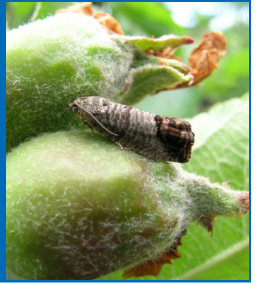


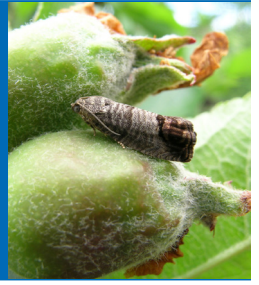
Apple Pest Management Transition Project

Tree Fruit Research & Extension Center



Apple Pest Management Transition Project

Tree Fruit Research & Extension Center



Apple Pest Management Transition Project Signup

Name: _____

Email: _____

Primary phone: _____ 2nd phone: _____

Mailing Address: _____

City, State & Zip code: _____

How would you like to receive meeting notices and the Newsletter? (check box below)

email* (plain text) email* (rich text/html) regular mail

*Please add pmtp.info@wsu.edu to your address book to receive our mailings.

Orchard name: _____

General Orchard Location: _____

Apple acres: _____ I make pest management decisions: yes no

Primary role in the apple industry: (choose only one): grower _____ manager _____
consultant _____ other _____

Are you using CM Mating Disruption: yes no Product/Rate: _____

Are you using Guthion: yes no Total lbs product: _____ Acres Treated: _____

Are you satisfied with your codling moth control? yes no its OK

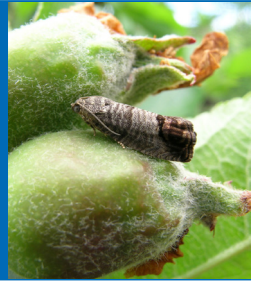
Did you participate in the Pest Management Transition Project in 2009: yes no

Are there specific things you would like more information about: i.e. Mating Disruption,
New Insecticides, Secondary Pests, Web Resources (like DAS), etc.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Administration Contact Information



Executive Committee

- * **Dr. Jay Brunner**, WSU Tree Fruit Research & Extension Center, 1100 N. Western Ave., Wenatchee, WA 98801 Office: 509-663-8181 x238; Email: jfb@wsu.edu
- * **Bruce Grim**, Executive Director, Washington State Horticultural Association, P. O. Box 136, Wenatchee, WA 98807-0136; Office: 509-665-9641; E-mail: bruce@wahort.org
- * **Dr. Jim McFerson**, Manager, Wash. Tree Fruit Research Commission, 1719 Springwater Ave., Wenatchee, WA 98801; Office: 509-665-8271 x1; Email: mcferson@treefruitresearch.com
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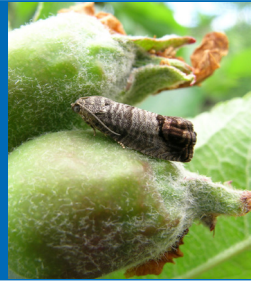
<http://pmtip.wsu.edu>

pmtip.info@wsu.edu

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Azinphos-methyl Phase-Out



EPA Decision on Guthion Phase Out

2007	limit of 4 lb ai/A	8 lb product
2008-2009	limit of 3 lb ai/A	6 lb product
2010	limit of 2 lb ai/A	4 lb product
2011-2012	limit of 1.5 lb ai/A	3 lb product

Regulatory action is requiring changes in pest management programs.

There is little chance that regulatory action on older insecticides will change.

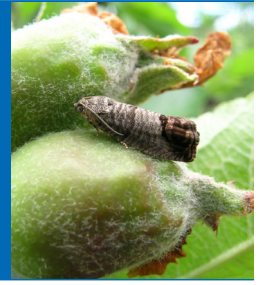
Pest Management Transition Project

Objectives:

1. Reduce the usage and recommendations of organophosphate (OP) insecticides for pest control in WA apple orchards while increasing the recommendations and use of new IPM practices. To increase adoption of new IPM technologies through sharing information on successes and failures.
2. Increase the use of the WSU-Decision Aid System (DAS), which will improve real-time pest management decisions and assist with IPM adoption.
3. Increase knowledge about reduced-risk pesticide safety and IPM practices among year-round and seasonal farm workers in order to increase their awareness of a safer work environment created through the adoption of OP-alternatives.

Section 2

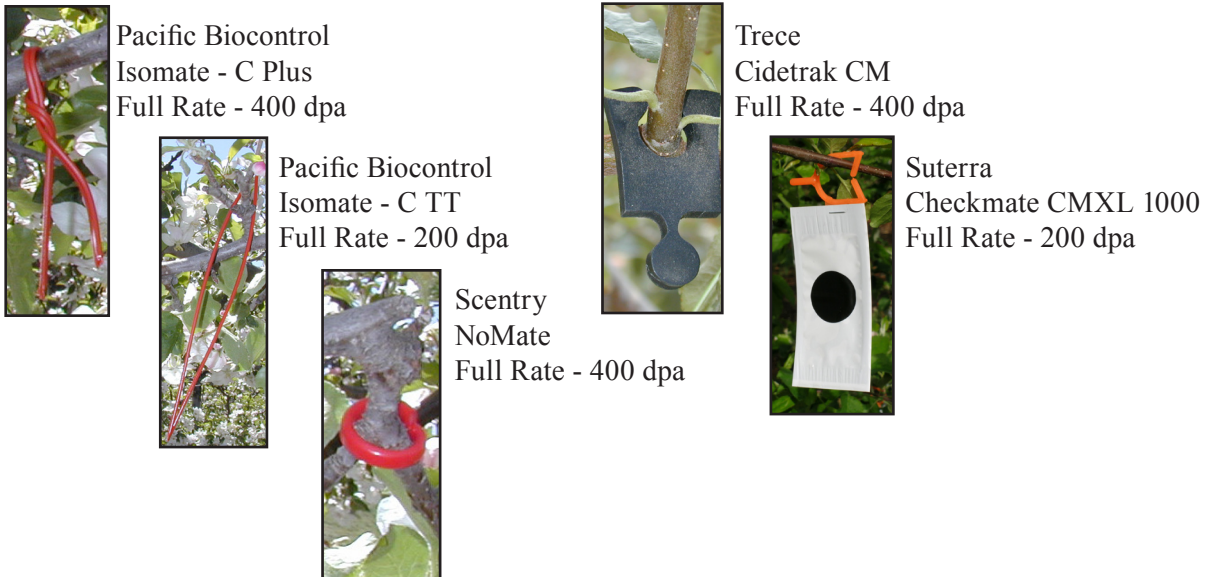
Mating Disruption



Mating Disruption

Mating disruption, use of pheromones, should be considered a foundation of any apple pest management program. When using hand-applied dispenser products (Fig. 1), it provides season long control of the key pest, codling moth. In our experiences, mating disruption reduces the need for additional insecticide applications for codling moth, reduces crop injury, and, over time, reduces costs of pest control.

Figure 1. Various Hand-Applied Dispensers



The mating disruption products that we believe are the most reliable and for which we have the most experience are the hand-applied dispensers. Full label application rates of these products are 200 to 400 per acre. There are other options for applying pheromones (Table 1), but, in general, their use increases the risk of crop injury or the need to apply more supplemental insecticides.

Table 1. A summary of the kinds of dispensing systems for pheromones.

Technology	Puffers	Meso-dispensers	Hand-applied dispensers	Mini-dispensers	Sprayable
Density/acre	1	16-20	400	10,000	A real lot
Release rate mg/disp./day	200	8-20	0.5-1.0	0.005-0.01	Very low
Longevity	Season	Season	Season	20-50 days	3-30 days



Mating Disruption

How pheromones work

In order to mate, codling moth males must locate females, usually from a significant distance. The female produces a pheromone, a specific chemical that she releases. The male is able to detect extremely small amounts of this pheromone and fly to the source where mating occurs.

How mating disruption works

The hand-applied mating disruption products release the same pheromone as the codling moth female, but they release 10,000 times more. The high amount of pheromone inhibits the ability of the male codling moth to locate and mate with the female.

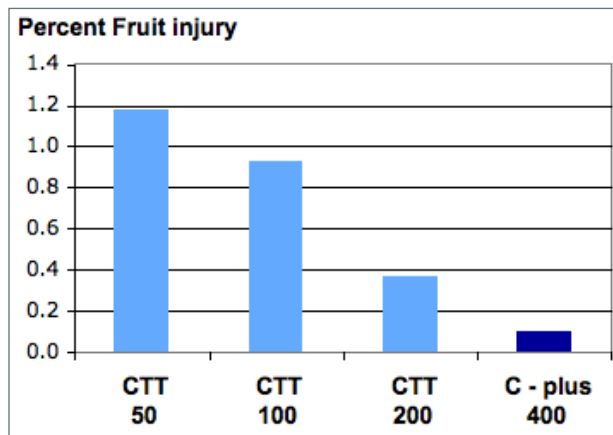
When to apply mating disruption

Pheromone treatments should be in place *prior to the first moth flight*.

How many dispensers to apply

The **full rate** of any dispenser type should be used unless codling moth density is so low growers are already using a reduced supplemental insecticide program. Under a good pheromone-based codling moth control program it is possible to eventually reduce the number of dispensers per acre.

Reducing the number of dispensers per acre increases the risk of crop injury and consequently the need for supplemental insecticide sprays. The graph at the right shows data from a study conducted in 2007. As the number of dispensers per acre were reduced in this study the level of crop damage at harvest increased.



Monitoring mating disruption orchards

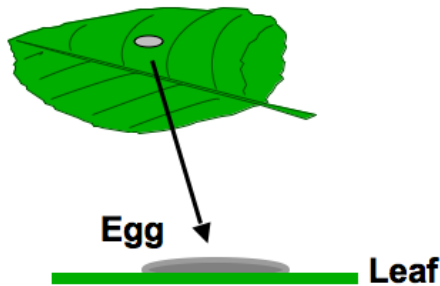
Pheromone traps baited with a high load lure (10X) or a combination of pheromone and host-plant kairomones (combo lure) should be used to monitor pheromone treated orchards. Use one trap every 2 to 3 acres. Using fewer traps will increase the chance of false negatives, that is, traps capture no moths but fruit injury occurs. Visual monitoring for fruit injury is also recommended, especially along orchard borders. Visual monitoring can be done quickly and adds confidence to decisions about the need to apply supplemental insecticides.

Section 3

Using OP Replacements



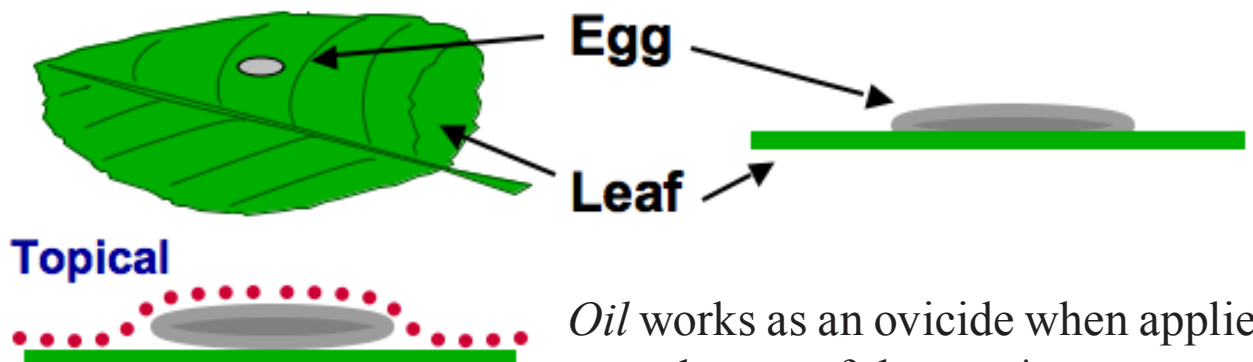
Ovicides ~ How do they work?



Codling moth eggs are laid on the upper surfaces of leaves near fruiting clusters and on fruit.

There are two ways to affect eggs prior to hatch:

1. Apply the product **before eggs are laid** (*residually*) OR
2. Apply the product **over the top of the egg** (*topically*)



Topical

Oil works as an ovicide when applied over the top of the egg.*

Residue



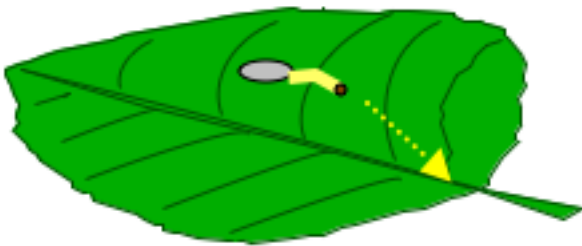
Esteem, Intrepid, Rimon, and Altacor work as ovicides when the egg is laid on top of a residue.

*Assail and Calypso are used as larvicides, but also act as topical ovicides. The ovicidal activity improves the overall level of control that is achieved.



Larvicides ~ How do they work?

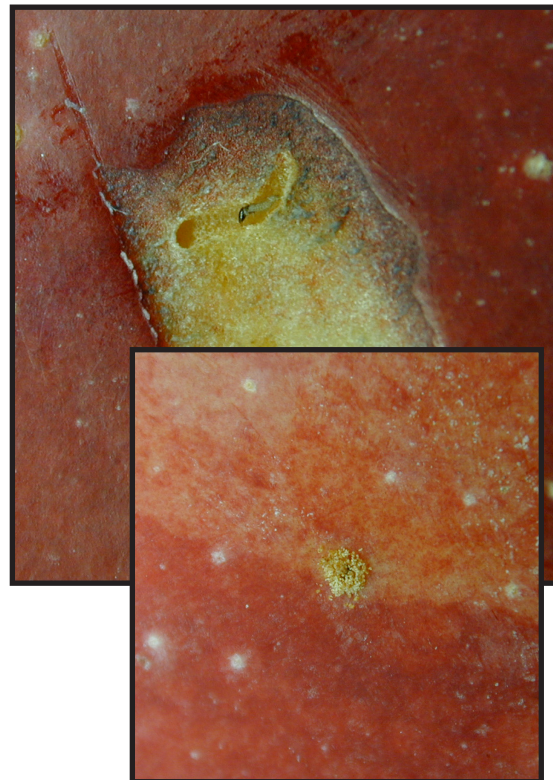
Newly hatched larva enters fruit within 2-3 hours.



Traditional larvicides kill larvae as they crawl across residues or when they eat residues as they bore into the apple. (*Guthion, Imidan*)



Most new insecticides that act against larvae must be consumed to be effective. (*Assail, Calypso, Intrepid, Virus, Altacor, Delegate*)



Coverage is very important with new insecticides



Changes to Codling Moth Degree Day Model

What is biofix and how does DAS implement it?

Biofix is an easy to observe event (example: first moth capture) that was previously used to synchronize the model and field populations. None of the current models on DAS require a biofix within the state of Washington. We make no guarantees outside Washington State for any of the models.

The codling moth model is the model most people think of when they think of biofix. We had 32 orchard years worth of data taken at the WSU research centers in Wenatchee and Columbia View and compared this to 81 orchard-years worth of data from consultants from throughout the state. We found that if we compensated for the roughly weekly trap checking intervals used by consultants, that biofix occurred on average at 175 DD (°F) from 1 January for both data sets. We then compared model predictions to observed adult flight and egg hatch and found that there were no benefits in terms of accuracy using a biofix. Our codling moth model therefore automatically sets a biofix at 175 DD from 1 January. In the past, we would reset the model DD to 0, then accumulate the heat units from that point. However, this is counter-intuitive and confusing; for example 160 DD will occur twice during the same season and likely within 40 days of each other. Instead of using the old convention of resetting the biofix, we are now simply accumulating degree-days since 1 January. However, for people used to the old system, we will also report in parenthesis, the older number. For example, the start of egg hatch is at 425 DD from 1 January (250 DD old model).

The codling moth model used in Washington is probably fine in areas more northerly than Washington State, but definitely should not be used in more southern areas. We are collecting biofix timing information throughout North America and preliminary results show that the timing of first moth is related to temperature and solar radiation, but above 46°N latitude it levels off at roughly 175 DD. After further work, we will build the corrections into DAS to account for first moth in areas outside the state.

What are degree-days and why are they used in the models?

Degree-days (DD) are used in models because they allow a simple way of predicting development of cold-blooded organisms (insects, mites, bacteria, fungi, plants). The idea is that the development of cold-blooded organisms depends on the temperatures that they experience in the environment, because they cannot regulate their temperature to any significant degree. It has been shown that the biochemical processes involved in development through a particular stage (such as the egg or larval stages) require a given amount of time and that the amount

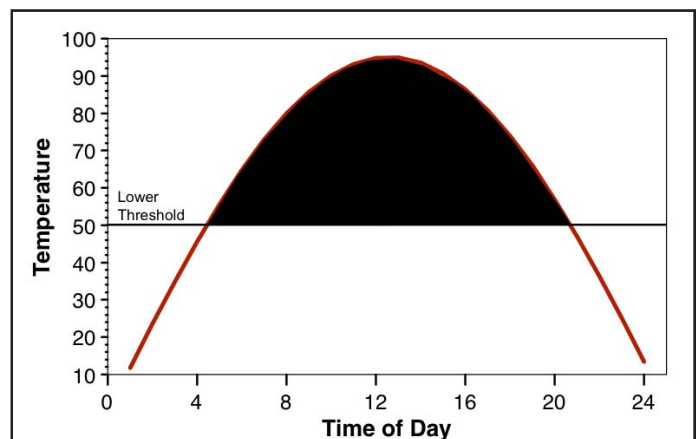


Fig. 1. The amount of heat accumulated (black area) using a lower threshold of 50°F and no upper threshold using a single sine approximation from daily maximum and minimum temperatures.

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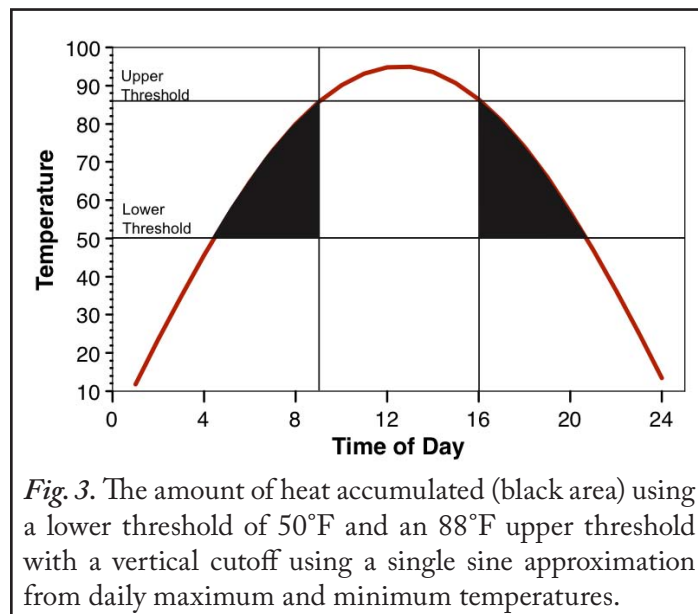
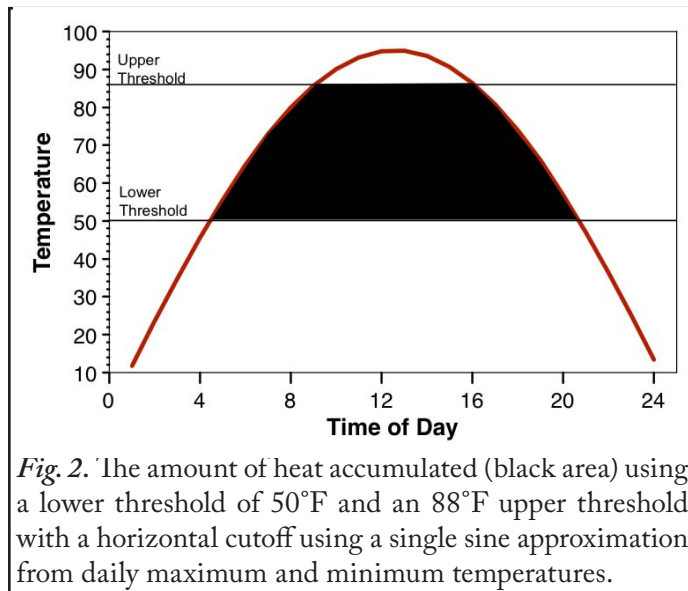
Targets and Treatments – Degree Day Models



of time varies depending on the temperature the organism experiences. Work in the early 1920's showed that there was a temperature below which development did not occur (= lower threshold for development) and above a certain temperature development rapidly slowed (= upper threshold for development). In between the lower and the upper thresholds, the developmental rate was a straight-line function of the temperature. This meant that development could be predicted by knowing how long the organism was held at any temperature between the thresholds. Another way of saying this is that the amount of heat units required to complete development was constant – a finding that is the basis for the models used on DAS.

Formally, the heat units are termed degree-days (DD) and by definition a DD is the amount of heat that accumulates when the temperature is 1° above the lower threshold for development for a period of 24 hours. Each organism has a different lower threshold for development, which makes comparisons sometimes more difficult. For the insects on the DAS system, each of them have a slightly different upper and lower thresholds for development.

For most of the models on DAS, we use a single sine wave fit to the daily maximum and minimum temperatures to determine the DD accumulations. There are three ways commonly used to modify the sine wave. The simplest form uses no upper threshold for development and this is used for western cherry fruit fly and apple maggot. In this case the heat units are calculated by the computer as simply the entire area under the temperature curve (Fig. 1). For a codling moth, peach twig borer, and *Lacanobia* fruit worm, we use a horizontal cutoff, which eliminates the heat accumulations that occur above the threshold (Fig. 2). In effect, this approximation suggests that the development rate is constant above the upper threshold. While this doesn't seem logical given the discussion above, it works in practice pretty well. The other type of cutoff is a vertical cutoff, where no heat units are accumulated once the temperature goes above the threshold (Fig. 3). This type of cutoff is used for *Pandemis* leafroller, *Obliquebanded* leafroller, *Campyloomma* bug, and San Jose Scale.



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Targets and Treatments



Delayed Dormant

- * **San Jose Scale (SJS)** and **Mite eggs** are controlled by horticultural mineral oil applied at delayed dormant.
- * In the past, Lorsban has been used to control **Leafroller (LR)** at delayed dormant, but there are now many good options to use for leafroller control at petal fall.
- * **Woolly apple aphid (WAA)** is a pest of increasing importance in OP transition scenarios. Lorsban, applied pre-bloom, can suppress WAA colonies. Diazinon has also been used to manage WAA when populations exceed tolerances. New insecticides for control of WAA are lacking, but there may be options in the future.

SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)
Oil Lorsban						

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Targets and Treatments



Petal Fall Control - Leafroller Larvae and Codling Moth Eggs

- * Proclaim and Success (Delegate) provide fast acting control of leafroller, and are good control options if leafroller populations are high enough to justify concern about damage from feeding larvae, but they do not provide control of codling moth eggs.
- * Belt and Bt are slower acting but effective against leafroller. Neither provide control of codling moth eggs.
- * Altacor, Intrepid, Rimon, and Esteem are slow acting but effective against leafroller and add value because they provide control of codling moth eggs that are laid on top of residues.

SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)
Oil Lorsban	Proclaim Success Delegate Belt Bt Altacor Intrepid Rimon Esteem					

Apple Pest Management Transition Project

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Targets and Treatments



First Generation Codling Moth Larvae

- * If Proclaim, Success (Delegate), Belt, or Bt are used for leafroller control at petal fall and no other ovicides are used, control of codling moth larvae will need to be initiated at 425DD (250 DD).
- * Additional larvicide applications will need to be applied based on the length of expected residual control of the product used.
- * Under high pressure, codling moth larvicide programs that begin at 425DD (250 DD) may require three applications to control the first generation.

SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)	
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)	
Oil Lorsban	<div style="border: 2px solid red; border-radius: 50%; padding: 10px; display: inline-block;"> Proclaim Success Delegate Belt Bt </div>	→	Delegate (Entrust) Altacor Assail Calypso Intrepid virus	→	Delegate (Entrust) Altacor Assail Calypso Intrepid virus	→	Delegate (Entrust) Altacor Assail Calypso Intrepid virus
	Altacor Intrepid Rimon Esteem						



Using Oil as an Ovicide to Delay First Larvicide Applications

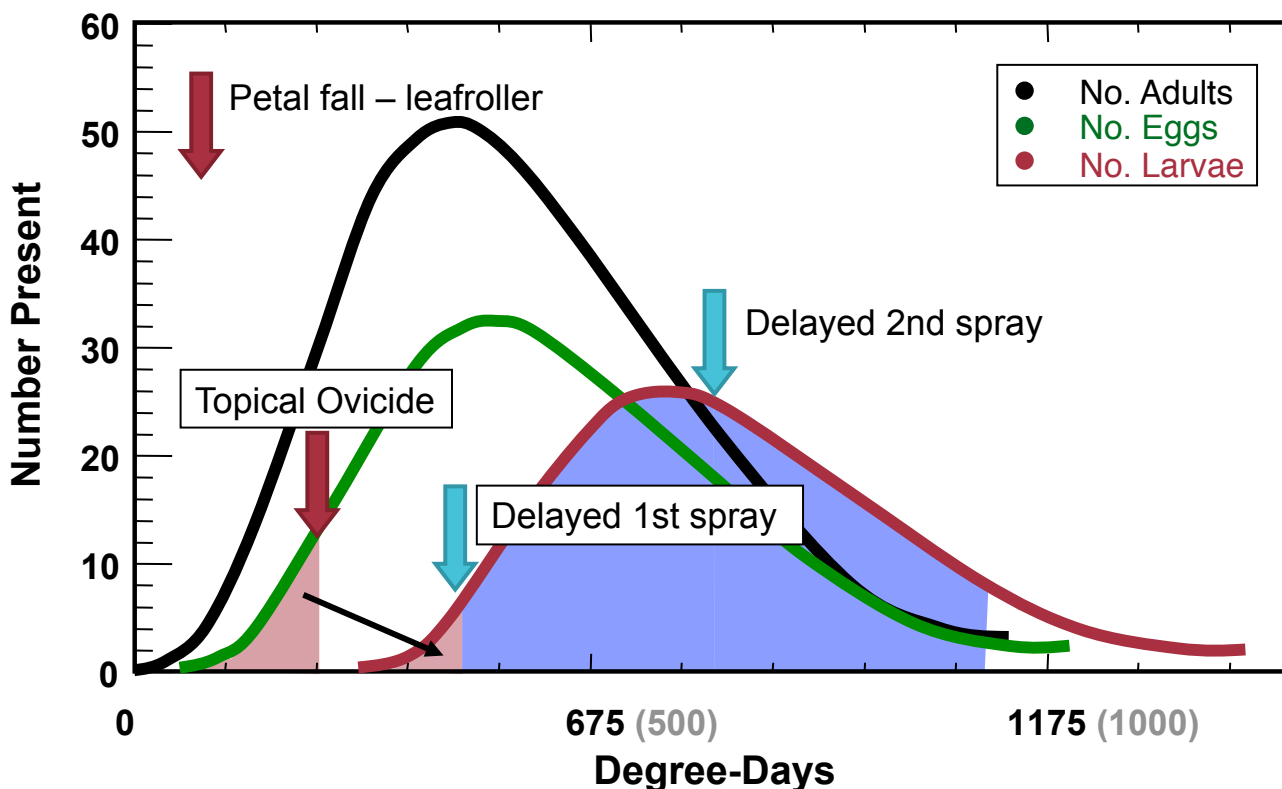
- * If Proclaim, Success (Delegate), Belt, or Bt are used for leafroller control at petal fall, it is still possible to control codling moth eggs before egg-hatch begins by applying horticultural mineral oil at 375DD (200 DD) at a rate of at least 1% v:v.
- * Oil is a topical ovicide (kills eggs that are covered by the application) and its use at 375DD (200 DD) allows a delay of the first larvicide application until 525DD (350DD).
- * Additional larvicide applications will need to be applied based on the length of expected residual control of the product used.

SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)
Oil Lorsban	Proclaim Success Delegate Belt Bt Altacor Intrepid Rimon Esteem	Oil		Delegate (Entrust) Altacor Assail Calypso Intrepid virus		Delegate (Entrust) Altacor Assail Calypso Intrepid virus



Using Oil as an Ovicide to Delay First Larvicide Applications

- * Oil, applied at 375DD (200 DD), kills eggs that have already been laid in the orchard.
- * Larvae that would have emerged beginning at 425DD (250 DD) do not, because they were killed in the egg stage.
- * Delaying the first larvicide application places the most active insecticide residues in the period of peak egg-hatch activity.
- * Additional larvicide applications will need to be applied based on the length of expected residual control of the product used.





Using a Codling Moth Ovicide at Petal Fall

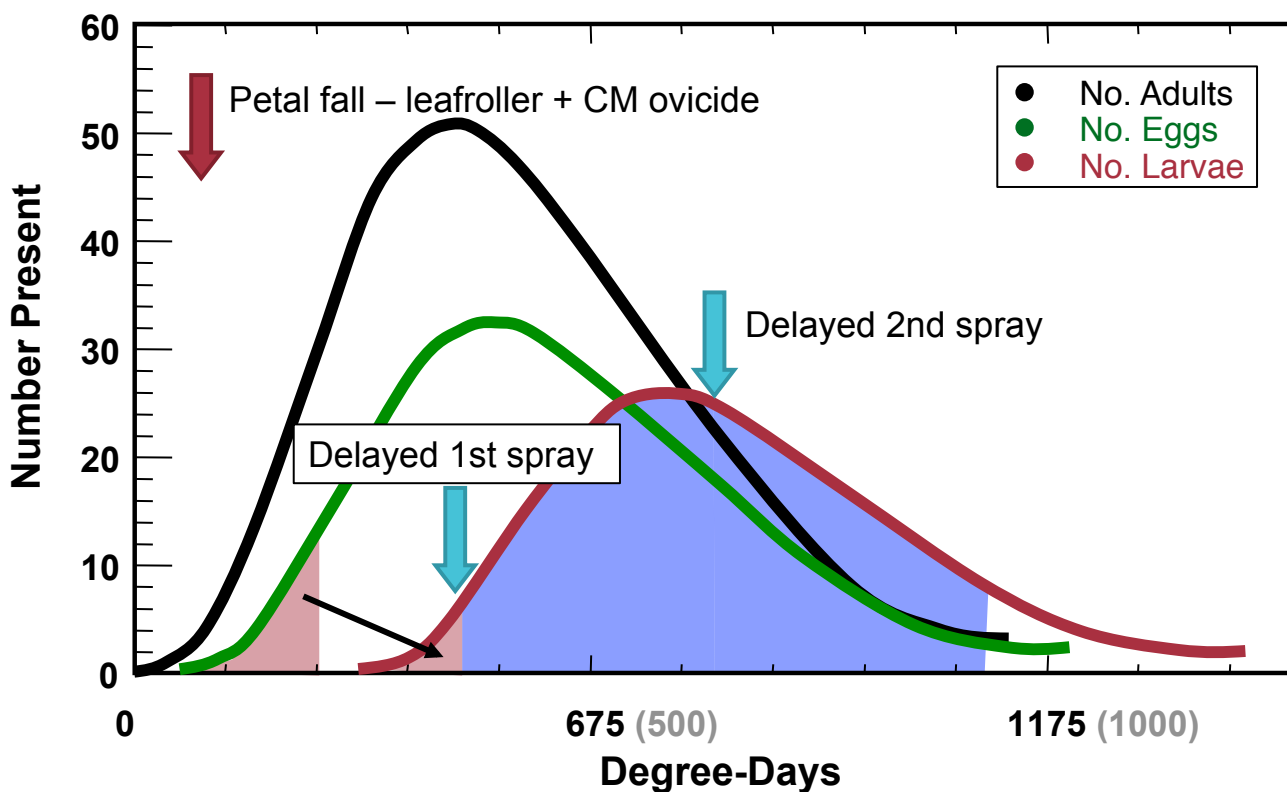
- * If Altacor, Intrepid, Rimon, or Esteem are used at petal fall, codling moth eggs will also be controlled.
- * These products act as residual ovicides, that is - they kill eggs that are laid on top of the residues from an application.
- * If Altacor, Intrepid, Rimon, or Esteem are used at petal fall, the first larvicide application can be delayed until 525DD (350DD).
- * Additional larvicide applications will need to be applied based on the length of expected residual control of the product used.

SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)
Oil Lorsban	Proclaim Success Delegate Belt Bt Altacor Intrepid Rimon Esteem			Delegate (Entrust) Altacor Assail Calypso Intrepid virus	→	Delegate (Entrust) Altacor Assail Calypso Intrepid virus



Using a Codling Moth Ovicide at Petal Fall

- * Altacor, Intrepid, Rimon, or Esteem kill codling moth eggs that are laid on top of their residues.
- * The larvae that would have emerged beginning at 425DD (250 DD) do not, because they were killed in the egg stage.
- * Delaying the first larvicide application places the most active insecticide residues in the period of peak egg-hatch activity.
- * Additional larvicide applications will need to be applied based on the length of expected residual control of the product used.



Apple Pest Management Transition Project

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Targets and Treatments



Tank-Mix Ovicide + Larvicide at 525 DD (350 DD)

- * A tank-mix combining an ovicide + larvicide can provide very robust codling moth control.
- * The ovicide (Intrepid, Rimon, or Esteem) kills a portion of the eggs already in the orchard as well as eggs that are laid after the application.
- * The larvicide (Delegate, Altacor, Assail, Calypso, or virus) kills larvae as they hatch and begin feeding.
- * Eggs that would have hatched at the end of the generation do not because they were killed by the ovicide in the tank-mix.

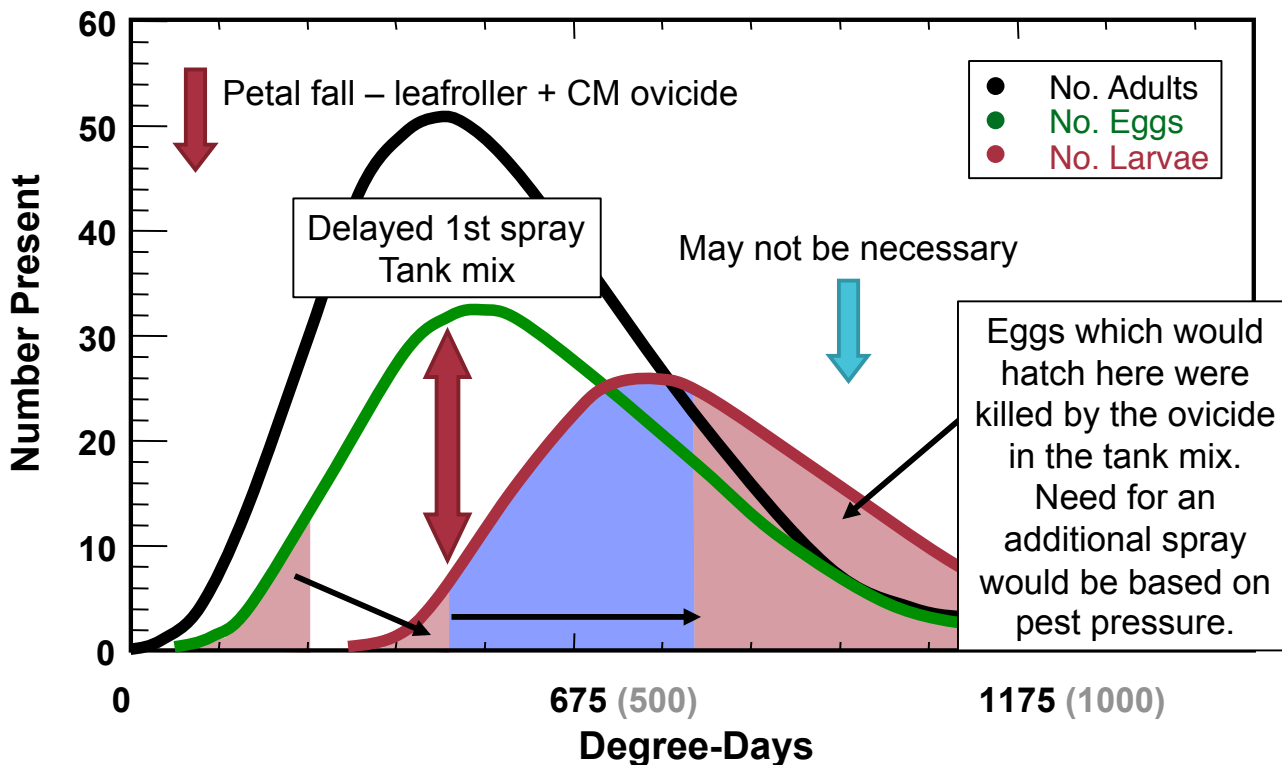
SJS, LR mite (egg)	LR (larva) LR&CM (egg)	CM (egg)	CM (larva)	CM (larva)	CM (larva)	CM (larva)
Delayed dormant	Petal fall 225-275DD (50-100DD)	375DD (200DD)	1 st cover 425DD (250DD)	Delayed 1 st cover 525DD (350DD)	2 nd Cover 625-675DD (450-500DD)	3 rd Cover 875-925DD (700-750DD)
Oil Lorsban	Proclaim Success Delegate Belt Bt Altacor Intrepid Rimon Esteem		larvicide +	Delegate (Entrust) Altacor Assail Calypso Intrepid virus +		May not need 2 nd Cover
			+	Altacor Intrepid Rimon Esteem		

Tank mix strategy



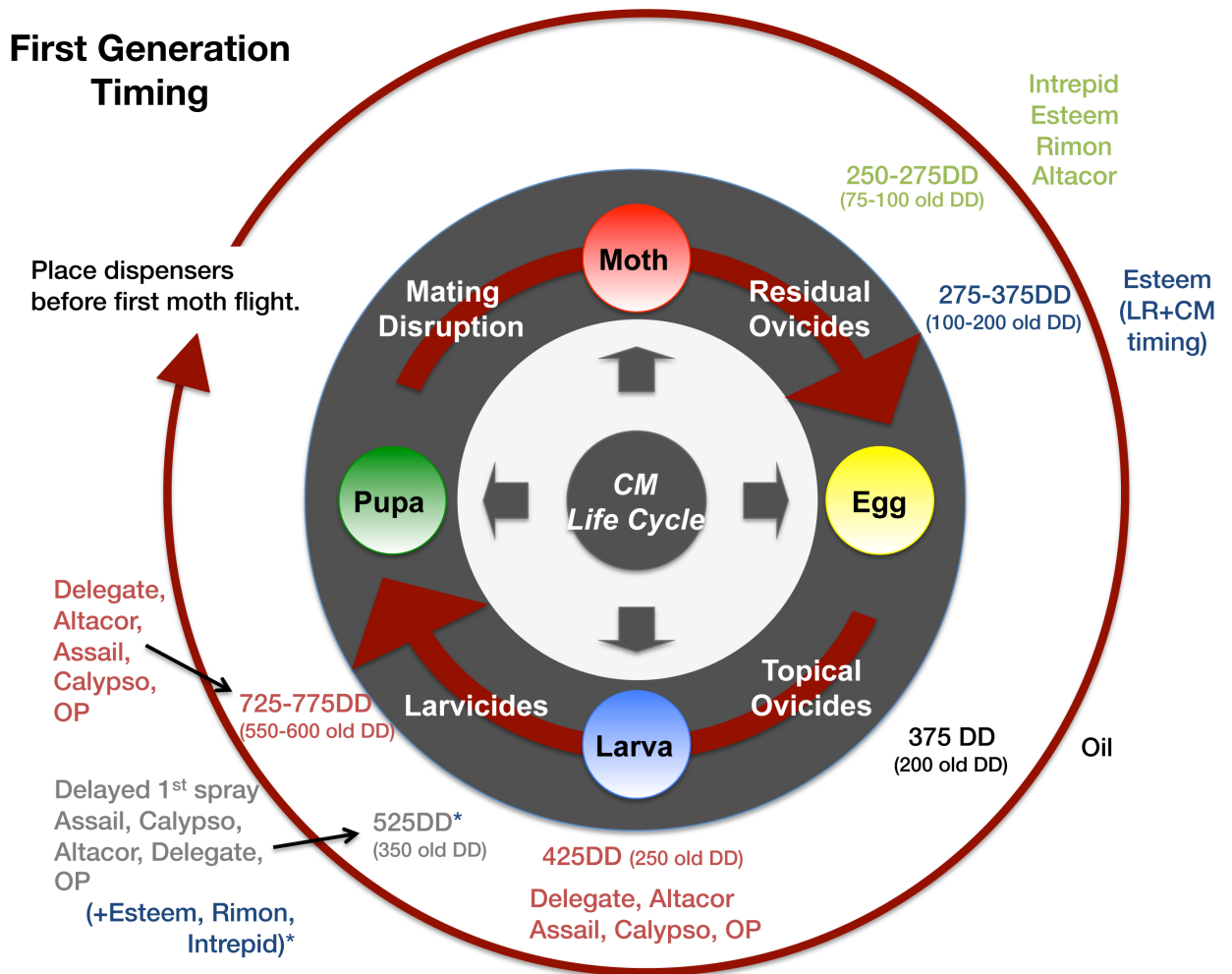
Tank-Mix Ovicide + Larvicide at 525 DD (350 DD)

- * This approach begins with a residual ovicide at petal fall (Intrepid, Esteem, Rimon, or Altacor) **OR** a topical ovicide at 375DD (200 DD) (Oil), which allows delaying the tank-mix to 525DD (350DD).
- * The ovicide (Intrepid, Rimon, or Esteem) kills a portion of the eggs already in the orchard as well as eggs that are laid after the application.
- * The larvicide (Delegate, Altacor, Assail, Calypso, or virus) kills larvae as they hatch and begin feeding.
- * Eggs that would have hatched at the end of the generation do not because they were killed by the ovicide in the tank-mix.
- * Monitor to determine the need for additional applications.





First Generation Codling Moth Timing



* Ovicides to be used in tank mixes with larvicides only. Do not substitute these products directly for a larvicide as fruit protection will be sacrificed.

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Codling Moth Granulosis Virus (CM-Gv)



Toxicity of codling moth granulosis virus:

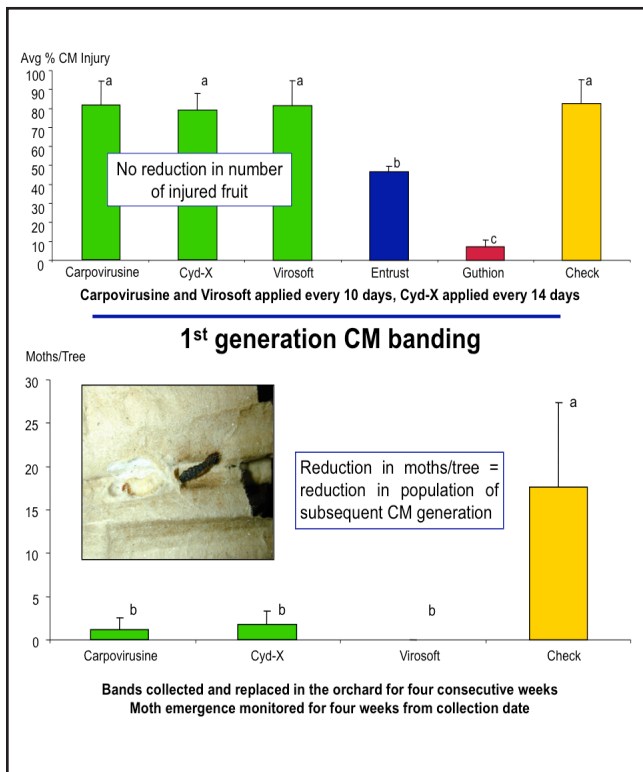
Codling moth granulosis virus (CM-Gv) was originally discovered in dead CM larvae collected in Mexico. Since then, CM-Gv has been found around the world. After CM-Gv is ingested by the larva, the granules dissolve. CM-Gv infects the gut and replicates before moving to the fat body. Infected larvae cease activity, change color, and eventually dissolve. CM-Gv is highly toxic even in very small amounts; however, unique insecticidal properties have made it challenging for commercial apple growers to develop the best use patterns for CM-Gv.



Delayed mortality –

Measuring impact on subsequent generations:

Under normal field conditions, CM generally consume only a small amount of CM-Gv. At this dose, it can take 14-21 days before CM-Gv replicates to a lethal level. The result is that there is often little or no reduction in fruit injury during the first generation of CM-Gv use. To determine the impact on the current larval generation, growers may need to dissect larvae from infested apples.



In research trials at the WSU-TFREC, cardboard bands were placed at the base of trees to recapture larvae that had exited apples. Bands were collected every two weeks and held for two more weeks to assess larval survival and the emergence of 2nd generation adults. The number of larvae that were recaptured was reduced in the 1st generation, but not in the 2nd. Pheromone traps are essential to monitoring adult emergence during the 2nd generation to measure the impact of 1st generation CM-Gv treatments.

Virus in Organic Orchards – attack CM at as many points in the life cycle as possible:

- Mating disruption to reduce eggs.
- Repeated oil applications to kill eggs.
- Repeated virus applications to kill larvae.
- Target “hotspots” with Entrust.

Apple Pest Management Transition Project

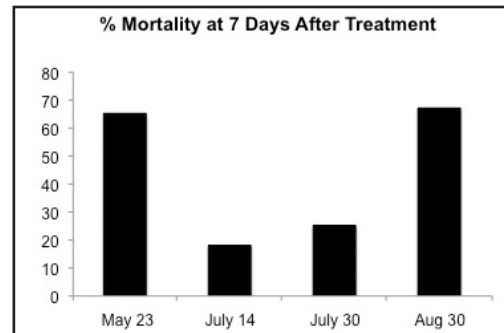
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Codling Moth Granulosis Virus (CM-Gv)



Residual control of virus:

The most important factor limiting the widespread adoption of CM-Gv by conventional growers may be short residual control. This chart shows mortality of larvae exposed to apples 7 days after treatment. Note the decline during July. Europe relies heavily on CM-Gv, but climactic conditions are very different than central Washington. First generation sprays appear to be reliable, but the intensity of UV degradation during summer can lead to variable results.



Using virus in organic orchards:

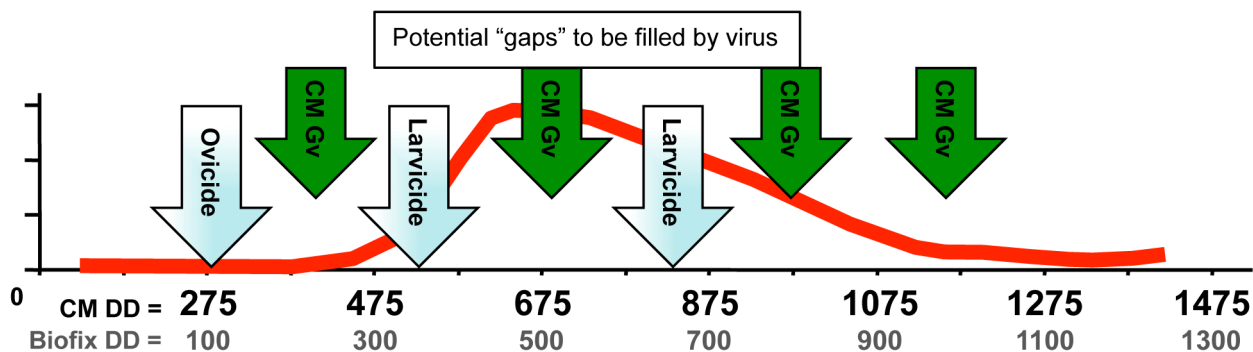
The majority of organic orchards in Washington rely on CM-Gv to control CM larvae. However, CM-Gv alone is not sufficient to maintain low pest populations. Mating disruption, combined with repeated oil applications, is required to reduce egg hatch. Entrust is a highly effective CM larvicide, but judicious use is important. Entrust is used for control of thrips, leafroller, and CM. Overuse of Entrust will lead to insecticide resistance. Entrust should be used to suppress the CM population, then limited to spot treatments in high pressure areas. Growers will likely need to reapply CM-Gv every 7-10 days in moderate pressure orchards through the entire season to achieve acceptable crop protection.

Potential uses in conventional orchards:

Finding the best use for CM-Gv in conventional orchards has been a challenge. One strategy is to use CM-Gv as a “gap” spray. The time period between a 275DD (100 DD) ovicide and a 525DD (350 DD) larvicide application may be uncomfortably long for some growers. CM-Gv can be effective when applied between those sprays [425DD (250 DD)]. Likewise, applying CM-Gv between larvicide applications [775DD (550 DD)] may allow growers to extend retreatment intervals. Continuous flights in high pressure areas often obscures the traditional break between 1st and 2nd generations. CM-Gv may be a good fit in that extended time period where the potential for damage is low but larvae may still be hatching and feeding.

Virus in Conventional Orchards:

- Short residual control decreases efficacy during summer generations.
- Treat the “gap” between insecticide applications.
- Treat the “gap” between CM generations.



Section 4

Resistance Management

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Insecticide Resistance Management



Resistance Management

Washington growers now have a number of new products available for codling moth and leafroller control. The key to conserving the efficacy of these new products will be to avoid their overuse. The use of codling moth mating disruption has been, and will continue to be, a very important means of reducing the needs for insecticide input and is, therefore, a valuable tool in a resistance management program.

In most orchards using codling moth mating disruption, insecticides will be necessary to supplement control. In choosing these supplemental controls, it is important for growers to conscientiously avoid using insecticides with the same mode of action against successive generations of a pest.

It can become a challenge to keep track of which insecticide class has already been used in the growing season and should, therefore, be avoided later in the growing season.

One method that may help keep track of insecticide use is to adopt a resistance management checklist such as the one that follows. Here, the growing season is divided into two parts, based on the development cycles of codling moth and leafrollers.

If a product is used in the first part of the season, it is marked “X.” It is possible to use a product from the same class, or even the same product, more than one time in the first part of the season, because only one generation of a pest is exposed to the chemical class.

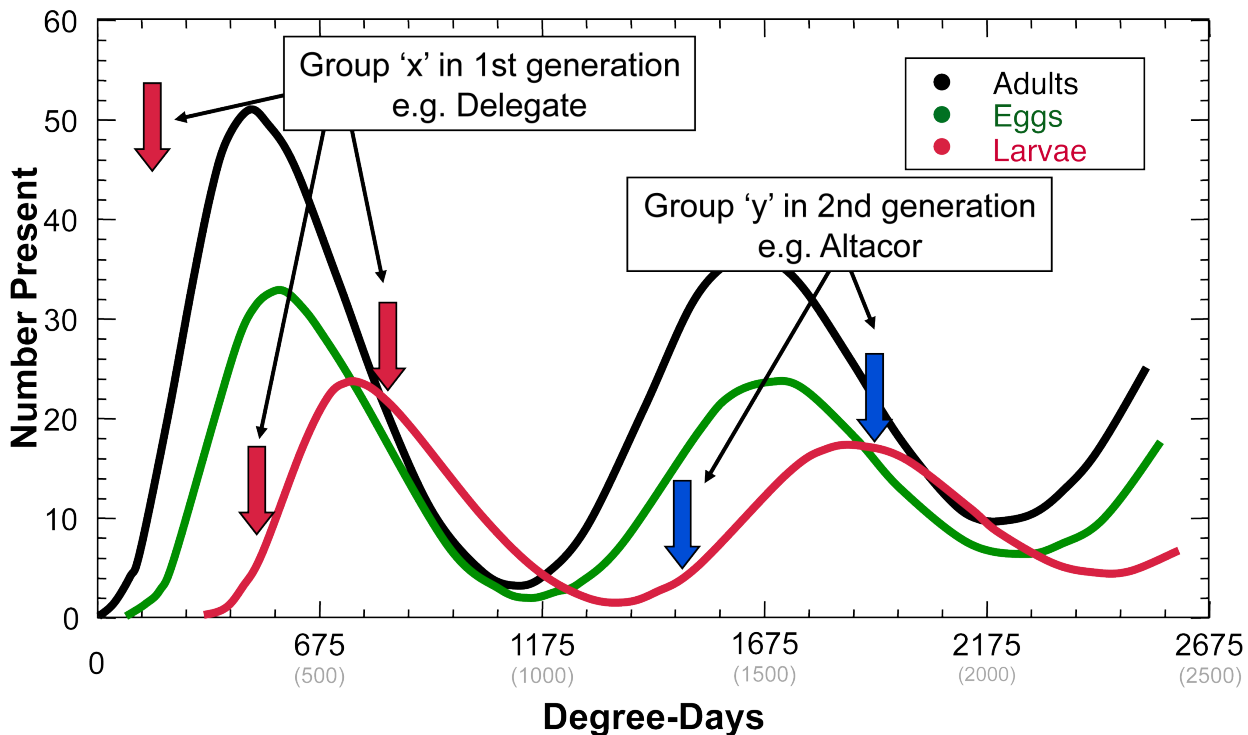
The early-season choices limit what products can be used in the second part of the season if a sound resistance management program is being followed.

Planning is an important part of resistance management program. Advanced planning will lead to better management decisions in pest control and help to ensure that Washington growers will retain the use of new pest control products in their pest management programs.



Resistance Management Strategies

- * Avoid using the same class of insecticide against successive generations.
- * Use the group number developed by the Insecticide Resistance Action Committee (IRAC) to identify the class of insecticide to which each product belongs.
- * Using the same class of insecticide multiple times against one generation is acceptable. Choose a different class of insecticide to target the next generation to avoid developing resistant populations.



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Insecticide Resistance Management



Most labels will show the ***insecticide group number***.


This number identifies the class of insecticide. Avoid using the same class of insecticide against successive generations. Planning is an important part of implementing a sound ***resistance management strategy***.

Calypso is a ***group 4A*** insecticide.

Delegate is a ***group 5*** insecticide.

These products could be used against successive generations as part of a sound resistance management strategy.

GROUP	4A	INSECTICIDE
-------	----	-------------



Calypso[®] 4 Flowable Insecticide

FOR CONTROL OF CERTAIN INSECTS INFESTING VARIOUS CROPS
SHAKE WELL BEFORE USING

ACTIVE INGREDIENT: Thiacloprid
[3-[(6-chloro-3-pyridinyl)methyl]-2-thiazolidinylidene]cyanamide 40.4%

INERT INGREDIENTS: 59.6%

Contains 4 pounds of thiacloprid per gallon.

EPA Reg. No. 264-806 EPA Est. No. 264-MO-002

KEEP OUT OF REACH OF CHILDREN

For M



IF SWALLOWED:

IF ON SKIN OR CLOTHING:

IF INHALED:

IF IN EYES:

Specimen Label

Insecticide

™Trademark of Dow AgroSciences LLC

For control or suppression of lepidopterous larvae (worms, caterpillars), dipterous leafminers, thrips, and certain psyllids in banana and plantain, bushberries, caneberries, citrus, cranberry, fig, grape, pome fruits, stone fruits, tobacco, and tropical fruits.

Group	5	INSECTICIDE
-------	---	-------------

Active ingredient: 7,15-dione, 2-[(6-deoxy-3-O-ethyl-2,4-di-O-methyl-α-L-mannopyranosyl)oxy]-13-[[[2R,5S,8R]-5-(dimethylamino) tetrahydro-6-methyl-2H-pyran-2-yl]oxy]-9-ethyl-2,3,3a,4,5,5a,5b,6,9,10,11,12,13,14,16a,16b-hexadecahydro-14-methyl-, (2R,3aR,5aR,5bS,9S,13S,14R,16aS,16bR) and 11H-aa-indolizino[3,2-d]pyrazolo[4,3-b]pyridine, 2-[(6-deoxy-3-O-ethyl-2,4-di-O-methyl-α-L-mannopyranosyl)oxy]-13-[[[2R,5S,8R]-5-(dimethylamino) tetrahydro-6-methyl-2H-pyran-2-yl]oxy]-9-ethyl-2,3,3a,5a,5b,6,9,10,11,12,13,14,16a,16b-tetradecahydro-4,14-dimethyl-, (2S,3aR,5aS,5bS,9S,13S,14R,16aS,16bS) 25.0%

Other ingredients 75.0%

Total 100.0%

Contains 25% active ingredient on a weight basis (250 g ai/kg)

EPA Reg. No. 62719-541

Keep Out of Reach of Children
CAUTION

Precautionary Statements
Hazards to Humans and Domestic Animals

Causes Moderate Eye Irritation

Avoid contact with eyes or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco.

Personal Protective Equipment (PPE)
Applicators and other handlers must wear:
• Long-sleeved shirt and long pants
• Shoes plus socks

Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

User Safety Recommendations
Users should:
• Wash hands before eating, drinking, chewing gum, using tobacco or using the toilet.

First Aid
If in eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-992-5994 for emergency medical treatment information.

Environmental Hazards
This product is toxic to aquatic invertebrates. Do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when cleaning equipment or disposing of equipment washwaters. Do not apply where runoff is likely to occur. Do not apply when weather conditions favor drift from treated areas. Drift and runoff from treated areas may be hazardous to aquatic organisms in neighboring areas. Apply this product only as specified on the label.

This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.

Notice: Read the entire label. Use only according to label directions. Before using this product, read Warranty Disclaimer, Inherent Risks of Use, and Limitation of Remedies elsewhere on this label. If terms are unacceptable, return at once unopened.

In case of emergency endangering health or the environment involving this product, call 1-800-992-5994. If you wish to obtain additional product information, visit our web site at www.dowagro.com.

Directions for Use
It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
Read all Directions for Use carefully before applying.

Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your state or tribe, consult the state or tribal agency responsible for pesticide regulation.

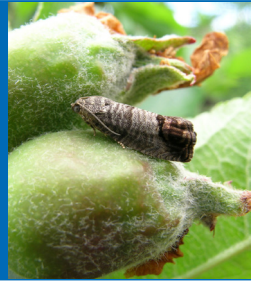
Section 5

Monitoring

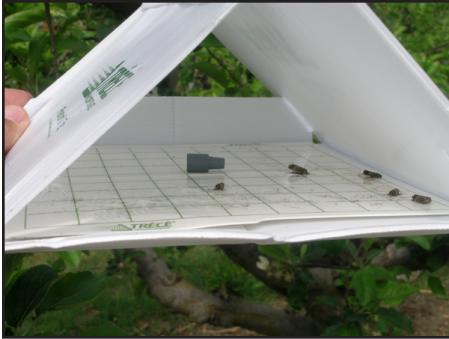
Apple Pest Management Transition Project

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Monitoring Codling Moth

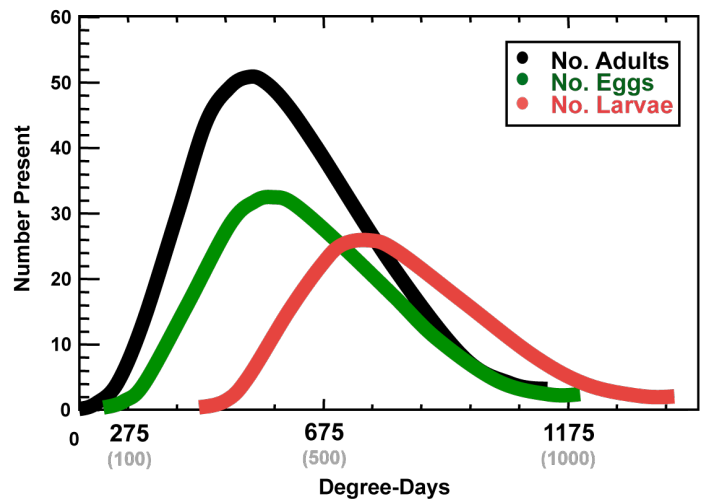


Monitoring ~ Spray Decisions



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).

Apple Pest Management Transition Project

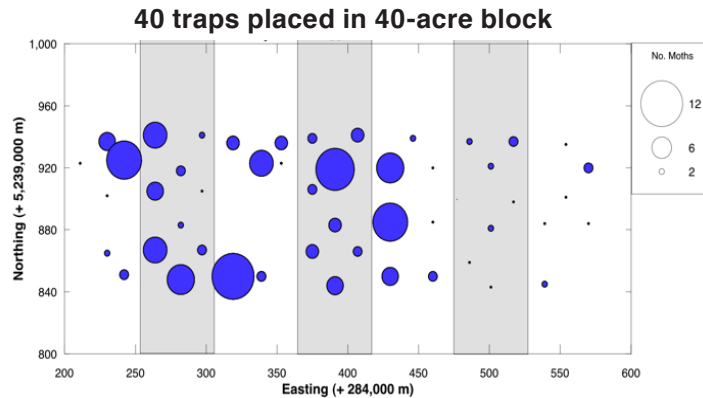
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Monitoring Codling Moth



Monitoring ~ Placing Traps & Lures

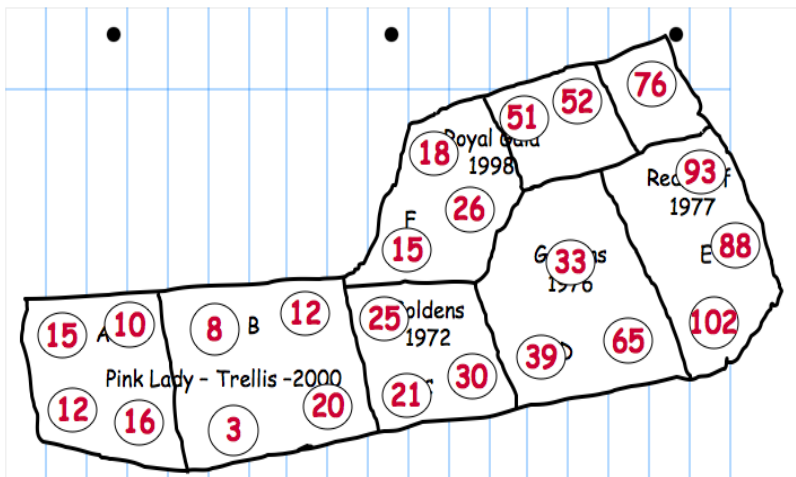
We recommend traps be placed at 1 trap/2.5 acres. Enough traps must be used to accurately measure the population density and distribution. A very intensively trapped orchard (right) shows a clustered population. Note the variation of captures between traps that are in close proximity to each other. If 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.



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.





Apple Pest Management Transition Project

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Monitoring Codling Moth



Figure 1

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

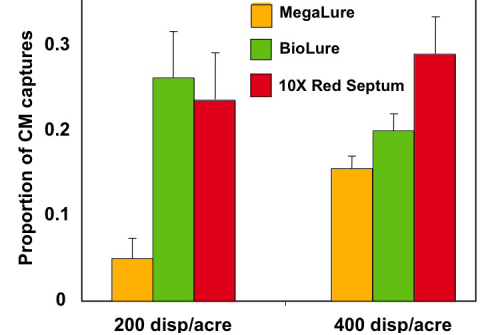
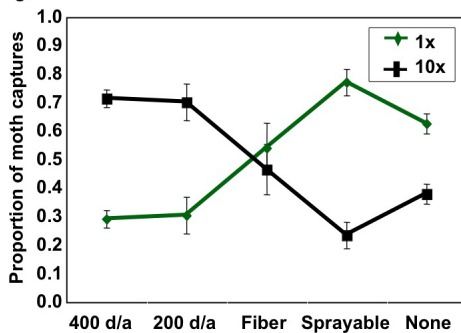


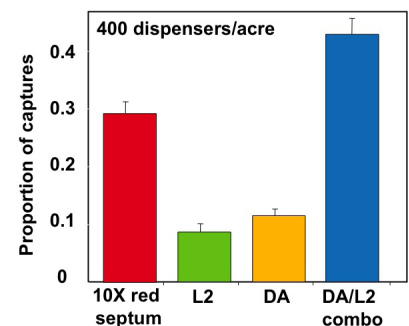
Figure 3



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 (Trécè), 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



Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Monitoring Codling Moth



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’.

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.

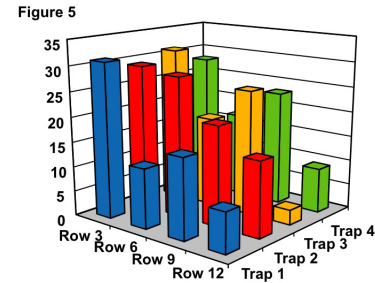
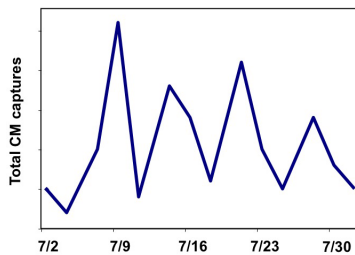


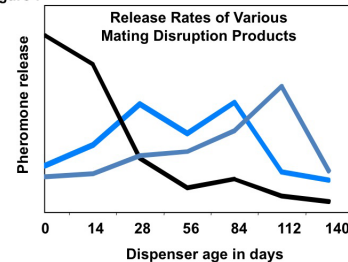
Figure 6



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.

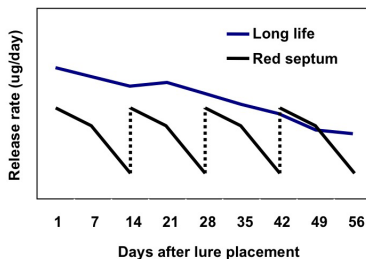
Mating disruption products have their own release profile that changes through the season (Fig. 7). Variable pheromone release from mating disruption dispensers has an obvious impact on the attractiveness of lures operating in that environment. Lures also have specific release characteristics that are 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.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

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 as 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.



Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

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

Section 6

Secondary Pests

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Secondary Pests



While the Pest Management Transition Project is focusing on the challenges of moving the apple industry from use of organophosphate (OP) insecticides for key pests, codling moth and leafrollers, to registered alternatives, the whole orchard pest management system must be considered. Most of these pests would be classified as secondary, because control of these pests does not shape our IPM programs; indeed, many indirect pest problems are induced by the control measures for direct pests. Transitioning to OP alternatives can increase concerns with some secondary pests but could reduce concerns with others.

Woolly Apple Aphid

One pest that stands out as increasing in importance in the OP transition scenarios is the woolly apple aphid (WAA). Research has shown that pre-bloom applications of Lorsban (chlorpyrifos) suppress WAA colonies and delay the build up of colonies on the tree. Diazinon, an OP insecticide, has been used for years to manage WAA when populations exceed tolerances. Diazinon and Thiodan labels carry increasing levels of restrictions, but these materials can still be used to control WAA. There is a suggestion that certain OP alternative insecticides are interfering with biological control of WAA leading to more frequent and larger outbreaks of this pest than in the past. New insecticides for control of woolly apple aphid are lacking, but there may be options in the future.



Woolly Apple Aphid Colony - E. Beers



European red mite - E. Beers

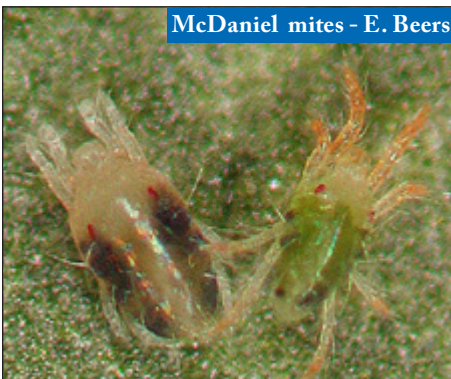
Spider Mites

Spider mites (European red mite - image left, twospotted spider mite - image at right, McDaniel mite - image below left) have historically been controlled in apple orchards by the western predatory mite. This predator



Twospotted spider mite- E. Beers

became highly resistant to OP insecticides over 30 years ago, and functioned well when apple pest control depended primarily on



McDaniel mites - E. Beers

OP insecticides. Some of the OP alternative insecticides, Assail, Calypso, and possibly

Rimon, have disrupted biological control of spider mites and growers have experienced mite populations that require applications of specific miticides. Understanding what products contribute to the disruption of integrated mite control will help reduce pest management costs by re-establishing biological control of spider mites, thus eliminating the use of specific miticides.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Secondary Pests



Western Flower Thrips

Thrips migrate into orchards in the spring and cause injury to certain apple varieties when they lay an egg in a developing fruitlet. This injury is still visible at harvest on light-colored fruit and can cause a downgrading of fruit. OPs have not been an option for thrips control in the past because of the near-bloom timing. Precise timing of thrips materials is essential for good control.



Thrips damage - E. Beers

Stink Bugs

There are several species of insects that are referred to generally as “stink bugs”. They get their name because of glandular secretions they emit when disturbed, like when you pick one up. Problems with stink bugs over the last decade have been attributed primarily to the Conspense stink bug (image at right). Recently other stink bug species, like the green soldier bug (image below) have been implicated in crop losses. Stink bugs reproduce outside of the orchard but damage fruit in late summer and fall when

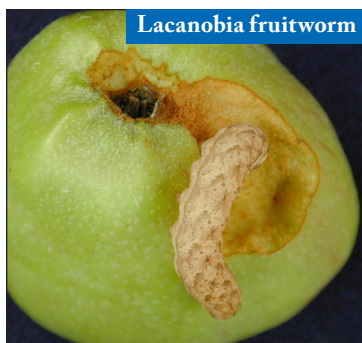


Conspense stink bug



Green soldier bug

as adults they migrate into orchards. There are no effective OP alternative insecticides to control these pests except pyrethroids (Danitol, Asana, Warrior). While we do not recommend use of these products in apple orchards because of negative effects on biological control, they are recommended for control of stink bugs when the crop is threatened from adults invaders in late summer or fall. Damage from stink bugs can be confused with bitter pit. Traps are available to help monitor stink bug presence near or in orchards.



Lacanobia fruitworm

Other Pests of Interest

**Leafhoppers, Leafminer,
Lacanobia fruitworm,
Green Aphids, Rosy Apple Aphid**

OPs have not been effective on many of these indirect pests for decades; if anything, the OP-alternative materials

(e.g., the neonicotinyls) are more effective, and may have contributed to a decline in pest status of these insects (leafhoppers, leafminers, green aphids). One exception is rosy apple aphid; although the neonicotinyls are effective, their timing for lepidopteran pests is generally too late for damage prevention.



Western tentiform leafminer

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Integrated Mite Management in Apples



Current status of mites in apples

Spider mites have historically been controlled in apple orchards by the western predatory mite. This predator became resistant to OP insecticides over 30 years ago and functioned well in Guthion-based codling moth programs. Uncontrollable outbreaks during the 1960's were stabilized by biological control. By the mid-1990s only 10% of the acres in Washington required insecticidal control of mites.

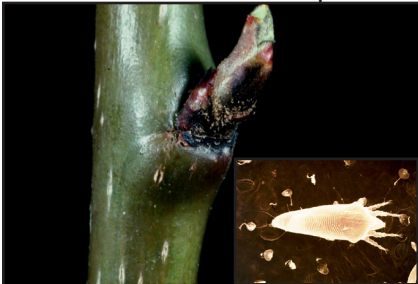
However, some of the OP alternative insecticides (Assail, Calypso, and Rimon) have disrupted biological control of mites. In 2005, 55% of Washington apples required a miticide. Understanding what products contribute to the disruption of integrated mite control will help reduce pest management costs by re-establishing biological control, thus eliminating the use of specific miticides.



Western predatory mite feeding on European red mite - E. Beers

The role of apple rust mites

Moderate densities of rust mites are considered beneficial on apples. Rust mites serve as an alternate food source for predatory mites, allowing them to survive in periods of low spider mite densities. Care should be taken to preserve rust mites during early season insecticide, fungicide, and thinning spray programs. Predator populations that thrive on rust mites early in the season can maintain spider mite densities below detectable levels during the summer months.



Environmental and cultural influences on mites

Rust mite populations tend to crash during periods of prolonged hot weather. Without this alternate food source, the number of predatory mites may also decline making trees more vulnerable to attack from spider mites. High spider mite populations have been associated with hot, dry summers. Spider mite population increases have also been associated with dusty foliage, especially next to dirt roads. Rainy, cool weather may reduce mite survival and thus suppress spider mite populations. Cold, dry winters can reduce the number of overwintering predatory mite adults.

It is possible to reduce two spotted spider mite populations with overtree irrigation either by modifying the climate, reducing dust on the leaves, or simply by washing mites from the tree. Red mites do not seem to be affected by irrigation practices.

Remember, mites are not a problem in unsprayed orchards. The mite problems seen in commercial orchards occur when they are liberated from biological control.

Reestablishing Predators in Disrupted Orchards:

“Seed” orchards to hasten recolonization by predators.

- Transfer growing shoots with rust mites and predatory mites to orchards with disrupted biological control.
- Place at least one shoot in each tree.

Purchase insecticide resistant predators from an insectary.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Integrated Mite Management in Apples

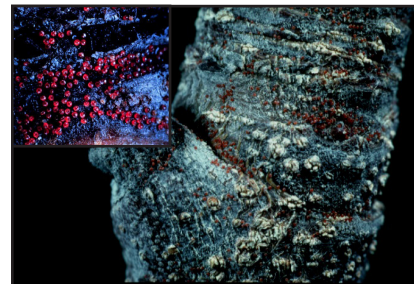


The effect of early season spray programs on mites

Apple growers have a long history of using lime-sulfur early in the season for disease management with little impact on mite management. However, the increased rates and frequency of applications used in thinning programs has been associated with negative impacts on predatory mites, and high mortality of rust mites. Ammonium thiosulfate and carbaryl are also toxic to predatory mites. Thinning sprays are one of the most important programs for determining profitability for apple growers. Therefore, pest management programs must be able to adapt to thinning programs, but growers should be aware of the potential negative impacts of some product choices.

Insecticide programs that impact mites

As growers move away from a reliance on OP insecticides, many are choosing not to use Lorsban at Delayed-Dormant. However, it is still very important to apply oil at the half-inch green stage to control red mite eggs. Eggs are most vulnerable just prior to hatch, thus a true dormant oil application is not as effective.



Carzol use against thrips has the negative side effect of being highly toxic to both predatory mites and rust mites. Assail, Calypso, and Rimon use against codling moth have been implicated in disruption of mite biological control. Summer kaolin sprays have been shown to be repellent to predatory mites. Pyrethroids have long been known to cause disruption to some of the most stable biological control programs.

The negative effects associated with thinning and insecticide programs can be additive, leading to an unstable mite situation. The probability of a mite outbreak increases with the number of disruptive applications.

Before deciding if a miticide application is warranted, consider these factors:

- * Mature, vigorous trees with moderate crop load can tolerate a considerable amount of mite feeding.
- * Mite damage is worse in orchards that are water stressed by hot, dry, windy weather, and soil with poor water retention.
- * Summer oils can be used to suppress moderate populations so that conventional miticides are not needed.

Choosing a miticide

One of the most important considerations when choosing a miticide is selectivity. Many miticides are more toxic to predators than the targeted spider mites. The use of selective miticides can assist the establishment of biological control. Further, miticides with low toxicity to rust mites will help to stabilize integrated mite control.

Important Spray Considerations:

- Use delayed-dormant oil against overwintering red mite eggs.
- Protect apple rust mites whenever possible.
- Avoid products that kill or disrupt predatory mites.

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Integrated Mite Management in Apples



Active Ingredient	Trade Name	IRAC	Class	MoA	Target	ERM	TSM	ARM	Typh
Miticides									
Horticultural mineral oil	Omni Supreme	none	Oil	Suffocation	Egg	3-4	2-3	2-3	M
Petroleum oil	Saf-T-Side					2-3	2-3	2-3	M
Abamectin	Agri-Mek	6	Avermectin	Chloride channel activator	Early Season	3	3	4	H
Clofentezine	Apollo	10	Non-specific	Mite growth inhibitor	Egg	2-4	---	1	L
Etoxazole	Zeal				Egg/Larvae	3-4	3-4	---	---
Hexythiazox	Savey				Egg/Larvae	2-4	---	1	L
Fenbutatin oxide	Vendex	12	Organotin	Inhibit ATP synthase	Motile	1-4	2-3	3-4	M
Fenpyroximate	FujiMite	21	METI Inhibitor		Motile	4	---	M	M
Pyridaben	Nexter					4	2-3	4	M
Spirodiclofen	Envidor	23	Tetronic acids	Inhibit lipid synthesis	All stages	3-4	3-4	---	---
Bifenazate	Acramite	25	Bifenazate	Neuronal inhibitor	Motile	3-4	4	---	L
Nutrition, Disease, Thinning, Horticulture									
Lime Sulfur	Rex	none	Calcium sulfur	Caustic	Thinning/Disease	---	---	H	M-H
Amonium thiosulfate	ATS	none	Thiosulfuric acid	Caustic	N + S	---	---	---	M-H
Carbaryl	Sevin	1	Carbamate	Ach-ase Inhibitor	Thinning	---	---	2	M-H
Kaolin	Surround	none	Particle film	Irritant	Sunburn	---	---	---	M-H
Limit use of these insecticides to preserve mite biological control									
Formetanate hydrochloride	Carzol	1	Carbamate	Ach-ase Inhibitor	WFT	3	2	3	M-H
Methomyl	Lannate				Leps	---	---	L	H
Oxamyl	Vydate				WTL	2	2-3	3	M-H
Endosulfan	Thionex	2	Organochlorine	GABA chloride antagonist	Various	2	---	M-H	L
Fenpropathrin	Danitol	3	Pyrethroid	Sodium channel modulator	Various (also CM)	---	---	---	H
L-cyhalothrin	Warrior					---	---	---	H
Acetamiprid	Assail	4	Neonicotinyl	Nicotinic receptor agonist	CM	Unknown mechanism of disruption			
Thiacloprid	Calypso								
Novaluron	Rimon	15	Benzoylurea	Inhibit chitin synthesis	CM / LR	Unknown mechanism of disruption			
Potassium salts/fatty acids	M-Pede	none	Fatty acids	Membrane disruption	WAL	---	---	M	M

Rating System: 4 = excellent control; 3 = acceptable in low pressure situations; 2 = suppression activity only; 1 = poor control; L = low impact; M = moderate impact; H = high impact; --- = no data.

Section 7

Clean-up Programs

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Codling moth clean-up in an organic orchard



In 2002, a 270-acre certified organic demonstration orchard was established in the Royal Slope area of WA. During the first year of the project, 2,836 codling moth adults were captured in pheromone-baited traps. This included an average of 67 moths/trap over a three-week period of the second generation (Fig. 1). Pheromone mating disruption was used in 2002, while the spray program relied primarily on frequent oil applications as ovicide. Total insecticide cost was \$407/acre. The grower was forced to hand remove 158 bins of damaged apples (1000 man-hours). Still, 5% damage was noted at harvest and the grower packed only 16 of 25 boxes/bin (64% pack-out).

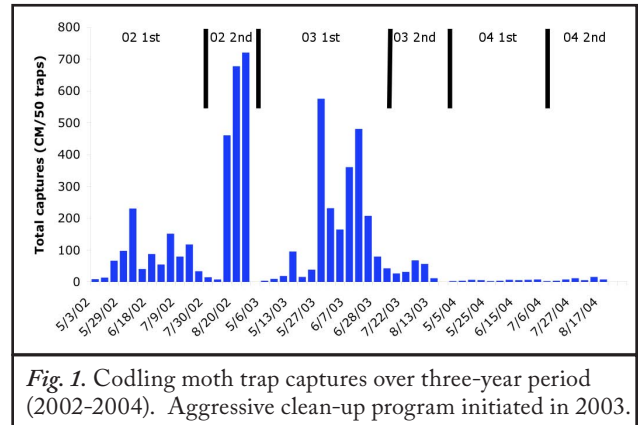


Fig. 1. Codling moth trap captures over three-year period (2002-2004). Aggressive clean-up program initiated in 2003.

In 2003, a high carryover population resulted in an average capture of 46 moths/trap during the first generation (2,261 moths). After using a management program that continued to have mating disruption as the foundation and employing two newly registered organic products, Entrust and Cyd-X granulosis virus (neither available in 2002), codling moth captures were reduced to an average of 3.6 moths/trap during the second generation (227 moths).

Less than 1% damage was noted at harvest and no hand removal of CM injured fruit was needed in 2003. The grower packed 21 of 25 boxes/bin (85% pack-out). The total insecticide cost was \$80/acre more (20% increase) in 2003 but this was more than offset by the reduction in lost fruit and higher pack-out (Table 1). The new organic management program returned an additional \$1,772/acre in 2003 despite the increased cost of insecticides.

In 2004, 78 moths were captured over the entire season. The reduction in codling moth pressure following the 2003 cleanup efforts allowed for reduced insecticide inputs while maintaining a high level of fruit protection. The savings in insecticide costs returned an additional \$130/acre to the grower.

Table 1: Summary of organic codling moth clean-up program, 2002-2004.			
	2002	2003	2004
Trap captures (total moths)			
First generation	587	2,261	35
Second generation	2,249	227	43
Fruit damage	5%	<1%	<1%
Hand removal of damage:			
\$/acre ¹	\$37	0	0
Crop Removal (bins/a)	0.6	0	0
Harvest (Bins/acre) ²	39	40	40
Pack-out	64%	85%	85%
Crop value (\$/bin) ³	200	200	200
Insecticide cost (\$/acre)	407	480	350
Value (bins/acre x \$/bin)	\$7,800	\$8,000	\$8,000
Less crop loss (pack-outs)	\$4,992	\$6,800	\$6,800
Less thinning + Insecticides	444	480	350
Net⁴	\$4,548	\$6,320	\$6,450

1, Assumption: 1000 hours x \$10/hour / 270 acres.
 2, Assumption: Average harvest of 40 bins/acre with no hand removal of fruit.
 3, Assumption: Organic Delicious apple returns to grower of \$200/bin.
 4, Net value of crop based on cost of codling moth management program and pack-outs. This value does not represent actual net profit to grower, as other management costs outside of codling moth control were not included.

Insecticide treatments for immediate results:

- Hand-applied pheromone at 400 disp/acre.
- Oil applied at 375DD (200 DD) as an ovicide.
- Entrust and oil at 525DD (350DD), repeated every 10-12 days (3 applications).
- Virus alternated with Entrust during the 1st generation.
- Spot treatments of virus and Entrust during 2nd generation.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Codling moth clean-up in a conventional orchard



Over the course of a two-year research project in an apple orchard managed with conventional insecticides, a very high codling moth infestation was transformed into a manageable population. The situation was typical of orchards that have undergone ownership restructuring. The result is often at least a partial neglect in horticulture and pest management allowing codling moth pressure to increase dramatically.

Despite an intensive spray program and half-rates of mating disruption, the study area suffered over 25% codling moth damage in 2005 (Table 2). Most damage was noted high in the tree canopy. We felt inadequate pruning was likely to blame for poor spray coverage, allowing the population to build in the top of the trees.

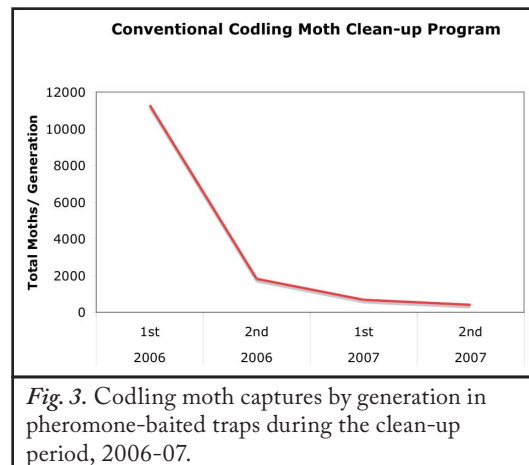


Fig. 3. Codling moth captures by generation in pheromone-baited traps during the clean-up period, 2006-07.

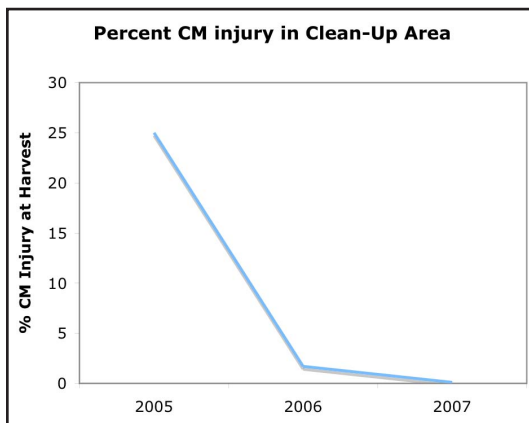


Figure 4. Codling moth damage at the harvest evaluation prior to (2005), and during the clean-up period, 2006-07.

In early 2006, major saw cuts replaced detailed pruning to improve spray penetration. Mating disruption rates were increased to 400 dispensers/acre, and a heavy spray program continued. Total trap catch in the 160-acre study area was 11,282 moths during the first generation of 2006, but declined to 1,824 during the second generation (Fig. 3). Nine specific codling moth sprays were applied over the entire season.

In 2007, total trap captures were 681 moths and 406 moths during the first and second generations, respectively. Just three codling moth sprays were applied over the whole season, which included an insect growth regulator applied as an ovicide at 200 degree-days. Damage across the entire project was reduced to just 0.10% (Fig.4).

The expense of this cleanup effort was considerable. Heavy pruning resulted in a significant decrease in yield, but increased pack-outs made up for the loss in production. Within two years, the management program with mating disruption at its foundation was biologically stable and economically viable, returning approximately \$2,850 more per acre than prior to the codling moth cleanup program (Table 2).

	2005	2006	2007
Trap captures (total moths)			
First Generation	8,316	11,282	681
Second Generation	15,656	1,824	406
Fruit damage	25%	1.7%	0.1%
Harvest (Bins/acre)	73	56	66
Pack-out ¹	60%	83%	85%
Crop value (\$/bin) ²	150	150	150
Insecticide cost (\$/acre)	\$400	\$420	\$220
Value (bin/acre x \$/bin)	\$10,950	\$8,400	\$9,900
Less crop loss (pack-outs)	\$4,380	\$1,428	\$1,485
Less Insecticides	\$370	\$420	\$220
Net³	\$6,200	\$6,552	\$8,195

1. Assumption: Average return to grower of \$150/bin.
 2. Assumption: Average return to grower for conventional Granny Smith apples of \$150/bin.
 3. Net value of crop based on cost of codling moth management program and pack-outs. This value does not represent actual net profit to grower, as other management costs outside of codling moth control were not included.

Stabilized Codling moth management following clean-up:

- Hand-applied mating disruption at 400 disp./acre.
- Ovicide applied at 375 DD (200 DD).
- Most effective larvicide available applied at 525 DD (350 DD), with repeat in 17 days.
- Spot treatments of non-disruptive larvicides during 2nd generation.

Section 8

Cultural Practices

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Airblast Sprayer Calibration



Determine proper speed of travel. For most airblast sprayers, driving from 1.0 to 2.5 miles per hour will ensure that coverage is obtained in the upper central portion of the tree. As the growing season progresses, and leaf and shoot growth add to the density of the trees, you may have to recalibrate. Sprayer coverage can be confirmed by applying Surround as a test product. Adjust the speed of travel until a visual check shows that you have adequately covered the hard-to-reach areas of the tree. Write down the gear and revolutions per minute (rpm) used, then measure the number of seconds it takes to drive 88 feet at this speed. Divide the seconds into 60 to get miles per hour.

$$\text{mph} = \frac{60}{\text{seconds to drive 88 feet}}$$

Determine gallons per acre. The number of gallons of spray mixture you apply affects the type of coverage more than the evenness. Low volume applications apply distinct droplets, while high volume sprays apply a sheet of water. Tree Row Volume (TRV) is one way to estimate the gallonage required to achieve a dilute application.

$$\text{TRV} = 0.7 * \frac{43,560 \text{ sq ft/acre} * \text{tree height (ft)} * \text{tree width (ft)}}{1000 * \text{distance between rows (ft)}}$$

For canopies of higher density multiply by 0.75, 0.8, etc., (up to 1.0) instead of 0.7. While these calculations can be helpful, there is no substitute for experience. When applying insecticides at water volumes less than dilute, use caution to ensure that coverage is not compromised. Less than 80 gpa is generally considered inadequate for airblast applications.

Set up sprayer nozzle manifold. Place the nozzles on the manifold in relation to the tree size and shape. Place the largest nozzles in line with the thickest part of the tree, then arrange the medium and small-sized nozzles so that the gallons per minute output tapers off on either end. Keep output per minute highest along the part of the manifold that lines up with the bulk of the tree.

Nozzle Calibration

- To determine proper nozzle size for your sprayer, first calculate the gallons per minute (gpm) to spray from each side of the sprayer by using desired gallons per acre (gpa), tractor speed (mph), and row space (ft).

$$\text{gpm} = \frac{\text{gpa} * \text{mph} * \text{row space (ft)}}{990}$$

- Use a nozzle chart and the output pressure from your spray pump to determine the disc and core that produce the desired output.

Checking Calibration

- Fill sprayer with water to overflowing.
- Run both sides for 3 minutes at operating pressure (2 minutes if spraying dilute).
- Use a calibrated bucket to refill sprayer and measure gallonage sprayed.
- Divide gallonage sprayed by 6 to determine output per side (divide by 4 if sprayer was only run 2 minutes).
- Compare actual sprayer output with calculated output. If necessary, alter pump pressure slightly to adjust sprayer output.
- Recheck your gallons per minute output regularly.

For more information please refer to WSU extension bulletin 1575.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Airblast Sprayer Calibration



Example: You would like to calibrate your sprayer for trees that average 15 ft in height and 8 ft in width, with 18 ft between rows. You have already determined that 1.5 mph is the optimal driving speed. First calculate gallons per acre output using Tree Row Volume, then determine the gallons per minute per side that the sprayer must produce to achieve this calibration. Finally, using a nozzle chart, choose eight nozzles producing a total output per minute per side close to this amount that will place two-thirds of the output from the upper half of the manifold (the portion that lines up with the bulk of the tree).

Step 1: Use the formula to calculate Tree Row Volume: $TRV = 0.7 * \frac{43560 * 15 \text{ ft} * 8 \text{ ft}}{1000 * 18 \text{ ft}} = 203$

Step 2: Use the formula to calculate gpm per side: $gpm = \frac{200 \text{ gpa} * 1.5 \text{ mph} * 18 \text{ ft}}{990} = 5.45$

Step 3: Calculate 2/3 of this total for the upper half of the manifold: $.667 * 5.45 = 3.64$.

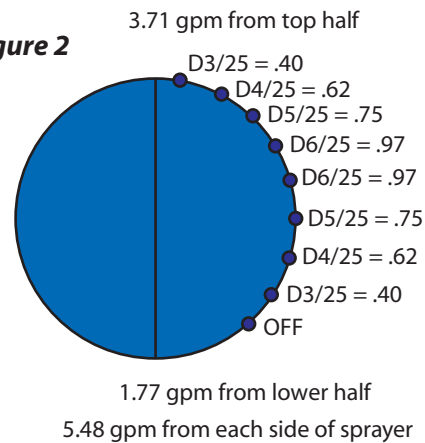
Step 4: Calculate 1/3 of the total gpm per side for the lower half of the manifold: $.333 * 5.45 = 1.81$.

Step 5: Use a nozzle chart like the one shown in Figure 1 (below) and the output pressure from your spray pump to determine the disc and core that will produce the desired output for each nozzle.

Figure 1

Orifice Disc No.	Core No.	GPM @ 200 psi
D2	25	0.34
D3	25	0.40
D4	25	0.62
D5	25	0.75
D6	25	0.97
D7	25	1.18

Figure 2



One possible arrangement to achieve this output is shown in Figure 3 (below). Nozzle arrangement on the manifold is pictured in Figure 2 (above).

Figure 3

Nozzle	1	2	3	4	5	6	7	8	9	Total
GPM	0.40	0.62	0.75	0.97	0.97	0.75	0.62	0.40	0.00	5.48
Disk/Core	25/3	25/4	25/5	25/6	25/6	25/5	25/4	25/3	Off	

Recheck calibration regularly throughout the season.

Section 9

Web Resources

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

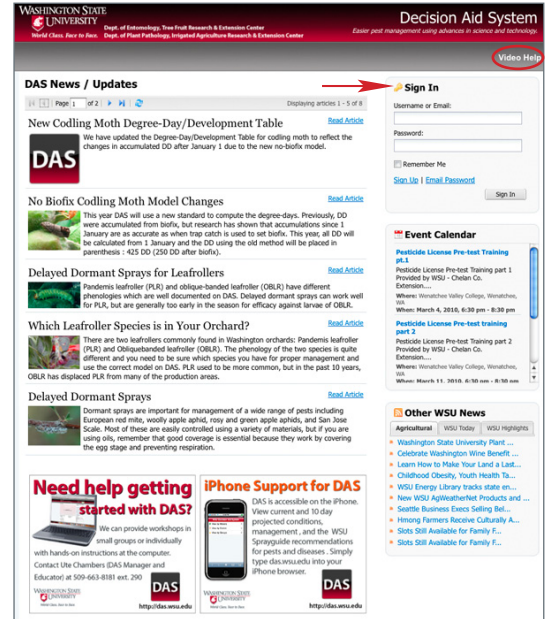
Web Resources: WSU-Decision Aid System (DAS) 4.0



Front Page

The redesigned DAS front page (<http://das.wsu.edu>) provides IPM information of general interest, as well as seasonal-specific issues that will be updated frequently. The front page now offers two short videos that briefly describe DAS and explain how to register and login. These videos can be accessed by clicking the link “Video Help” at the top right (circled in red).

The new “Sign In” field (red arrow) on this page makes it easier to register and login. Below that is a newly added Event Calendar and WSU News box are intended to keep you informed about other events and topics.

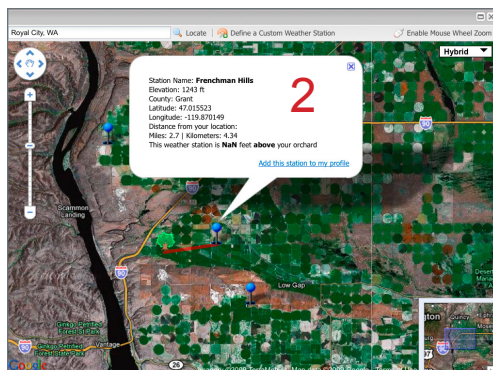
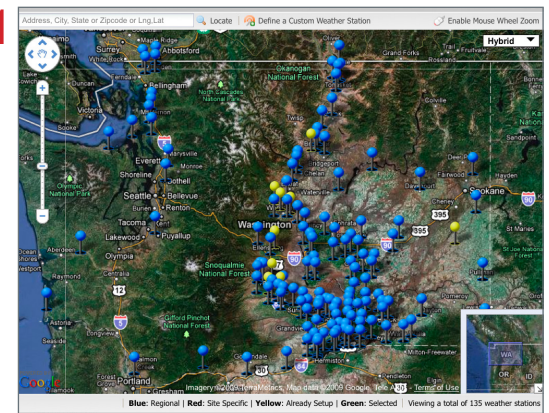


Profile Page

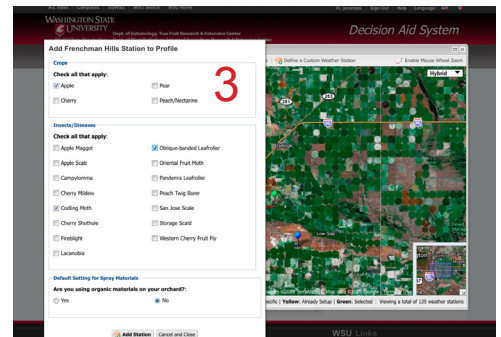
When you log on, you will be directed to your profile page where you setup and edit weather stations and enter information about your orchard (crop, pest models, management). From here you can view your models (sorted by model or station) or access other features from the main menu bar at the top.

Adding and Editing a Station

On the profile page, click on the “Add Station” button and the Google Maps interface comes up. Type the name or zip code of the city closest by in the box in the top left and the map will show (1) a close up of the area with AWN weather stations marked in different colors (legend at the bottom of the page). Move the tree icon in the map to your orchard. You can switch the type of map using the buttons at the top right in both of these images. You can then click on any AWN weather station nearby which opens a box that shows distance and elevation differences between your orchard and that station (2). If you want to use the weather station, click the “Select This Station” button in the information box. In the new window that opens up (3), fill out which crops, models and management options (organic or conventional) apply.



To edit existing stations, first select that station from your profile page, then choose “Edit Station”. This opens the data window where changes regarding crop, model and management option can be made.



Workshops: On request, we can provide workshops, in small groups or individually, on how to use DAS.

Contact: Ute Chamber - DAS Manager/Educator, uchambers@wsu.edu or 509-663-8181 x290

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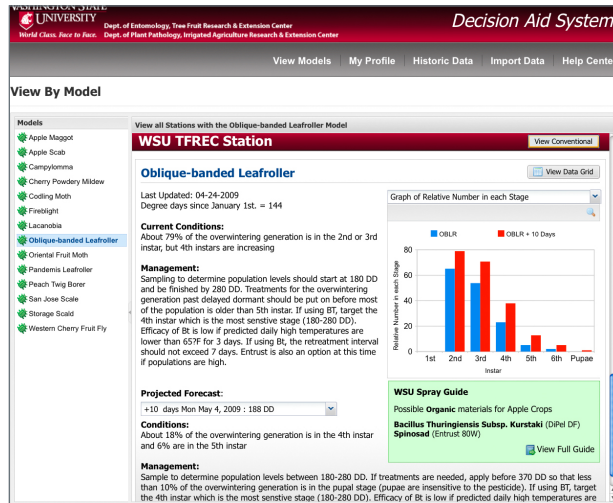
Tree Fruit Research & Extension Center

Web Resources: WSU-Decision Aid System (DAS) 4.0



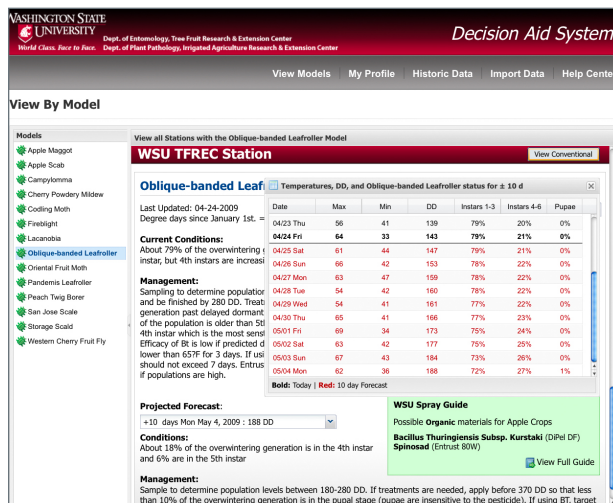
View Models Screen

The “View Models” menu allows you to choose to view the model output by station (all models from a given site displayed sequentially), or by model (a particular model at each of the sites in your profile), or by group (for example, all stations you visit at the same time regularly). The screen shot shows the view by model – on the left, you select which model output you want to see displayed on the right. The model output gives you the current degree days (DD) accumulated, the current pest condition and recommended management options, and, underneath, the projected pest condition and projected management recommendations. On the right, you can find the current and projected pest development plotted in a graph as well as the mini-WSU spray guide underneath. You can scroll down to see the complete message and the model output for other sites.



Features:

- * The graphs here can be changed to show the relative number versus DD or calendar date; cumulative percent through a stage on calendar date or DD.
- * You can change the projected forecast by using the menu; any time from 1-10 days is possible.
- * You can switch between viewing the organic and conventional management recommendations (including the mini-spray guide) by clicking the “View Organic/View Conventional” button.
- * By clicking on the “View Full Guide” button in the mini-spray guide you can go to the full WSU Spray Guide.



Data Grid and Weather Forecasts

The data grid shows the graph information in a table. By clicking on the “View Data Grid” button above the graph, the data grid is revealed. The grid shows the data for the last 10 days (in black) with today’s data in bold and the projected data (using weather forecasts) out to 10 days in the future (in red). This box scrolls using the bar on the right and below it.

The data shown by the data grid varies depending on the model. In the oblique-banded leafroller (OBLR) model, for example, it shows the date, maximum and minimum temperature, degree days (DD), and the percentage of the population found in instars 1-3, 4-6, and pupal stage. In other models, the data grid will show different things. For example, the fireblight model will show the date, the fireblight hours, risk index, rainfall, predicted probability of rainfall, and predicted amount.

An important use of this function is to get a quick forecast of temperatures. For example, as stated in the management section for OBLR, efficacy of *Bt* is low if daily high temperatures are lower than 65 °F. By choosing to see the data grid, you can look at the maximum temperatures and decide if *Bt* use would be appropriate.

Models Currently Available

Apple maggot, Campyloasma bug, Codling moth, Lacinobla fruit worm, Oblique-banded leafroller, Oriental fruit moth, Pandemis leafroller, Peach twig borer, San Jose scale, Western cherry fruit fly; Apple scab, Cherry powdery mildew, Firelight; Storage scald.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Web Resources: *WSU-Decision Aid System (DAS) 4.0*



WSU Spray Guide/Pesticide Database

The full WSU Spray Guide can be accessed by clicking on the “View Full Guide” button in the mini spray guide in the model output. The full spray guide displays all recommended pesticides for the particular pest or disease you were viewing in the model output for the chosen crop at the current time of the season. At any time you can switch to a different pest, crop or treatment period in the drop down menus on the top.

In the first category, general information of the pesticide is provided, including the trade name, class, resistance class, bee toxicity, REI, PHI, rate, and organic or conventional practice. Information of the resistance class helps you in resistance management by alternating pesticides with different modes of action.

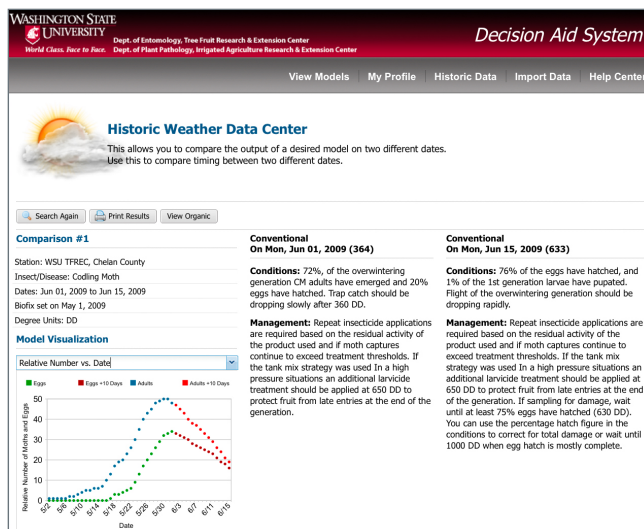
The second category shows the level of efficacy (high or moderate) of each pesticide against major pests. Pesticides can show high and moderate efficacy against the same pest when trials resulted in variable control success. The efficacy table can help you control pests that occur and can be treated at the same time.

The third category provides information of negative effects (L = low, M = medium, H = high, none = no impacts known, ? = no data on effects available) of each pesticide on natural enemies, including predators and parasitoids of spider mites and aphids. In the fourth category, you can find more notes and comments of interest.

Historic Weather Data Center

This feature allows you to look back at the season and see differences in model predictions between different dates. For example, suppose you wanted the spray for codling moth to go on 1 June, but the sprayer broke and you were not able to get it on until 17 June, and now you want to see if that delay caused the damage you see in your orchard. Go to the Historic Data section, choose the location and model you want, then choose the two dates you are interested in. You can set up any four combinations like this that could have the same or different weather source, models or dates. Choose the “Submit” button on the bottom and the model output appears. (Tip: The two chosen dates per comparison should not be more than 1 month apart to

The screenshot shows the 'Historic Weather Data Center' interface. At the top, there's a navigation bar with 'View Models', 'My Profile', 'Historic Data', 'Import Data', and 'Help Center'. Below that, a title 'Historic Weather Data Center' is followed by a brief description: 'This allows you to compare the output of a desired model on two different dates. Use this to compare timing between two different dates.' The main area contains four comparison boxes (Comparison 1-4). Each box has dropdown menus for 'Location', 'Pest or Disease', and 'Select Model'. A central calendar widget allows selecting two dates. At the bottom, there are 'Submit' and 'Reset All' buttons.



prevent computing errors and endless waiting. If you want to compare different years, choose short periods for in each year in a separate comparison.)

The comparison output provides information that WSU-DAS would normally provide on those dates and displays graphic output for the chosen dates (this can be customized as in other screens with the drop down menu). You can switch between organic and conventional recommendations using the button just above the comparison title.

Your Feedback Is Welcome

We welcome comments and suggestions on how to further improve WSU-DAS.

Contact: Ute Chambers – DAS Manager/Educator
uchambers@wsu.edu or 509-663-8181 ext. 290.

Apple Pest Management Transition Project

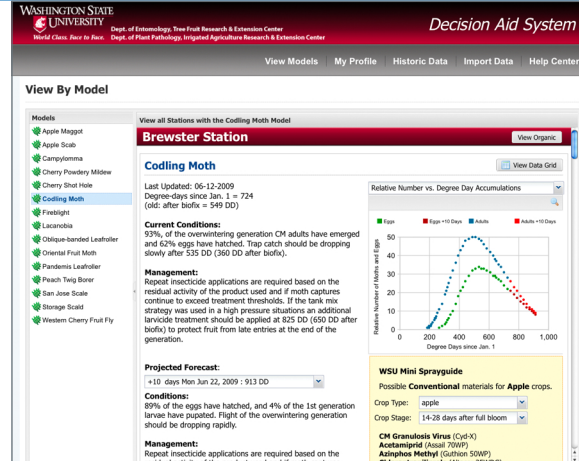
Tree Fruit Research & Extension Center

Web Resources: WSU-Decision Aid System (DAS) 4.0



No-Biofix Codling Moth Model

Our research has shown that first codling moth emergence occurs on average at 175 DD after January 1 and that using a biofix does not increase the accuracy of model predictions when compared to actual adult flight and egg hatch. Therefore, we removed the biofix from the model. Beginning in 2010, DD accumulation started January 1 and will continue throughout the season. This means that 175 DD will be added to all codling moth events (e.g. the new 425 DD is equal to “250 DD after biofix”). New DD and old “DD after biofix” will be displayed in the codling moth model output and management recommendations to help the transition.



Help Center

The DAS Help Center provides an online user manual as well as short (between 1 and 4 minutes long), narrated video tutorials. These videos demonstrate the various features of WSU-DAS step by step so that you can see the full range of features available. If both help resources do not offer the solution to a problem, you can submit a “trouble ticket” (question or comment) through the Help Center. We will also have a frequently asked questions (FAQ) section that will have answers as we receive questions from users.

DAS on iPhone

DAS is now accessible on iPhones from anywhere that you have a mobile signal. As on a computer, model output on the iPhone can be viewed by model or station and includes current and projected pest conditions and management recommendations. Currently, the iPhone-specific system has no graphs and only the mini-WSU Spray Guide is available, but updates regarding these two items are under development.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Web Resources: pmtp.wsu.edu



The best place to get the most up-to-date information about the Apple Pest Management Transition Project is from its own web site located at:

<http://pmtp.wsu.edu>

Here are just a few web site highlights:

Home page

The Home page prominently displays the project's Mission and Goals statement and provides the major links to the rest of the site on the left side as well as a list of Special Interest links on the right for other useful IPM and industry related sites.

The screenshot shows the website header with the WSU logo and project title. The left sidebar contains navigation links: Home, Calendar, eNewsletter, Project Information, Education, Reference Tools, Assessment & Documentation, EQIP Program, Send Us Comments, and Request Contact. Below these is a search bar for TFREC and contact information. The main content area features a large image of an apple orchard with the text 'Promoting safe, effective and sustainable apple orchard pest management'. Below the image is the 'Project Mission and Goals' section, including 'The Mission' and 'Our Goals'. On the right, there are sections for 'Special Interest' (with social media links), 'Quick Links', 'News & Events', 'Industry Links', and 'IPM Resources'.

The screenshot shows the 'Events Calendar' page. It includes a navigation sidebar on the left and a main calendar area. The calendar is for February 2010 and shows several events: 'Mid-Columbia C' on Feb 2, and '6:30pm IPM Work' on Feb 10, Feb 24, and Feb 28. A legend at the top identifies event categories: IU Meetings (blue), Administrative Meetings (orange), General Interest (green), Special Events (red), and DAS Events (purple). Navigation options like 'Today', 'February 2010', and 'Print' are visible.

Calendar / Events page

The Calendar and Events page can be accessed from any PMTP page using the link found on the left hand column. This page highlights major events related to IPM training or special interest to the industry including workshops, training sessions, and field days. More information about the highlighted events can be found by using the links within the summary text provided. The page also contains a live Google Calendar showing all scheduled events. Clicking on a specific event opens a detail window giving more information such as location, times, contact person and a map link. Events have been categorized by type and color coded to help you identify events of interest to you.

Apple Pest Management Transition Project

Tree Fruit Research & Extension Center

Web Resources: pmtp.wsu.edu



eNewsletter

The Apple Pest Management Transition Project produces newsletters throughout the growing season touching on timely subjects to help with your current orchard issues. The eNewsletter is posted online and is available for download as a PDF. You may subscribe to the mailing list to be notified when a new issues comes out. To do this click on “Subscribe” at the top of the page. All back issues of the eNewsletter are archived and available to read online or to download.

PMTP Newsletter – Woolly Apple Aphid

In this issue:

- Woolly Apple Aphid
- Life-Cycle
- Damage
- Biological Control
- Insecticidal Control

2009 Newsletter Archive	2008 Newsletter Archive
Volume 2:6 August 15, 2009	Volume 1:10 Nov. 1
Volume 2:5 July 15	Volume 1:9 Sept. 1
Volume 2:4 June 15	Volume 1:8 Aug. 15
Volume 2:3 May 15	Volume 1:7 Aug. 1
Volume 2:2 May 1	Volume 1:6 June 15
Volume 2:1 April 15	Volume 1:5 June 1
	Volume 1:4 May 1
	Volume 1:3 April 15
	Volume 1:2 April 1
	Volume 1:1 March 15

Woolly Apple Aphid

Woolly apple aphid is a pest that has increased in stature as Washington apple growers transition away from the use of organophosphate insecticides. Though the reasons for increased woolly apple aphid problems are not completely understood, the more predominate theories are: 1) some of the new, reduced-risk insecticides that are used to replace azinphos (Guthion) for codling moth are disrupting biological control of woolly apple aphid, and/or 2) the use of broad-spectrum organophosphate insecticides [Chlorpyrifos (Lorsban), Guthion, methyl parathion (Pencap), which had previously suppressed woolly apple aphid, is not allowing populations to grow through the season and become more problematic – especially near harvest. New and ongoing research projects, such as the Enhancing Western Orchard Biological Control Project (<http://enhancedbiocontrol.wsu.edu>) hope to increase our understanding of the interaction between insect pests, beneficial insects, and the new insecticides that are being introduced into our orchard systems.

Efficient Use of Speed Sprayer Technology

Move mouse over text to view visual guide to terms used in the calculations. Move the mouse away to hide image.

Orchard Information

tree height (ft)	15
canopy drip line (tree radius, ft)	25
lower canopy distance from ground (ft)	
tree spacing (ft)	
drive row spacing	

Tractor/Sprayer

fan (cfm, sm PT)	
tractor speed (in)	
fan height from ducting angle	
time to turn (sec)	
drive row length	
orchard side (=)	

Calculate

Effect of Tractor Speed on Air Displacement

Effect of Tractor Speed on Time to Spray an Acre

End Calculations

Reference Tools

The PMTP web site offers many helpful features and reference tools to assist you with your Apple IPM management needs. One of these tools includes an interactive application which allows you to determine the most efficient way to use your orchard sprayer. Here you enter values that match your conditions. If you are unsure what measurement to enter, move your mouse over the description and a helpful diagram pops up to show

you. Once all your data is entered, graphs will be generated showing the relationship between different speeds and spray coverage.

Other site features include:

- * **Project information** - such as background, project oversight and timelines;
- * **Educational items** - such as articles, the handbook (downloadable), event details, reference tools (Codling moth identification guide, speed sprayer use, MRL info.);
- * **Assessment and Documentation** - where all the project reports are found, including information about the grower and consultant surveys;
- * **Contact Forms** - contact us about joining an Implementation Unit, subscribing to the mailing list, or send us your comments. *New items are added frequently - so keep checking!*

For more information about this project visit: <http://pmtp.wsu.edu> or email us at: pmtp.info@wsu.edu

Section 10

Appendices

