

**FINAL PROJECT REPORT****WTFRC Project Number:** ARS Project**Project Title:** Direct control of codling moth with pear ester

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**Cooperators:** Rick Hilton, Phil Van Buskirk, Doug Light, and Bill Lingren**Other funding Sources** None**Agency Name:****Amount awarded:****Notes:****Total Project Funding:** \$24,000**Budget History:**

<b>Item</b>	<b>Year 1: 2005</b>	<b>Year 2: 2006</b>	<b>Year 3: 2007 (extension)</b>
<b>Salaries</b>	0	0	0
<b>Benefits</b>	0	0	0
<b>Wages</b>	8,200	8,200	0
<b>Benefits</b>	1,300	1,300	0
<b>Equipment</b>	0	0	0
<b>Supplies</b>	1,700	1,700	0
<b>Travel</b>	800	800	0
<b>Miscellaneous</b>	0	0	0
<b>Total</b>	<b>12,000</b>	<b>12,000</b>	<b>0</b>

## Significant findings

### 2005

- ❖ Trécé Inc. formulated pear ester as a 5.0% A.I. microencapsulated product (Cidetrak® DA-MEC).
- ❖ Application of the Cidetrak DA-MEC at rates from 0.001 – 1.0% did not effect the distribution of codling moth eggs relative to apple fruit.
- ❖ The distribution of codling moth eggs on shoots treated with 0.001 – 0.01% DA MEC was not affected on four apple cultivars.
- ❖ Spraying apple fruit clusters with a 1.0% Cidetrak DA-MEC solution significantly increased the number of eggs laid near fruit clusters; but concentrations of 0.001 and 0.1% did not.
- ❖ The addition of 0.01 and 0.1% Cidetrak DA-MEC to a seasonal spray program of 0.5 – 1.0 lb Guthion significantly reduced fruit injury 38 – 63% at harvest.
- ❖ Concentrations of Cidetrak DA-MEC as low as 0.00001% on filter paper were attractive to neonate codling moth.
- ❖ Concentrations of Cidetrak DA-MEC  $\geq$  0.1% continued to attract neonate codling moth for at least 7 days, while lower rates were only attractive up to 3 days.
- ❖ A combo ‘puzzle-piece’ dispenser loaded with sex pheromone and pear ester effectively managed codling moth in its first field test conducted in a California apple orchard..
- ❖ Fruit injury was reduced from 1.4 to 0.3% in apple plots treated with 24 AKISS (Attractive Killing Interception Sensory Stations) per acre baited with a combo pheromone / pear ester lure in a California trial.

### 2006

- ❖ A combo ‘puzzle-piece’ dispenser loaded with sex pheromone and pear ester effectively shut-down traps baited with virgin female moths all season and outperformed the Checkmate dispenser late in the season.
- ❖ Traps baited with Cidetrak® CM-DA Combo dispensers did not catch moths and dispensers were seen to significantly reduce close-range moth orientation (< 20 cm).
- ❖ The Pherocon CM-DA and Pherocon CM-DA Combo lures remained effective for at least 7 weeks. The Combo outperformed the Biolure™ 10X lure in orchards treated with 400 Isomate-C PLUS™ dispensers/acre.
- ❖ AKISS performed poorly in 2006 due to short-lived residual toxicity and attractiveness.
- ❖ Moth catches were significantly lower in replicated 5-ac orchard plots treated with either the pheromone-only or combo puzzle piece dispensers than comparable blocks treated with Isomate-C PLUS. No differences in fruit injury were found in orchards treated with any dispenser type.
- ❖ The microencapsulated pear ester formulation (Cidetrak DA-MEC) reduced codling moth injury > 60% when added at rates of 12 – 24 ml/100 gallons to half rates of Imidan.

### 2007

- ❖ Three experimental ‘puzzle piece dispensers’ loaded with a blend of sex pheromone and pear ester outperformed a similar dispenser loaded only with sex pheromone and Isomate-C PLUS and in shutting down virgin female-baited traps in a replicated small plot study.
- ❖ The residual content of sex pheromone and pear ester was measured in field-aged commercial lures, Pherocon DA and Pherocon CM-DA COMBO. Both lures remained attractive for > 8 wks.
- ❖ Flight tunnel tests showed that the addition of pear ester expands the dosages of sex pheromone that are attractive to male codling moth.
- ❖ Laboratory tests showed that male codling moths response to sex pheromone can be turned off by pre-exposure to either pear ester or sex pheromone. However, sensory adaptation was not increased by the addition of pear ester to high rates of pheromone.

- ❖ The addition of a microencapsulated formulation of pear ester (Cidetrak DA-MEC) improved most of the nine insecticides tested by decreasing the percentage of codling moth-injured fruit from 25-45% and reduced the incidence of live larvae within fruit up to 80% in field trials.
- ❖ Levels of fruit injury were reduced nearly 70% in small plots where one AKISS was placed on each tree during the first moth generation.

### **Results and Discussion**

The discovery of pear ester as an attractant for adult and larval codling moth has been a tremendous asset for pest management in Washington's orchards. In less than 10 years, a significant proportion of growers are using the Pherocon CM-DA COMBO lure that combines sex pheromone and pear ester to monitor codling moth in sex pheromone-treated orchards. Codling moth male antennae have specific receptors for pear ester and the addition of pear ester improves the orientation of male moths to pheromone-baited traps and increases moth catches. This lure is long-lasting and we have developed the use of action thresholds based on a standardized protocol for its use. The COMBO lure catches a relatively low percentage (5-15%) of female moths and while similar thresholds have also been established for the cumulative catch of female moths, few trap checkers bother to sex the moths. The pear ester lure catches a more equal sex ratio and similar numbers of female moths as the COMBO lure but is not widely used. Hopefully, more growers will adopt the use of these thresholds, in particular, as site-specific spatial pest management becomes more widely practiced. Detection of female codling moth using pear ester-baited traps placed along the borders of orchards will hopefully become a standard program to help growers apply insecticides more judiciously in their orchards.

Codling moth females lay their eggs near or on fruit. Broadcast sprays of pear ester have been shown to cause eggs to be laid on average further from fruit. The increased wandering time/distance contributes to a greater exposure of larvae to insecticide residues. When the microencapsulated formulation of pear ester (Cidetrak DA-MEC) is added to effective insecticides, such as organophosphates and neonicotinyls, their activities can be significantly improved even at reduced rates. Adding pear ester to materials that are only moderately effective for codling moth can also improve these materials. In particular, insecticides that have good activity for leafrollers and some activity for codling moth, such as Success and Intrepid, can be improved. Differences in the levels of improvement that can be achieved by adding pear ester to various insecticide classes have occurred and the potential causes for this need to be better understood. For example, pear ester has strongly improved neonicotinyl insecticides, but not the anthranilic diamides. Cidetrak DA-MEC is exempted from tolerances and can now be tested on up to 100 acres per state. Full registration of this material is expected in 2009.

Cidetrak DA-MEC can also be used by growers to enhance mating disruption. From 2002-2005 Dr. Doug Light evaluated the use of the DA-MEC to enhance sex pheromone in walnuts and applying only 2-3 sprays a year he was able to reduce nut injury in orchards by nearly 50% compared with using pheromone alone. Unfortunately, DA-MEC has not been tested for mating disruption in Washington. However, I conducted a field test in 2007 where Cidetrak DA-MEC was added to several insecticides in an orchard that was also sprayed with Checkmate CM-F sprayable pheromone formulation. Prior to this, all previous tests with DA-MEC for larval activity were conducted in non-disrupted orchards. Despite extremely high moth pressure (170 moths per trap in the 1<sup>st</sup> flight) levels of fruit injury were ca. 80% lower than expected based on the results from three similar studies conducted at the same time in other orchards where traps had similar moth catches. These data led me to formulate a hypothesis that the pear ester formulation applied as a larval spray interacted with the sex pheromone to enhance the control of codling moth in this orchard. A project has been developed to evaluate the use of pear ester (Cidetrak DA-MEC) to enhance both larval sprays and sex pheromone-based mating disruption. Orchards can be treated with either hand-applied pheromone

dispensers or the sprayable pheromone formulation and pear ester can either be added to each insecticide spray, with applications of other horticultural amendments, or in combination with the sprayable pheromone to maintain a season-long treatment program.

The new Cidetrak ‘puzzle-piece’ dispenser (Cidetrak CM) developed by Trécé Inc. which releases only sex pheromone has outperformed (shutting down pheromone-baited traps) Isomate-C in field trials conducted over the past two years by both WSU and our laboratory. Similar dispensers formulated with three blends of pear ester and pheromone all outperformed (shutting down virgin female-baited traps) the pheromone-only Cidetrak, Isomate, and Checkmate dispensers in small plot trials. Current studies continue to fine-tune the optimal loading of both pear ester and sex pheromone in this dispenser (Cidetrak CM-DA COMBO) in collaboration with the manufacturer. Hopefully, a combination dispenser will be registered during 2009.

Efforts to develop an effective, easy-to-use, and inexpensive killing station baited with pear ester have been underway since 2001 with support from the WTFRC. The use of mass-trapping with pear ester-baited traps was not effective as we found that female codling moths avoid entering into standard trap designs. Similarly, coating traps with insecticides on both the outside and inside was very effective only during the first moth flight and provide inadequate control during the second moth flight due to the low numbers of female moths that were killed by these traps. Several years were spent evaluating different designs but ultimately these were scrapped as insecticide residues did not last long enough and killing stations had to be frequently serviced and replaced. Future studies will address the use of a new synergized pear ester lure developed by Dr. Peter Landolt and several new designs of the killing station. These studies are primarily focused on developing a useful product for homeowners to manage backyard trees and to develop a tool for growers to supplement control along orchard borders where moth immigration into orchards is concentrated.