

## TERMINATION REPORT

**PROJECT NO:** 7093  
**TITLE:** Pheromone lures for monitoring codling moth  
**YEAR INITIATED:** 1993-94    **CURRENT YEAR:** 1996-97  
**TERMINATING YEAR:** 1996-97  
**PERSONNEL:** Jay F. Brunner, Associate Entomologist  
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The objectives of this project were to:

- compare the attractiveness and longevity of lures for monitoring CM in conventionally treated apple orchards,
- determine the relative effectiveness of placing pheromone baited traps at different positions in the canopy in MD treated apple orchards,
- develop more effective lures for monitoring CM in pheromone treated apple orchards.

All of these objectives have been addressed by the research conducted and have been achieved. We have shown that the industry "standard" lure used in conventional orchards to monitor CM has serious limitations with respect to longevity. The potential to use or develop other lures for monitoring CM has been shown and parameters for release rates established. Likewise, a high load lure has been developed and tested in mating disrupted orchards. What has become the most used high load lure, a red septum with 10 mg of codlemone, has serious limitations, especially with respect to longevity in the second CM generation. Parameters have been established for release rates from high load lures used to monitor CM in mating disrupted orchards. Private companies are in the process of developing new lures based on these parameters. The placement of traps at mid- and high-canopy positions in mating disruption orchards showed the value of the latter for tracking CM phenology and may provide a more sensitive indicator of the need to apply additional control measures.

### ACCOMPLISHMENTS:

Pheromone lures used in traps to monitor codling moth (CM) in conventional orchards were compared for relative efficacy and longevity. The industry standard, a red rubber septum loaded with 1 mg of codlemone and produced by Trécé, Inc., proved to have serious shortcomings relative to other lures. Attractancy of the red septum lure lasted 3-4 weeks in the spring and about two weeks in the summer. A lure produced by Hercon, Inc., referred to as a luretape, captured CM moths for the entire first generation flight and for 45 days during the second generation. Two other lures showed promise. A plastic membrane type lure produced by Biolure, Consep, Inc., and a gray rubber septum loaded with 3 to 5 mg of CM pheromone and provided by Trécé Inc., captured as many or more CM than the red septum lure. These results have stimulated interest in pheromone companies to improve their products, and newly engineered lures are now available for commercial use.

Pheromone release rates from aged septa are currently being analyzed by ion mobility spectrometry (IMS) techniques. Preliminary release rate results are consistent with moth catch data. Lures were most attractive when release rates were between 0.5 and 3.0 µg per hour. Attractancy declined significantly when release rates fell below about 0.3 µg per hour. High temperatures appeared to increase pheromone emission rates.

Monitoring is difficult in orchards treated with mating disruption (MD) for CM control. The normal trap loaded with the 1 mg red septum lure is essentially ineffective. A red septum containing 10 mg of CM pheromone has shown promise as a monitoring tool in MD orchards.

However, failure of high load traps to consistently detect "hot spots" in pheromone treated orchards has raised concerns over policies to recommend this monitoring system as a tool in pheromone based IPM programs. Our research has demonstrated that attractancy of high load lures lasts 3-4 weeks in the spring but only two weeks in the summer. Effective use of a 10 mg red septum in commercial orchards probably will require changing lures every three weeks during the first generation CM flight and at least every two weeks during the second generation CM flight.

Better lures are needed to reduce the expense and difficulty associated with maintaining consistent trap attractancy in orchards treated with CM pheromone. New high load-rate lures were tested in 1994 and 1995 by utilizing portions of a pheromone dispenser. A trap baited with one-quarter of a matrix-type pheromone dispenser (TNO) consistently captured as many or more CM over a 49-day period as a trap baited with a 10 mg red septum changed every 10 days. As a result of this research, companies producing pheromone lures for monitoring are designing new high load-rate lures for monitoring CM in MD orchards.

Analysis of release rates using IMS indicated that the reduced attractancy of the 10 mg lure was closely associated with a sharp decline in the release rate of codlemone during the second codling moth flight period. A significant reduction in the attractancy of the high load lure occurred when release rates dropped below 3 µg of codlemone per hour. Based on our analysis of release rates from high load red septa, new lures with release rates of 5-10 µg per hour should be available for testing in 1996.

The performance of traps placed at mid-canopy or in the upper canopy was directly compared in 12 orchards in the Howard Flat Codling Moth Area-wide Management Pilot Project (CAMP). The 10 mg lure baited traps placed in the upper canopy captured about three times more moths in the first CM generation flight but almost seven times more moths in the second generation than traps placed at mid-canopy. The high traps were a better indicator of CM phenology, closely tracking the seasonal pattern of moth catch in standard traps placed in conventional orchards at Howard Flat. The increased effort required to monitor traps placed high in the canopy may be offset by the greater sensitivity and thus possibly greater reliability of these traps to predict the potential for fruit injury compared to traps placed at mid-canopy.

## **RESULTS:**

### **Standard lures - Conventional block monitoring**

**1994 comparisons:** The effectiveness of four pheromone lures for monitoring CM was determined in 1994. Three of the lures were commercially available products: a red septum (Trécé, Inc.), a plastic membrane (Biolure, Consep, Inc.), and a luretape (Hercon, Inc.). The fourth lure was a gray septum loaded with 3-fold more pheromone than the commercially available gray septum (Agrisense). In addition, a red septum replaced every 10-12 days was included as a standard.

The luretape was the most attractive lure throughout the first generation flight of CM. It was the only lure that consistently performed better (i.e. captured more moths) than the red septum replaced at regular intervals. After 53 days of exposure in the field, moth capture was significantly higher in traps baited with the luretape than in traps baited with any of the other lures, including a new red septum. In contrast, field aging had a significant negative effect on the attractancy of the red septum and membrane lures. Moth capture in traps baited with either lure declined after the first 21 days. At least a 50% reduction in moth catch was recorded in membrane or red septum baited traps relative to a trap baited with a new red septum for the remaining 32 days of the experiment. The performance of the gray septum was more variable. Attractancy of the gray septum was equal to that of the red septum of the same field age for the first 31 days, but it was significantly more attractive during the next 22 days. Moreover, the 53-day old gray septum was significantly more attractive than a fresh red septum.

Each of the four lures performed differently during the flight of the second generation compared to the first generation. The red septum was again the least attractive lure, but the reduction in moth catch occurred sooner in the second compared to the first generation. The attractiveness of the field-aged red septum relative to the red septum replaced every 10-12 days declined significantly

during the first period following a lure replacement. In contrast, the same relative decline in moth catch in traps baited with these two lures did not occur until the second period following lure replacement in the first generation comparison. The other three lures, the gray septum, luretape and membrane, were at least as attractive as a fresh red septum for 45 to 67 days. The gray septum had the greatest longevity.

**1995 comparisons:** The effectiveness of three pheromone lures for monitoring CM was determined in 1995. The lures tested were the commercially available red septum (Trécé, Inc.) and a gray septum loaded with either 3.5 or 5.0 mg of codlemone. All lures were aged throughout the duration of the test, with the exception of a red septum replaced every eight days which acted as a relative standard against which to judge the attractancy of other lures.

The attractancy of the gray septum loaded with either 3.5 or 5.0 mg of codlemone was similar to that of a standard red septum. Both gray lures maintained their attractancy throughout the first generation flight of CM. After 48 days of exposure in the field, there was no significant difference in moth capture in traps baited with a gray septum loaded with either the 3.5 or 5.0 mg of codlemone and traps baited with a red septum replaced every eight days. In contrast, aging had a significant negative effect on the attractancy of the red septum. Moth capture in traps baited with this lure declined after 2-3 weeks. Moth capture in traps baited with the aged red septum was less than half that of traps baited with a new red septum from the third trapping period to the end of the test.

Relative performance of all lures was poorer during the second generation CM flight compared to the first. The red septum was again attractive for the shortest period of time, but the reduction in relative moth catch between days 16 and 24 was more dramatic compared to the first generation. Red septum-baited traps only captured about one-third the number of moths as traps baited with a new red septum each trapping period for the remainder of the second generation flight. After 16 days exposure in the field, the gray septum loaded with either 3.5 or 5.0 mg of codlemone also was significantly less attractive than the red septum replaced at regular intervals. The gray lures continued to attract about 50% fewer moths than a fresh red septum throughout the middle of the summer. However, during the last two weeks of the second generation flight the gray septum, particularly the one loaded with 3.5 mg of codlemone, was again as attractive as the red septum replaced at regular intervals.

**Pheromone emission rates:** Differences in pheromone emission rates were probably the major factor affecting the performance of lures. The rate of pheromone released from different lures is currently being determined by IMS technology. Lures were collected at weekly intervals during both CM flights in 1994 and 1995. Preliminary analysis of field-aged lures collected in 1994 indicates a strong relationship between measured emission rates and relative moth catch. Lures were most attractive when emission rates were between 0.5 and 3.0  $\mu\text{g}$  per hour. Their performance declined significantly when emission rates fell below about 0.3  $\mu\text{g}$  per hour. A longer period of high emission from the red septum in the spring compared to the summer correlated well with the prolonged attractancy of this lure in the spring as reported herein. High summer temperatures appeared to increase the pheromone emission rate, thus shortening the effective life of the lure.

#### **High load lures - Pheromone block monitoring**

**1994 comparisons:** Four kinds of pheromone lures were compared for effectiveness in monitoring CM in pheromone treated orchards. Two lures were commercially available products, a red septum loaded with 1 mg of codlemone (Trécé, Inc.) and a red septum loaded with 10 mg of codlemone (Trécé, Inc.). The other two lures consisted of portions of two mating disruption products, one-half of a Hercon tape and one-quarter of a TNO dispenser. These modified dispensers contained approximately 20 mg of codlemone. The 10 mg red septum and tape dispenser were compared during the first generation CM flight, while the 10 mg red septum, 1 mg red septum and

modified TNO dispenser were compared during the second generation flight. To determine the effect of field aging on attractiveness of lures, a 10 mg red septum was replaced every 10 days to use as a control in the comparisons.

The aged 10 mg red septum lure and tape dispenser lure captured the same relative number of moths as the non-aged 10 mg red septum lure during the first 19 days of the test. A significant reduction in the attractancy of both lures relative to a new 10 mg red septum lure was recorded during the third 10-day period, as well as the remainder of the 49-day comparison. Codling moth activity level could be underestimated by as much as 50% if either lure was not replaced at 3-week intervals during the first generation CM flight.

The 10 mg red septum and TNO lures were equally attractive during the first nine days of the second generation CM flight. Subsequently, however, the effectiveness of the 10 mg red septum declined dramatically, with no moth catch recorded after 19 days of field exposure. The attractancy of the 10 mg red septum was maintained if it was replaced every 10 days. Effective use of this lure in commercial orchards probably requires changing lures every two weeks during the second generation CM flight. The TNO lure had a significantly greater field life. Throughout the 49-day trapping period, moth captures in traps baited with the TNO lure were equivalent to catches recorded in traps baited with a new red septum. The 1 mg red septum replaced every 10 days was a poor lure throughout most of the flight.

**1995 comparisons:** Three kinds of high load pheromone lures were compared for effectiveness in monitoring CM in pheromone treated orchards. The lures tested were the commercially available red septum loaded with 10 mg of codlemone (Trécé, Inc.), a Biolure membrane (Consep, Inc.), and one-eighth of a CIDeTRAK pheromone dispenser (Trécé, Inc.). The amount of codlemone in the two experimental lures was not determined. To evaluate the effect of aging on attractiveness of lures, a red septum replaced every eight days was used as a control.

The experimental high load lures engineered by Consep and Trécé were significantly less attractive than the 10 mg red septum, capturing about a third as many moths as the red septum replaced at regular intervals throughout the first generation comparison. Attractancy of the 10 mg red septum remained as high as a new 10 mg red septum for about three weeks during the spring flight. A significant reduction in the relative attractancy of the red septum was observed during the third and fourth trapping periods, days 25-40.

The effectiveness of the 10 mg red septum declined dramatically during the second trapping period, days 8-14. No moth catch was recorded after the 10 mg red septum had been in the field for three weeks. The consistent attractancy of the 10 mg lure could only have been maintained if it was replaced weekly under these conditions. Effective use of the 10 mg red septum in commercial orchards probably will require changing lures every three weeks during the first generation CM flight and at least every two weeks during the second generation CM flight. Better lures are needed to reduce the expense and difficulty associated with maintaining consistent trap attractancy in orchards treated with CM pheromone.

**Pheromone emission rates:** Pheromone emission rates of field exposed 10 mg lures are currently being analyzed by IMS technology. Lures were collected at weekly intervals during both CM flights in 1994 and 1995. Preliminary analyses of 10 mg red septa collected in 1994 have indicated significant differences in emission rates of lures during the first and second generation flights of CM. In both spring and summer flights, emission rates dropped sharply during the first 10 days, from about 7.5  $\mu\text{g}/\text{hour}$  on day 1 to 3.5  $\mu\text{g}/\text{hour}$  on day 10. Emission rates continued to decline in the summer, with only 1.0  $\mu\text{g}/\text{hour}$  emitted on day 21. In contrast, emission rates above 2.5  $\mu\text{g}/\text{hour}$  were maintained between days 10 and 31 of the spring flight. The longer period of high emission of codlemone in the spring compared to the summer correlated well with the prolonged attractancy of the 10 mg red septum in the spring as reported herein. High summer temperatures appeared to increase the rate of pheromone emission or production of repellent isomers, thus shortening the effective life of the lure.

**Summary:** Several kinds of CM pheromone lures are commercially available and used to monitor the activity of this pest in conventionally treated apple and pear orchards throughout the Pacific Northwest. Despite possible differences in attractancy and longevity, all lures are used in conjunction with the same thresholds and lure replacement intervals. To determine the potential impact of this practice on CM management, we initiated direct comparisons of various CM pheromone lures. Substantial differences in the attractiveness and longevity of lures were detected. The industry standard, a red rubber septum loaded with 1 mg of codlemone, proved to have serious shortcomings relative to other lures. Attractancy of the red septum lure lasted 3-4 weeks in the spring and about two weeks in the summer. A lure produced by Hercon, Inc., referred to as a luresheet, captured CM moths for the entire first generation flight and for 45 days during the second generation. Other lures, including several commercially available products, captured as many or more CM than the red septum lure and were attractive for up to eight weeks.

A pheromone trap (Pherocon 1CP) baited with a red septum containing 10 mg of codlemone has been widely adopted as a component of pheromone based CM control programs. CM activity in pheromone treated orchards is more effectively monitored with this high load lure than with a standard red septum containing 1 mg of codlemone. Furthermore, the high load lure trapping system can be used to predict the need for supplemental controls in pheromone treated orchards. However, reports have increased on a lack of reliability of this monitoring system to indicate the potential for fruit injury in MD orchards. With the objective of improving the attractancy and overall performance of high load pheromone trapping systems in MD orchards, we initiated studies using both the 10 mg red septum and newly engineered high load lures. Through these efforts we have determined that the 10 mg red septum is only attractive for 3-4 weeks in the spring and two weeks in the summer. Analysis of release rates using IMS technology indicated that the reduced attractancy of this lure occurred when release rates dropped below 2.5 µg of codlemone per hour. The performance of the high load lure trapping system was improved by placing traps in the upper canopy rather than at mid-canopy.

**BUDGET:**

Allocated FY 1995-96: \$ 10,496  
 Request for 1996-97: 0

	<u>1995-96</u>	<u>1996-97</u>
Timeslip (1 person @ \$7/h*40*20)	\$ 5,600	0
Operations (pheromone lures & traps)	1,000	0
Travel		
Project needs (50% car rental+fuel (\$150 * 6) + 100=1000)	1,000	0
Other (lure release rate analysis)	2,000	0
Employee benefits		
Timeslip (6000 * 0.16)	<u>896</u>	<u>0</u>
Total	\$10,496	\$0

## **PUBLICATIONS:**

### **1. Proceedings and trade journals:**

Gut, L. J. and J. F. Brunner. 1996 (in preparation). Monitoring codling moth with pheromone traps. *Good Fruit Grower*.

Brunner, J. F. and L. J. Gut. 1995. Control of codling moth using pheromones in Washington apple orchards. *The Grower*, March 1995, 28(3).

Gut, L. J. and J. F. Brunner. 1994. Pheromone-mediated control of codling moth in apple orchards. *Good Fruit Grower* 45(9): 35-48.

Gut, L. J. and J. F. Brunner. 1994. Implementation of pheromone-based pest management programs in pear in Washington, USA. *Int. Org. Biol: Control/West Palearctic Reg. Sect. Bull.* 17(2): 77-85.

### **2. Technical reports:**

Gut, L. J. and J. F. Brunner. 1995. Evaluation of pheromone lures for monitoring codling moth in conventional orchards. Western Orchard Pest and Disease Management Conference, Portland.

Gut, L. J. and J. F. Brunner. 1995. Evaluation of pheromone lures for monitoring codling moth in pheromone-treated orchards. Western Orchard Pest and Disease Management Conference, Portland.

Gut, L. J. and J. F. Brunner. 1994. Mating disruption of codling moth in apple. Western Orchard Pest and Disease Management Conference, Portland.

Gut, L. J. and J. F. Brunner. 1994. Mating disruption of codling moth in pear. Western Orchard Pest and Disease Management Conference, Portland.

### **3. Extension and industry service presentations**

February, 1996. Chelan Hort Day (to be presented), Yakima, WA.

December, 1995. Wash. Hort. Soc. (to be presented), Wenatchee, WA.

December, 1995. Wash. Hort. Soc. (poster to be presented), Wenatchee, WA.

February, 1995. Washington Pest Shortcourse, Yakima, WA.

February, 1995. Annual meeting Blue Mountain Growers Association, Milton-Freewater, OR.

January, 1995. North Central Washington Annual Pear Day, Yakima, WA.

February, 1994. Washington Pest Shortcourse, Moses Lake, WA.

February, 1994. Annual meeting Blue Mountain Growers Association, Milton-Freewater, OR.

January, 1994. Sustainable Agriculture Conference, Portland, OR.

### **3. Field tours**

August, 1995. Wenatchee, WA.

July, 1995. Wenatchee, Orondo and Bridgeport, WA.

July, 1995. Howard Flat, WA.

April, 1995. Howard Flat, WA.

August, 1994. Wenatchee, WA.