Section 5

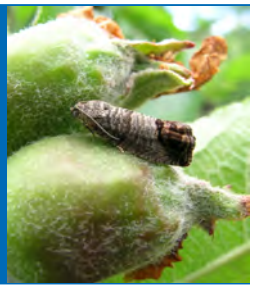
Monitoring

Washington State University

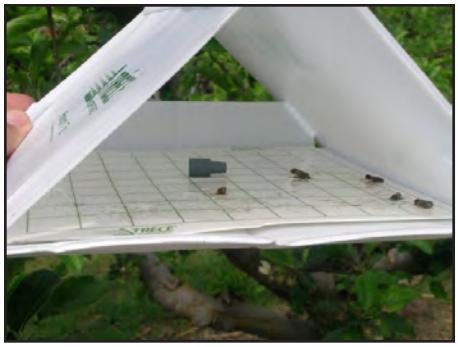
Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Monitoring Codling Moth

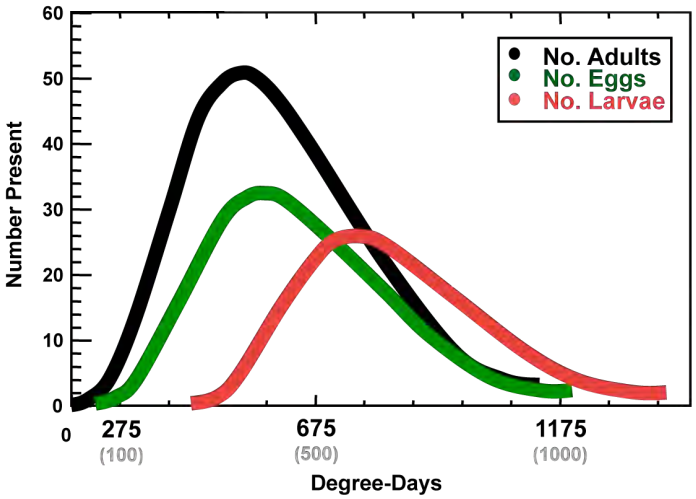


Monitoring ~ Spray Decisions



A monitoring program must be multifaceted, as no one measure can be relied upon for pesticide application decisions. Sticky traps (e.g. Delta style) baited with pheromone or kairomone/ pheromone combination lures are the best tools to measure relative population density in an orchard. Trap captures that don't match model predictions must be viewed as "real", and responded to appropriately. If placed properly, traps can also provide the first warning sign of immigration.

Major advances have been developed by WSU Entomologists to make computer models more accessible and user friendly. WSU Decision Aid System (das.wsu.edu) is an internet site that integrates the codling moth degree-day model with management and insecticide recommendations. Computer models offer growers a chance to predict events that are difficult to see in the field (e.g. oviposition and the start of hatch). Models are necessary to accurately time pesticide applications that specifically target eggs or the start of hatch.



Pheromone-baited sticky traps and computer models may never replace the need for growers to visually inspect their orchard for new signs of damage. Traps and models do not accurately measure or predict activity in isolated regions within an orchard. The best use of those systems are to predict average activity in an area. Visual inspection of hot-spots is still very important.

Practical Monitoring Program:

- Pheromone (or pheromone + kairomone) baited sticky traps at 1 trap/2.5 acres.
- Visual inspection of known hotspots, based on personal experience in an orchard.
- Use degree-day models through WSU Decision Aid System to predict events that are difficult to observe (e.g. oviposition).

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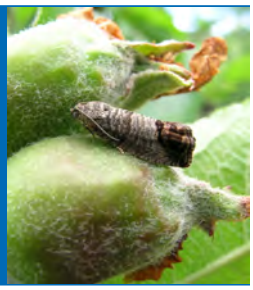
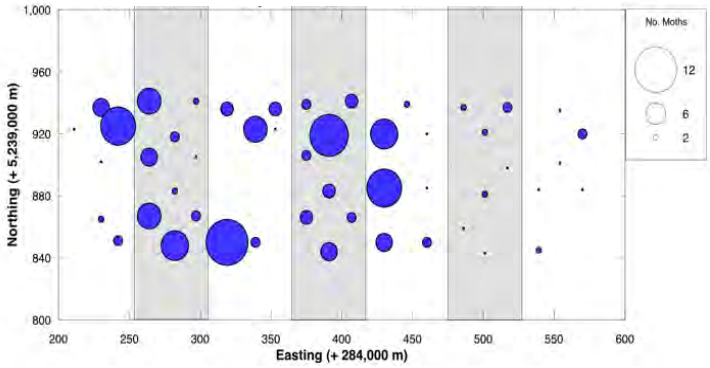


Monitoring ~ Placing Traps & Lures

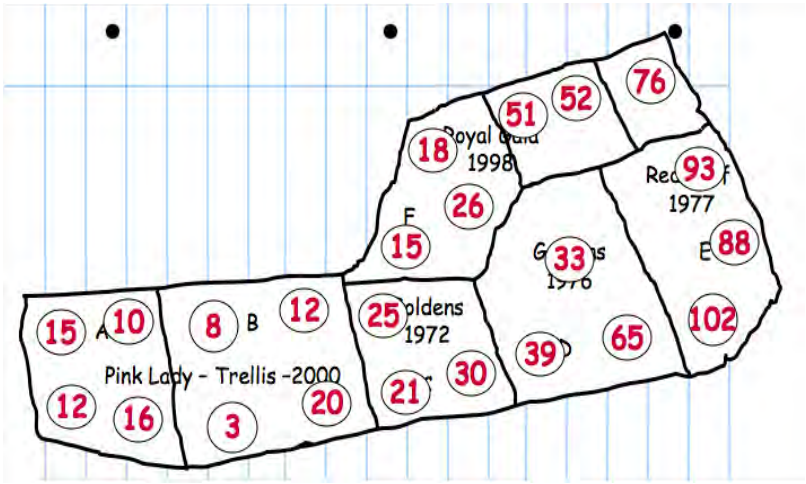
We recommend traps be placed at 1 trap/2.5 acres. Enough traps must be used to accurately measure the population density and distribution. A very intensively trapped orchard (right) shows a clustered population. Note the variation of captures between traps that are in close proximity to each other. If only 4 of these trap locations were used by this grower (1 trap/10 acres), it is easy to see how counts may be misleading. If 16 of these locations were used, the grower would get a better measure of moth density.

40 traps placed in 40-acre block



There are many acceptable lures for monitoring codling moth. High load lures (10X) work best for hand-applied or puffer pheromone treatments, while standard load lures (1X) work best for most other treatments (MEC sprayable, Fibers, or Flakes). Each lure type has its own pheromone release characteristics, so growers must maintain lures to manufacturer recommendations.

Accurate and detailed record keeping is essential to managing codling moth. A grower should be able to produce a map with cumulative trap captures at any time during the season. Detailed records will help to identify problem areas, and assist with insecticide choice and timing.



Treatment Thresholds:

Trap captures are affected by:

- Mating disruption product choice
- Trap density
- Lure choice
- Trap placement
- Trap maintenance

Therefore, a grower's experience with an orchard and its trapping system may be more important than a researcher's idea of a treatment threshold.

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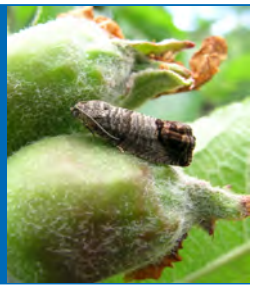


Figure 1

	Lure	Manufacture	Replace Interval
	Red Septum	Various	2-3 weeks
	BioLure	Suterra	4-6 weeks
	MegaLure	Trècè	6-8 weeks
	DA Combo	Trècè	6-8 weeks

High-load pheromone (10X), or kairomone/pheromone combo lures have proven most suitable for monitoring orchards that are using hand-applied pheromone. Lures differ in the amount of pheromone released per day and how long they last and must be maintained (i.e. replaced) to manufacturers' specifications (Fig. 1). Factors other than lures can affect moth capture in traps; the number of traps per area, the placement of traps in the orchard and in the tree, and keeping sticky liners clean.

In a study of orchards with 200 hand-applied disp/acre (Fig. 2), the MegaLure attracted fewer moths than the other high-load lures. In orchards with 400 disp/acre (Fig. 2), the MegaLure appeared to be equivalent to the BioLure. The 10X red septa consistently performs well, but needs to be replaced more frequently. Each of these lures has worked well in commercial orchards but when attempting to establish treatment thresholds, relative differences in captures will need to be considered.

Figure 2

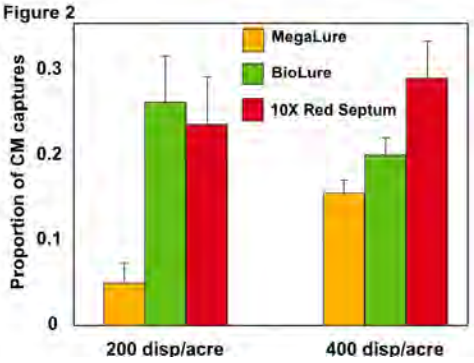
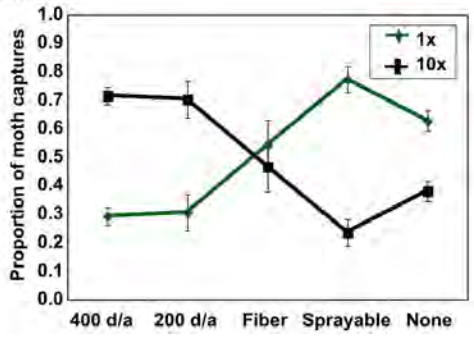


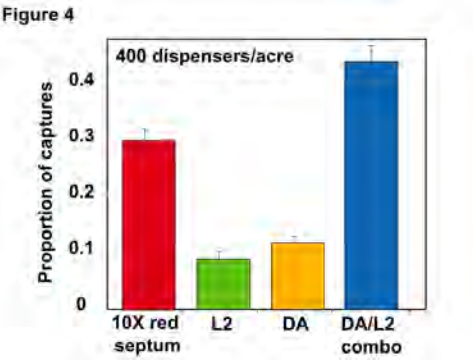
Figure 3



With the advent of new pheromone technologies the relative attractiveness of 1X and 10X lures needs to be understood. The 10X is the most appropriate choice for orchards using hand-applied pheromone. Little difference was seen between 1X and 10X lure-baited traps in orchards treated with Flakes or Fibers (Fig. 3). In orchards treated with Sprayable Pheromone or orchards without a pheromone treatment, the 1X lure was more attractive (Fig. 3).

The DA Combo lure is a gray septum containing a low pheromone load, similar to the L2 lure (Trécé), but has the added component of a plant kairomone (pear ester, DA Lure). Trap captures in orchards with 400 disp/acre indicated significantly higher attractiveness of the Combo lure than a 10X red septa (Fig. 4). The increase in attractiveness of the Combo lure makes it a good option in orchards that have a history of false negatives (i.e. no trap captures but incurring CM damage). Switching to a "better" lure will not correct a situation where false negatives occur because too few traps are used.

Figure 4



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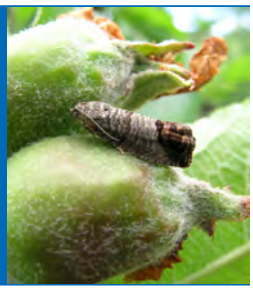
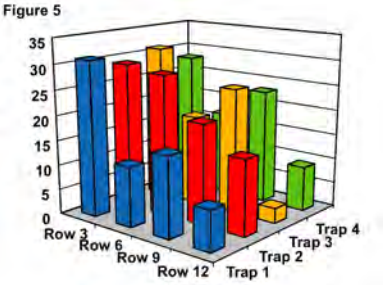


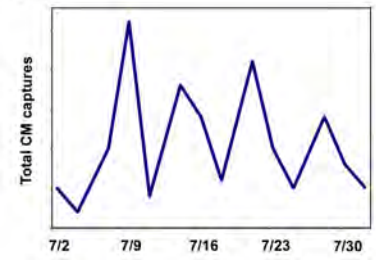
Growers and consultants can lose confidence with their pheromone-based monitoring program. This section addresses some sources of variability and confusion. A frequent question is, "What lure should I use?" The best answer is that no single lure is "best". Pheromone trap monitoring is inherently variable, thus it is difficult to say with certainty that the best lure is 'lure X', and you should spray when you catch 'Y moths'.

Figure 5



CM populations are often clustered, and this can be reflected in trap captures (Fig. 5). Enough traps must be used to assess average activity throughout an orchard. Those wishing to engage in their own lure comparisons should rotate traps at each evaluation to eliminate trap catch variability based on location.

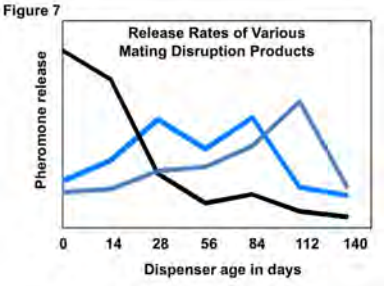
Figure 6



Daily moth captures are highly variable (Fig. 6) and dependent on moth emergence and climactic conditions. Cool temperatures and high winds can greatly reduce or eliminate adult activity. If temperatures are above 50°F adults emerge from the pupal stage but don't fly. Once conditions are acceptable, generally above 60°F, a sudden surge in flight may be noted.

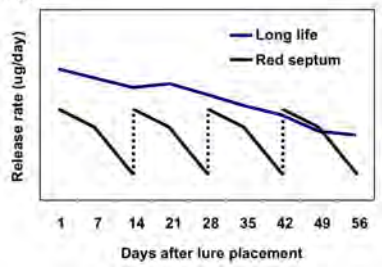
Mating disruption products have their own release profile that changes through the season (Fig. 7). Variable pheromone release from mating disruption dispensers has an obvious impact on the attractiveness of lures operating in that environment. Lures also have specific release characteristics that are dependent on temperature. Lures must be stored and handled such that the quality of the pheromone in the release device is preserved.

Figure 7



The release rate of pheromone from lures changes with time (Fig. 8). The red septa is notoriously short lived with 14-d change intervals recommended during the summer. The long-life lures have a more consistent release of pheromone and may eliminate a potential source of variability. Our best advice is to pick a lure you are comfortable with, stick with it, and use one trap every 2 to 3 acres. Be consistent with trap placement, lure maintenance, record keeping, and pheromone applications. Consistency generates reliable data that can be used for making treatment decisions, and measuring the relative efficacy of programs.

Figure 8



What can researchers do for growers?

- Evaluate release rate characteristics of new lures.
- Establish lure change intervals.
- Evaluate lure attractiveness under a variety of conditions.

What can growers do to improve confidence in monitoring programs?

- Accept inherent variability.
- Pick a lure you trust and stick with it.
- Use one trap every 2 to 3 acres.
- Maintain traps and lures to specifications.

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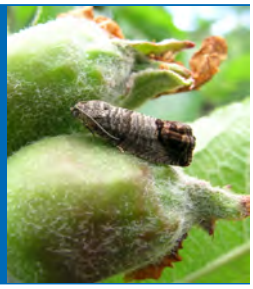
Monitoring Leafroller



Pheromone trapping

Pheromone lures are available for both the pandemis and obliquebanded leafroller and the delta trap works well for either species. Pheromone trapping is not has helpful in monitoring leafrollers as it is for codling moth because male moths move such great distances. One (1) trap in a 10-acre block is sufficient to follow the seasonal flight of leafroller moths. Traps do not need to be placed high in the tree. They should be checked once per week, the number of moths recorded, and trap bottoms changed after an accumulation of thirty (30) moths.

Visual examination for feeding injury

Visual monitoring for leafroller feeding injury is the best method of detecting their presence and density. It is possible to detect feeding injury as early as the pink stage of flower bud development (image left), however, it is better to delay monitoring for leafroller feeding until the petal fall period, just prior to determining the need for a control treatment. At this time many leafroller larvae have moved from feeding sites associated with flower clusters and are found on leaves of new shoots (image right). The best timing to monitor leafroller larvae is provided by models for both pandemis and obliquebanded leafroller found in the WSU Decision Aid System (http://das.wsu.edu).

Detecting leafroller feeding is not easy and requires some experience. Leafroller larvae occur in clumped distributions and it is therefore necessary to sample the entire orchard. Evaluating 40 trees in a 10-acre orchard block is recommended. Twenty (20) shoots (or fruit clusters if sampling is done at pink) should be examined in each tree. It is helpful to use a special **pole pruner** (image below left) to cut shoots high in the tree that appear to have an active feeding site so that they can be examined. Foliage damage from wind, mildew, or even blossom thinning sprays can make it more difficult to detect leafroller feeding sites. The criterion that separates these injuries from that of leafroller larvae is the presence of webbing (image below right) or frass associated with foliage injury.

Leafroller larvae do not remain in the same feeding site throughout their development but move from old to new feeding sites several times. Prior to a control spray being applied, old feeding sites are often detected and are a clue to an active feeding site nearby. After a control treatment has been applied an old feeding site can be an indication that the treatment was successful.

Young leafroller larvae of the summer generation feed near the mid-rib on the underside of a leaf and are therefore almost impossible to detect. Sampling can be conducted after leafroller larvae reach the third instar (stage) – see WSU Decision Aid System for timing recommendations for this sample – but by this time much of the fruit injury has already occurred.

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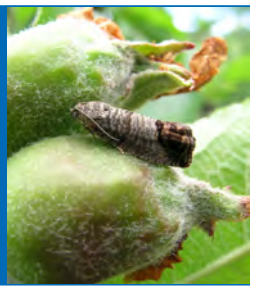
Monitoring Thrips and Campylomma



Monitor using a beating tray

The beating tray is another sampling tool used to assess the presence and abundance of several different kinds of insects. In tree fruit production it is primarily used to assess populations of thrips, the western flower thrips (bottom right image), and the mullein plant bug, *Campylomma verbasci* (Campylomma; center left images).

The beat tray is typically a square frame covered with either a white or black cloth (image above right). The black panel is often used to sample Campylomma in the spring as they small light green nymphs are easier to see on the contrast of a dark background.

Campylomma nymph (above) and adult (right) courtesy of Bradley Higbee.

The beat tray is held beneath a limb that is jarred by tapping it with a stiff rubber hose three times. The jarring of the limb dislodges insects on the limb and they fall onto the beat tray surface. The insects on the tray surface are counted and recorded. Usually twenty limb taps are taken in an orchard to determine the number of Campylomma or thrips present. The average number of pests per tray is used to determine the need to apply control treatments. The treatment thresholds for Campylomma vary by apple variety, with Golden Delicious being the most susceptible.

The beat tray sampling method is labor intensive but very valuable in assessing the presence and abundance of Campylomma and thrips in the spring. The sampling time window for these pests is short and at least for Campylomma a degree day model accessed on the WSU Decision Aid System is helpful in knowing when nymphs should be present. The beat tray can also be used to sample several other pest and beneficial insects, however, the relationship between the numbers found in beat trays and their potential impact in the orchard, good or bad, is not clearly understood.

Western flower thrips courtesy of E. Beers