

## Mating Disruption/SIR

Ridding orchards of codling moth—one female at a time

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*Abstract:* Following the discovery that ethyl (2*E*, 4*Z*)-2,4-decadienoate (DA) was a potent attractant for both sexes of codling moth (CM) we initiated studies to develop adult control strategies. This work has shown that the use of traps baited with a DA lure is a fairly expensive approach and reduces fruit injury by CM ca. 50% in MD-treated apple orchards. Parallel studies using insecticide-treated bait stations, however, have been more effective. Grids of esfenvalerate-treated delta-shaped stations at densities of 24-50 per acre have reduced fruit injury up to 98% at mid-season in MD-treated orchards. However, fruit injury in these studies at harvest was only reduced 30-40%. The reduction in efficacy of this approach toward the end of the season was likely impacted by several factors. All plots were 0.6 to 2.0 acres and surrounded by orchards heavily infested with CM (60-100% fruit injury). The influx of mated females from these areas into our plots likely overwhelmed the bait stations. The DA lure appears to be less attractive in the second versus the first CM flight. In addition, the presence of infested fruit is thought to contribute to the production of much higher levels of competing fruit volatiles that may further decrease the attraction of the DA lure. Unfortunately, CM emerges as an adult capable of mating their first night and subsequently laying eggs. Typically >75% of females trapped with the DA lure in MD-treated orchards are mated. This situation is made worse due to a bias of the DA lure for mated females.

### Report

Efforts to remove female moths from orchards with baits would likely work better with a more effective mating disruption program. Efforts should be expanded to reduce mating of females by either the use of higher dispenser (puffer) densities, a more effective semiochemical blend, or the use of an attracticide. In addition, our studies have been conducted only in 'Red', 'Golden', and 'Fuji' apples. Additional studies are needed in blocks of 'Granny Smith' and 'Anjou' because the DA lure appears to be relatively more attractive in these cultivars.

Several operational problems associated with the use of DA-baited insecticide-treated stations occurred during this preliminary study and need to be corrected in future studies. First, the cost of maintaining the esfenvalerate-treated delta traps was high. Traps were effective for about 2 weeks and then had to be re-treated. Subsequent studies have suggested that alternative insecticide rates and insecticides would be more effective. Our earlier studies found that the insecticide toxicity could be maintained for 4-6 weeks when mixed in a proprietary inert carrier. The 900 cm<sup>2</sup> Corex™ delta traps were fairly inexpensive to build, but their large size made them difficult to use. We previously showed that flat cards > 140 cm<sup>2</sup> stapled on the tree and baited with a central drop of DA-impregnated paste were effective in capturing a 50:50 sex ratio of CM. Switching from delta traps to cards could greatly reduce the cost and ease of the program.

However, additional work is needed to evaluate the cards' performance in both vertical and horizontal positions compared with the delta trap. DA formulated in long-lasting gray septa had to be replaced mid-season in our preliminary studies. Using individual paste droplets applied with an applicator could reduce the cost of the DA lure. Initial studies have shown that paste drops remain attractive for up to 6 weeks.

Alternative approaches to the use of the DA lure should be tested to remove female CM from orchards. Our studies have shown that during the first moth flight the capture of female moths in a DA lure-baited trap is equivalent to the captures on three clear plastic passive interception traps. However, during the second flight, this drops to parity between traps. In comparison, a standard UV-light trap is equivalent to only a single interception trap in the first generation (cooler temperatures limit the period of nocturnal moth flight), but its effectiveness increases to three traps in the second flight. These data suggest that the use of light traps could be an effective alternative to manage codling moth later in the season. Currently the consultant, Ron Britt, uses up to 4 light traps per acre to supplement MD in some orchards. Perhaps the most effective program would be the use of DA-baited insecticide-treated traps during the first flight and light traps during the second flight or a combination program.

Another approach that should be investigated to improve the performance of lure and kill for CM is to improve the attractiveness of the bait. Dr. Light's initial screening of apple and pear volatiles found some activity for several other compounds. These have not been tested in combination with DA to examine possible synergistic effects. Recent reports and continued work by Dorn's and Witzgall's research groups in Europe plus the work by Landolt have already suggested a few candidates and may lead to additional kairomones that are more attractive alone or in combination with DA.

### **Objectives.**

1. Further refine the use of the DA-based bait stations to manage CM through changes in the operational components of this approach.
2. Coordinate planned studies to develop improved MD with supplemental use of bait stations.
3. Evaluate the use of DA-based bait stations in combination with light traps to manage codling moth.
4. Evaluate the relative attractiveness of female CM to select apple and pear volatiles alone and in combination with DA.