apple making it unfit for fresh eating.



▲ **Photo 3.** Often the only sign an apple is infested with codling moth larvae is a small hole with frass, usually at the calyx end of the apple.

▲ **Photo 4.** The Apple Pest Reduction Program in the Bayfield area has helped remove unwanted apple trees and reduced the codling moth pest populations.

To monitor whether the mating disruption is working, pheromone traps are hung in the orchards. The traps attract the male moths and are used to determine when and how many moths are in the orchard (Photos 7, 8). If a trap catches even a single moth it can be assumed that the moths are able to follow a pheromone plume and find the females, warranting an additional control strategy. If the mating disruption works and no moths are caught, then chemical spray applications can be reduced or even eliminated.

Table 2 shows the average trap catches for the orchard blocks in 2008 and 2009. No pheromone disruption was used in 2008, and, thus, the trap counts are an indication of the typical codling moth populations. The pheromone disruption worked very well at shutting down the trap catches and presumably the ability of the moths to mate.

Near harvest time, the orchards were assessed for codling moth damage and no damage was found in any of the blocks treated with pheromone.

Orchard	Hrs/ac	Tubes/ac	Cost/ac*
1	1.9	400	$ 133.50
2	1.9	400	$ 133.50
3	2	400	$ 135.00

*$15/hr for labor, $105/400 tubes

Table 1. The material and labor cost of deploying pheromone emitters in three orchards.

Trap Catch*	Orchard 1	Orchard 2	Orchard 3
2008	69	193.3	24.5
2009	1	0.3	0

*average number of moths caught per trap per season

Table 2. The average number of moths caught per trap in three orchards in 2008 and 2009.

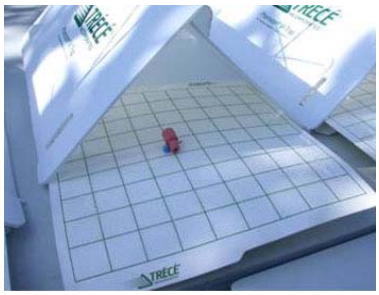
Conclusions

The two-step codling moth control program appears to be working for Bayfield growers and should provide an alternative or supplement to the typical chemical control programs. However, because there are other insect pests in the orchards at the same time as the codling moth, the pheromone disruption will not eliminate the need for spraying. Treatments for apple maggot or plum curculio will likely be necessary with the added benefit of providing some codling moth control. However, as was the experience of the growers in 2009, the pheromone disruption can reduce the number of sprays needed and can allow the growers to target the other pests. The goal in 2010 is to trial the pheromone disruption on a wider scale.

Photo Credits: 1-www.ukmoths.org; 2,3-Dan Mahr, 4-Peter Werts, 5,6,8 Jason Fischbach, 7-www.ipm.illinois.edu

▲ **Photo 5.** Removing abandoned blocks of trees such as the one outlined in red can greatly reduce pest pressure in adjacent orchards. The trap count in the orchard to the north of the abandoned block was 696 in 2008 when the trees were still standing and only 113 in 2009 after they were removed. No pheromone disruption was used in this part of the orchard.

◄ **Photo 6.** For this trial, Isomate C-Plus pheromone emitters were hung at a density of 400/ac. The emitters are single tubes that are wrapped around or twisted into a loop and hung on branches.



◄ **Photo 7.** One measure of whether the mating disruption is working is to trap the male moths using baited sticky traps. If the traps catch moths, the mating disruption is not working and some other sort of moth control is needed.

◄ **Photo 8.** The codling moth traps are hung in the orchard early in the season just prior to bud-break and left there all year.

Thanks to Einar Olsen, Eric Carlson, and Bill Ferraro for their participation in the trial. Funding for the abandoned apple tree removal program is from the Sustainable Agriculture Research and Education Farm-Rancher Program. Mating disruption trial funding is from an EPA Region V grant.