Improving codling moth trap catches

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One to three insecticide treatments are required each season to control codling moth, a major insect pest in the 200,000 acres of walnuts, apples, and plums grown in California. Pheromone traps have been used for the last ten years to monitor moth populations so that insecticide applications can be timed for the most effective control. These traps have also been tested as a means of estimating codling moth infestations and suppressing populations by mass-trapping the adult males.

Many factors may influence the effectiveness of pheromone traps. We conducted studies to learn how trap characteristics and placement would affect catches. Identification of these factors may lead to standardized maintenance procedures for more precise monitoring, as well as to improved mass-trapping regimes.

For the tests, we selected the Pherocon 1C trap (the one most commonly used in the western United States for codling moth, *Cydia pomonella* [L.]) with Bird Tanglefoot as the adhesive to mire the moths. The commercially available pheromone dispensers tested were rubber septa (rubber caps containing the pheromone) and thermoplastic hollow fibers. All traps were placed 6 feet high in apple trees, except in the trap height and canopy tests, when they were at various heights. They were oriented in the same direction in each orchard, except in the trap orientation test. Trees containing the traps were 100 to 150 feet apart (four to six trees) in all tests; trap placement was completely randomized, and tests were replicated. During the experiments, discing was avoided so that dust would not impair septum and liner performance.

Septum vs. fiber

Twelve traps containing fresh septa were compared with 12 containing hollow fibers in 1978. Traps with a septum or fibers were placed in apple trees, and moths were counted one week later. After the moths were counted, the pheromone dispensers were placed in a weather shelter in the test orchard for a week. Then the two-week-old hollow fibers and septa were tested again. The process was repeated once more to compare the attractiveness of four-week-old hollow fibers and septa. Treatments were replicated 12 times.

Moth catches averaged five, five, and 13 moths per trap per week in the fresh, two-week-old, and four-week-old traps, respectively. The septum and the hollow fibers did not differ significantly at zero, two, or four weeks of age, as determined by Duncan's Multiple Range Test at the 10 percent level. At the time of the study, we felt that hollow fibers or rubber septa could be used for codling moth trapping through at least four weeks. However, as will be discussed later, septa commercially available at present appear to have a shorter lifespan.

Effects of adhesive

Because the pheromone may diffuse from the septum into the adhesive, and the adhesive may cover most of the septum, in 1978 we investigated the possible influence of Bird Tanglefoot on attractance. Sixteen traps were baited with septa, placed either in the adhesive or above the adhesive on corks (eight replications each). During the nine-week test, moths were removed weekly and liners were replaced after four weeks.

There were no discernible differences in attractiveness between the septa in the adhesive and those separated from the adhesive.

Age of septa

In a 1977 trial, rubber septa were aged in liners of traps inside a weather shelter in an experimental orchard. In 1978, the septa were aged out of the adhesive in organdy-lined cylinders in the weather shelter. (We did not know at the time if the adhesive affected the pheromone, and the cylinders were the best way to prevent possible contamination.) Septa were aged one, two, and four weeks in 1977 and two, four, eight, twelve, and sixteen weeks in 1978; each time they were compared with fresh septa.

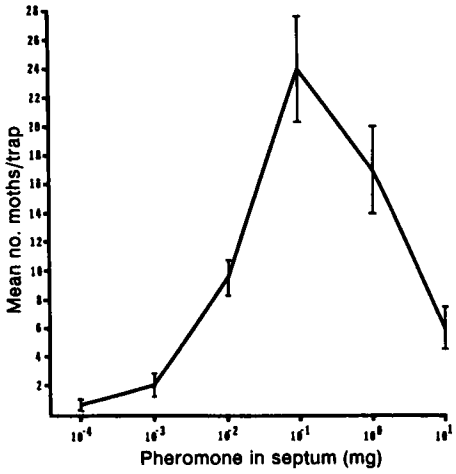
No significant differences were observed in any single comparison (table 1). Commercially available pheromone septa studied by UC entomologists in 1972 lost their attractance after two to three weeks. This discrepancy suggests that a change may have been made in the pheromone formulation since that time.

We were then concerned that the optimum pheromone concentration for attracting codling moths might be different than it was in 1972. We tested six concentrations for one week each: 0.0001, 0.001, 0.01, 0.1, 1, and 10 mg per septum. The optimal load rates after one week in the field were 0.1 and 1 mg (see graph). Our results were similar to the 1972 findings, except that we observed a much lower response to the 10 mg concentration.

Our results indicate that the possible change in formulation did not affect the optimum pheromone concentration but did extend the activity of the bait up to at least 16 weeks with no loss in efficiency. The commercial practice in the late 1970s was to replace the septa every four weeks, which was more often than necessary at that time. Septa now are replaced every two weeks; possibly the attractance of the current dispenser is once again different than in the past.

Age of trap liner

Catch efficiency of the trap liner can be decreased by dust and organic matter covering the sticky material, reducing its adhesive quality and the catching surface area. Some of the sticky material may also be removed along with the insects when they are counted.



The 0.1 and 1 mg concentrations of pheromone in rubber septa were the most effective in attracting codling moths.

TABLE 1. Weekly codling moth catches in traps baited with pheromone-impregnated septa of various ages

Septum age	1977 n	1977 Mean*	1978 n	1978 Mean*	Percent of fresh septum catch
Fresh	12	4.6	—	—	—
1 wk	12	3.8	—	—	84
Fresh	16	4.1	31	10.1	—
2 wk	16	3.1	31	8.4	82
Fresh	12	4.0	10	13.3	—
4 wk	12	3.6	10	10.6	82
Fresh	—	—	25	10.4	—
8 wk	—	—	25	9.2	89
Fresh	—	—	20	9.8	—
12 wk	—	—	20	7.2	73
Fresh	—	—	15	8.2	—
16 wk	—	—	15	8.3	102

* No significent differences were found by the least-significant-difference (LSD) test at the 5% level.

TABLE 2. Weekly codling moth catches in pheromone traps with liners of various ages

Liner age	No. moths caught/ trap before test	Mean*	Percent of fresh liner catch	D/L†
Fresh	—	4.8 a	—	—
1 wk	4.5	6.3 a	131	.60
Fresh	—	9.3 a	—	—
2 wk	10.8	6.5 a	70	.65
Fresh	—	7.3 a	—	—
3 wk	17.3	6.0 a	82	.75
Fresh	—	4.2 a	—	—
4 wk	23.3	2.0 a	48	.94
Fresh	—	6.4 a	—	—
5 wk	25.3	2.0 b	31	1.31
Fresh	—	3.7 a	—	—
6 wk	28.6	2.3 b	62	1.12

*Means followed by the same letter are not significantly different by the LSD test at the 10% level.
†Ratio of difference between means (D) and the LSD at the 10% level (L). A ratio of one or greater signifies a significant difference between means.

To determine how long a trap could be used in an orchard before loss of efficiency, we baited traps with rubber septa and placed them in two orchards. The liners were aged in the field for one to six weeks. Moths were removed weekly from the field-aged liners; new liners were provided weekly in the fresh traps.

Liners showed a significant loss in effectiveness by the fifth week (table 2). The four-week-old liners were almost significantly different from the fresh liners (as indicated by the ratio of 0.94 in table 2). The major foreign materials in the liner's sticky adhesive were codling moths. After four weeks, when catch efficiency began to decline, an average of 23 moths per trap had been removed.

Liner efficiency is undoubtedly affected by the number of moths removed, but other factors may also be important — the type of adhesive used, the amount of other organic and inorganic matter that may become lodged in the trap, and the temperature in the field. If the orchard is being disced, the trap would have to be changed more often than our studies indicate. Liners are commonly changed once a month; an earlier change would be required if more than 25 moths had been removed or if debris had built up in the traps.

Trap placement

Several researchers, in work on other insects, have reported the highest catches of male moths near the tops of tree canopies. Because no information was available for the codling moth, we placed pheromone traps baited with rubber septa just outside the tree canopies in an unsprayed orchard at various heights: 6, 9, or 14 feet on the north sides of different trees that were 15 to 20 feet tall.

In another test, pheromone traps baited with rubber septa were placed either just inside or at the edge of apple tree canopies. Both placements were made at equal frequencies at 6 feet and at 15 to 18 feet (near the treetops). There were three weekly tests; trap spacing and orientation were the same as in the height test.

Male moth catch was greatest at the treetops (table 3). This finding does not mean that traps placed there will catch moths before those at lower locations. In other tests with traps at different locations in an orchard, we have noted the first moth catch on the same day in the spring, regardless of vertical trap placement. If the goal is to trap out the moths, however, placement in the treetops would be more effective.

We grouped the data from the different heights by trap placement inside as opposed to outside the canopy. Catch of coding moth males at the periphery of the tree averaged 5.8 per trap per week for three weeks, whereas those inside the canopy were significantly lower, averaging 2.7.

Alignment with air movement

Wind tunnel studies by other scientists have shown that alignment of Pherocon 1C trap openings perpendicular to the air stream scatters the pheromone plume; a trap alignment parallel to the air stream produces a fine, more cohesive plume. To determine what effect the two plume patterns might have on trap catch, we compared perpendicular and parallel alignments to the prevailing air movement in an apple orchard: seven traps in each alignment placed 6 feet high on the outside of the canopies of different trees and separated by 25 feet. Wind velocity measurements through several summer nights during 1977 showed that air moved in a consistent pattern in the test orchard from late afternoon until morning.

TABLE 3. Weekly codling moth catches in pheromone traps at different heights in apple trees, 1977

Week	Height*	Mean catch†
	ft	
Aug 4-11	14	11.25 a
	9	4.25 ab
	6	3.75 b
Aug 11-18	14	8.50 a
	9	3.25 ab
	6	.50 b

*Four traps at each height.
†Means followed by the same letter are not significantly different by DMRT at the 5% level.

The parallel alignment resulted in significantly higher moth catches than did the perpendicular orientation (a mean number of four moths as opposed to one). The tree rows containing the traps were parallel to the air movement, and traps were between rows. Traps placed behind trees in rows that are perpendicular to the air movement might not be as efficient, since swirling eddies in those areas could disrupt the pheromone plume considerably. In orchards where the winds are not consistent, it may be possible to improve catch by adding a vane to the trap.

Conclusion

From these studies, we conclude that placing codling moth pheromone traps in a consistent location and orienting and maintaining them properly should minimize the variation in catches contributed by traps and improve the accuracy of estimates of potential damage.

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