2008 PMTP Field Tour Agenda

- Codling moth and leafroller  
  (3:00 pm - 3:30 pm)
- Secondary pests  
  (3:30 pm - 4:00 pm)
- Decision Aid System (DAS)  
  (4:00 pm - 4:30 pm)
- Hort. practices / Sprayer technology  
  (4:30 pm - 5:00 pm)

Pest Management Transition Project

Objectives/Funding
Recognizing an opportunity to move proactively and transition to new technologies that would not only meet but surpass EPA regulations, apple industry leadership sought and received funding through the State Legislature for the Pest Management Transition Project (PMTP). The objectives of the PMTP are:

1. To enhance understanding of new IPM technologies through educational programs and communication of research-based knowledge.
2. To increase adoption of new IPM technologies through sharing information on successes and failures and communicating with all stakeholders on project progress.
3. To document changes in practices, attitudes, and perceptions of growers, farm workers, and stakeholders.

Implementation Units
Implementation Units (IUs), comprised of localized groups of growers, managers, consultants, and fieldmen, were formed prior to the 2008 field season. The Implementation Units allow an opportunity for discussion and information sharing about pest management programs, new insecticides, and the use of new technologies for pest control.

Handbook
The Implementation Unit Handbook was given to all IU participants and is available online at: http://pmtp.wsu.edu/handbook.html. The handbook is a collection of information and strategies pertaining to pest management practices that will help Washington apple growers achieve acceptable crop protection while phasing out the use of azinphos-methyl.

Web Site
The PMTP web site (http://pmtp.wsu.edu) is the most up to date source for information pertaining to the Pest Management Transition Project and current pest management issues.
Implementation Unit Sign-up Form

Name: ____________________________________________________________________

Email Address: __________________________ Fax: ____________________________

Primary phone: ___________________ Optional 2nd phone: ___________________

Mailing Address: _________________________________________________________

City, State & Zip code: ____________________________________________________

Orchard name: ___________________________________________________________

General Orchard Location: _________________________________________________

Crops (acres): apple______ pear______ cherry______ other fruit___________

I’m a: grower______ manager______ consultant______ other_________

The questions below are optional but will help us better direct our education programs

Are you using Mating Disruption: yes no Product/Rate: ______________________

Are you using Guthion: yes no Total lbs:__________ Acres Treated:_________

Are you content with your current codling moth control program: yes no ok

How would you prefer to receive updates (newsletter, etc.): email mail fax

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

_____________________________________________________________________

_____________________________________________________________________

Return this form to: PMTP Project Manager, WSU-TFREC, 1100 N. Western Ave., Wenatchee, WA 98801
Disrupt the Life Cycle
Using a multi-tactic approach to disrupt the insect life cycle in as many places as possible is the best chance for successful control of key apple pests, such as the codling moth (CM).

CM Mating Disruption
Mating disruption provides a strong foundation to a robust codling moth management strategy. Mating disruption reduces the number of CM eggs laid, thereby reducing the number of insecticide applications necessary to control fruit injury.

In all experiences we have had, mating disruption reduces the need for additional insecticide applications for codling moth, reduces crop injury, and over time reduces the cost of pest control.

Ovicides
Using an ovicide to kill CM eggs is the next opportunity to disrupt the CM life cycle. 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);
2. Apply the product over the top of the egg (topically).

Altacor, Esteem, Intrepid, and Rimon, kill codling moth eggs when applied as residual ovicides - before eggs are laid. When using one of these products in the period between 50-200 CM degree days, which coincides with the control-period for overwintering leafroller larvae, CM eggs are killed and significant egg hatch in the orchard is delayed. This delay in egg hatch allows delaying the first larvicide application until 350DD. Oil (at a 1% v/v concentration) can also be used as a CM ovicide. When oil is applied at 200DD, CM eggs are killed topically and the first larvicide application can be delayed until 350DD.

Larvicides
If an ovicide is not used, codling moth eggs will begin to hatch approximately 250DD past biofix. Newly hatched larvae find and enter fruit within a few hours. Traditional larvicides (Guthion, Imidan) kill larvae as they crawl across residues or when they eat residues as they bore into the apple.

Most of the new larvicides (Assail, Calypso, Intrepid, Virus, Altacor, and Delegate) must be consumed to be effective. This makes thorough spray coverage and application timing very important.
Codling Moth and Leafroller

Insecticide Products for Leafroller Control
Proclaim, Success, and 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. None of these products provide control of codling moth eggs.

Bt is slower acting against leafroller but can still provide effective control. Bt does not provide control of codling moth eggs.

If Proclaim, Success, Delegate, 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 250 DD.

Insecticide Products for Combined Codling Moth and Leafroller Control
Altacor, Intrepid, Rimon, and Esteem take longer to kill leafroller larvae than Proclaim, Success, and Delegate, but add value because they provide control of codling moth eggs that are laid on top of their residues.

If Altacor, Intrepid, Rimon, or Esteem are used in the period between 50-200 DD, codling moth eggs will also be controlled. If one of these products is used in this period, the first larvicide application can be delayed until 350DD.

Horticultural mineral oil (HMO) is also an effective CM ovicide when applied over the top of CM eggs at a concentration of 1% v/v. Oil, applied at 200DD, will kill CM eggs already laid in the orchard and allow delaying the first larvicide application until 350DD.

Figure 2. Products for control of codling moth and leafroller

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Group No.</th>
<th>Codling Moth</th>
<th>Leafroller</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ovicial</td>
<td>larvicidal</td>
</tr>
<tr>
<td>Intrepid (methoxyfenozide)</td>
<td>18A</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Esteem (pyriproxyfen)</td>
<td>7C</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rimon (novaluron)</td>
<td>15</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Altacor (rynaxypyr)</td>
<td>28</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Assail (acetamiprid)</td>
<td>4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Calypso (thiacloprid)</td>
<td>4</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Success (spinosad)</td>
<td>5</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Delegate (spinetoram)</td>
<td>5</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Proclaim (emamectin benzoate)</td>
<td>6</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>HMO (oil)</td>
<td>---</td>
<td>X (topical)</td>
<td></td>
</tr>
<tr>
<td>CM Virus (virus)</td>
<td>---</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Bt</td>
<td>11A</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>
Secondary Pests

Secondary pests include all those that are either indirect (do not feed on fruit) or sporadic (limited acreage or not every year). However, both individually and collectively, they can cause considerable damage, and cost the grower money for either damage or control measures. Many secondary pests are good candidates for biological control, with many natural enemies to help keep their populations down. Secondary pests fall into two categories – those for which precise timing is required, and those that can be controlled whenever the population exceeds a certain level. Campylomma and thrips (both direct pests) are examples of secondary pests that require precise timing; aphids and mites can be controlled any time up to the preharvest interval of the pesticide chosen.

Mites. Spider mites have become more of a problem in recent years, probably linked to our change in spray programs. Integrated mite control was remarkably stable in an OP-based program, but changes in the codling moth/leafroller program, along with other changes, have contributed to increasing problems. There are many effective and selective miticides available currently; your choice will depend largely on how fast you need knockdown. The cool conditions to date should slow the development of spider mites, and reduce the pressure regionally.

Green Apple Aphid/Spirea Aphid. These aphids feed on succulent tissue, so high tree vigor promotes populations. Cool, rainy weather also promotes tree growth, as do light crops; 2008 could be an “on” year for aphids. The neonicotinyls are effective on green aphids; however, sole reliance on a single chemistry (ca. 12 years at this point) is a scenario ideal for resistance development. Widespread use of neonicotinyls for codling moth will make this tendency worse.

Rosy Apple Aphid. This species used to be sporadic, but has become more common in recent years. It can be especially problematic in organic orchards, due to the lack of highly effective aphicides. Pre-bloom applications tend to be the most effective, but often the need to treat an aphid population is not apparent until after bloom. Neonicotinyls are effective.

Woolly Apple Aphid. This is yet another aphid species that used to be a pretty minor pest, but has become an increasing problem in the past 5 years. Although it is an indirect pest, large populations in the fall can be a nuisance for pickers, and aphids, honeydew and “wool” can contaminate fruit. This aphid is especially problematic in that it also forms root colonies, where control is difficult. Once an orchard is infested, it is will likely be subject to periodic outbreaks. The time of year when woolly apple aphid populations build up is quite variable – they can occur as early as bloom through post-bloom; mid-summer; or late summer-fall. The fall populations tend to be the biggest problem because they occur so close to harvest that the population cannot be treated.

Thrips. Western flower thrips tends to recur in certain orchards, especially those in close proximity to sagebrush habitat. Thrips are opportunists, and will feed and reproduce on flowers of many plants. They are most abundant on apple around bloom, but low levels live on vegetative tissues throughout the season. The recommended timing for thrips used to be pink-bloom; this has been recently revised to petal fall-6 mm.

Campylomma. This is a sporadic pest for the most part, but certain orchards tend to have a history of damage. Sampling (typically with a beating tray) is time-consuming and not always effective. Most cultivars can be damaged (Campylomma appear not to like ‘Braeburn’); ‘Golden Delicious’ is highly susceptible, and ‘Delicious’ is much less susceptible. Timing for control is critical; it must be done before petal fall (mid- to late bloom) to effectively prevent fruit damage. Pheromone traps in the fall for predicting the next year’s population have been somewhat useful on ‘Delicious’, but error-prone on ‘Golden Delicious’.
Secondary Pests

Pesticide Choices for Secondary Pests (note that activity on codling moth and leafrollers is covered in a different section)

Neonicotinyls  (Assail, Calypso, Clutch, Provado and generic imidacloprid). These materials are generally good aphicides against green and rosy aphids, but weak against woolly apple aphid (temporary suppression). If you are using a neonie for codling moth, you will likely pick up or prevent an aphid problem. Assail has some activity against thrips, although perhaps not through knockdown. The neonicotinyls have been associated with increased densities/outbreaks of spider mites, although the mechanism is not clear. They are also toxic to some of the generalist predators.

BeLeaf. A relatively new material, it is similar to the neonicotinyls. Preliminary tests show it to be effective against green and rosy aphids (but not woollies). However, it is rate sensitive; lower rates may not be effective.

Carzol. A standard for thrips and Campylomma control, it has performed consistently well in trials. It is also a broad-spectrum miticide, and will likely be harmful to Typh populations.

Petroleum oil. Oil provides suppression of many soft-bodied insects, including aphids, leafhoppers, and mites. It is frequently used in a tank mix with other materials, at a low rate (0.25%) it acts as an adjuvant; at higher rates (1%), it is both an adjuvant and an insecticide. It has been shown to suppress woolly apple aphid populations when used in multiple applications. It is a useful tool for resistance management, in that no cases of resistance have been observed. Oil is most frequently applied pre-bloom (often in a tank mix), for San Jose scale and overwintering European red mite eggs. Oil+an OP in the prebloom has been a standard recommendation for decades; our changing spray programs may reveal some new challenges as we back away from this use.

Lorsban. When used at delayed dormant, this material likely suppresses a number of pests, including hatching aphids. Long-term suppression of woolly apple aphid has been shown from the delayed dormant application.

Diazinon. Currently the standard material for woolly apple aphid control, this is surprisingly still effective despite many years of use. Closed cab wording appeared on the label in 2008; this represents a major impediment for many growers.

Thiodan (endosulfan). One of the older materials, it has had a variety of uses, the primary one at this point being woolly apple aphid. There is probably a moderate to high level of resistance in rust mites, leafhoppers, and other aphid species. Closed cab wording has appeared on the label.

Neem. Temporary suppression of woolly apple aphid, and likely other aphid species.

This and more detailed information can be found at:

http://jenny.tfrec.wsu.edu/opm/       Orchard Pest Management Online
The Decision Aid System (DAS)
The Decision Aid System (DAS) is a web-based program that integrates weather data, insect and disease models, management recommendations, and pesticide recommendation databases. The DAS is powered by data from WSU-AgWeather Net and predicted weather from NOAA. The DAS provides one stop shopping for Time-Sensitive IPM Information.

On The Web
The Decision Aid System can be found at http://das.wsu.edu. Registration for DAS is free and an easy to use registration tutorial is available on line to help with the registration process. After registering and setting up a user profile, model output is available for each site and model that the user chooses to monitor.

Model Output
The output that is generated for each site will include the weather station name, model name, and general information such as date, degree-days since biofix, etc. Current conditions and management options that should be considered are shown in gray. Predicted conditions and management options forecasted from one to ten days are shown below in pink.
Decision Aid System (DAS)

Linked to WSU Crop Protection Guide
The DAS is also linked to the WSU Crop Protection Guide. Clicking the link will open a full screen view of the recommendations appropriate for the time of year, pest pressure, and program type.

Codling Moth Biofix Update
Setting codling moth biofix is often difficult due to variation in pest pressure, influence of mating disruption products, and different pheromone trapping technologies. The WSU TFREC is currently working on a no-biofix system for the codling moth model. The no-biofix model uses temperature accumulations starting on January 1 to determine a biofix set date. For 2008, DAS users had the option to enter their own biofix date. If a biofix date was not set, the CM model automatically set biofix based on temperatures since January 1.

User Defined Sites
DAS users are now allowed to define their own weather station. We recommend that anyone choosing this option first ensures that their weather equipment is calibrated and functioning properly. Once a user-site has been defined and set up in the user profile, the option to enter user defined station data is available. Data can be copied and pasted from a spreadsheet or text file, or typed in directly. Once the data has been entered, DAS will process the data and output the available information based on crops and models that were selected for the site. See the ‘user-defined site tutorial’ for more information.
Handgun spray applications at volumes as high as 2000 gal/acre were the accepted practice into the 1950s. With the introduction of airblast sprayers, the trend to lower water volumes started immediately. Airblast sprayers couldn't match the perfect coverage of handguns, but a balance was struck between efficacy and efficiency.

The science of spraying begins with a discussion of two factors, spray deposition and spray coverage. A fundamental principle of sprayer efficiency is that spray deposition becomes more variable, thus insecticide efficacy also becomes more variable, as canopy density increases. Wind velocity studies assume no resistance from leaves and all pesticide trials assume thoroughness of coverage.

Environmental conditions interact with droplet size to affect both deposition and coverage. The physics of droplet size is an important consideration when choosing a sprayer setup. For example, at 86°F, 80% humidity and 11 mph wind, a 50 μm droplet will evaporate within 1.5 ft of the nozzle.

The physics of droplet size

Droplet size has a major impact on both deposition and coverage for all sprayer types. The size and number of droplets is influenced by nozzles and pressure. Increased pressure and/or decreased spray volumes result in smaller droplets. Reducing the size of the droplet by 50%, results in 8X more droplets with the same volume of water.

The influence of droplet size on deposition and coverage is illustrated to the left. Assuming insecticide deposition is equal on all three leaves (same amount of water is deposited on each leaf), potential coverage can be increased with smaller droplets.
Sprayer Technology ~ The Physics of Droplets and Wind

Large droplets (>300 μm), typical of higher volume applications, carry more energy and thus sustained trajectory. The larger droplets are less prone to evaporation or deflection, but they have reduced movement through the canopy and may run-off the target.

Moderate droplets (100-300 μm), result in greater distribution and retention in the canopy. Whereas small droplets (<100 μm) loose energy quicker, and thus don’t penetrate the canopy as well. These small droplets result in greater variability in distribution and coverage.

Political, social, environmental, and economic concerns are influencing spray practices – especially in regard to spray drift. Differences in application methods, wind speed, planting density and canopy structure influence drift. The physics of droplet size also influences the potential for drift. This is illustrated in the time it takes for a droplet to drop 10 ft and the potential for a 3 mph wind to carry that droplet (left). Low volume applicators aim the spray better, but droplets under 100 μm are prone to drifting.

Air velocity is equivalent to spray penetration. Radial fans (right) lose energy or velocity exponentially (e.g. a 36” fan loses 50% velocity every 36”). Reducing the ducting angle decreases the rate at which velocity is lost. Linear fans (left) lose 50% velocity every 10 ft.

Although a radial fan employs a higher wind speed at the source (fan), the exponential loss of velocity results in lower wind speeds at distances droplets typically need to travel to reach foliage (3-10ft from fan). Note that at 16 ft from the fan, typical of large trees in older plantings, wind velocity is negligible. Thus, UC (1984) recommended, “No tree over 11 ft tall should be sprayed without a tower” sprayer.
Sprayer Technology ~ Fact Sheet

The fundamental theory of orchard spraying is to displace 100% of the clean orchard air with pesticide-laden air. Sprayer fan capacity and the time spent passing by a tree (tractor speed) have direct influence on air displacement. Air velocity and volume displacement vary widely between sprayers. New sprayer technologies try to address the issue of air displacement, while incorporating the physics of droplets and wind to improve on the 60-yr-old technology of airblast sprayers.

Fluorescent dye studies are often used to assess sprayer efficiency. Growers may choose to use kaolin clay (Surround) to assess coverage. Consider canopy structure when choosing a sprayer technology. It is critical that spray deposition and coverage be uniform throughout the canopy. A scenario that is typical with pesticide failure is spotty coverage in the top of the canopy.

<table>
<thead>
<tr>
<th>Nozzles</th>
<th>Droplet Size</th>
<th>Pressure at Nozzle</th>
<th>Sprayer Types</th>
<th>Basic Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc and Core</td>
<td>100-300 μm</td>
<td>100-300 psi</td>
<td>Airblast</td>
<td>• Disc (swirl plate) create droplets, core regulates flow. • Increased air velocity or pressure results in smaller droplets. • Increased flow results in larger droplets. • Different nozzles in manifold result in varying droplets. • Larger droplets have more energy to travel further.</td>
</tr>
<tr>
<td>Air Induction</td>
<td>Median ≈ 450 μm</td>
<td>80-120 psi</td>
<td>Airblast</td>
<td>• Nozzles operate via Venturi principle resulting in larger air-filled droplets. • Larger droplets are less prone to drift but move less in canopy. • Nozzles produce a flat-fan pattern.</td>
</tr>
<tr>
<td>Air Shear</td>
<td>40-80 μm</td>
<td>15-35 psi</td>
<td>Accutech and Electrostatic</td>
<td>• Lower pressure pump. • Nozzle discharges liquid at 90° to air flow, liquid is “sheared” into fine droplet size. • Droplets &lt;100 μm prone to drift.</td>
</tr>
<tr>
<td>Rotary Atomizer</td>
<td>80-140 μm</td>
<td>≈ 20 psi</td>
<td>Prop-Tec</td>
<td>• Nozzle built into fan – not a separate unit. • Very uniform droplet sizes controlled by airspeed at nozzle. • Clog proof and not affected by wear.</td>
</tr>
<tr>
<td>Ceramic Tip</td>
<td>Average ≈ 75 μm</td>
<td>80-200 psi</td>
<td>Quantum Mist</td>
<td>• 8-16 Rotational nozzles around axial fan spray head. • Varying nozzle angles changes deposition. • Full cone spray pattern.</td>
</tr>
</tbody>
</table>

*Windspeed, nozzle pressure, and droplet size are based on best knowledge and may vary based on manufacturer and sprayer set up.*
Sprayer Technology ~ Fact Sheet

The ultimate goal of spraying orchards is to deliver a uniform spray deposited over all surfaces of a tree. Losses to the soil underneath a tree and outside of an orchard through drift should be minimized.

Accutech sprayers (below) operate at a lower pressure and require less horsepower. Air-shear nozzles require very high wind velocity (195 mph). Most Accutech sprayers use a centrifugal fan and fish tail outlets. Tower designs can be customized to ensure proper cover. Accutech sprayers can be converted to deliver electrostatically charged droplets that are attracted to plant tissue.

Airblast sprayers (above) have a proven history of being robust applicators, reliable, simple to maintain, and have good resale value. Large sprayers move 60,000 cfm of air at speeds up to 120 mph. Small droplets with high drift potential are troublesome at high pressures. Modifying air intake at the fan with cut-out doughnuts can lower wind speed and reduce drift. Tower attachments allow for variable airflow, precision deposition, and reduced drift. Tower attachments allow growers to improve sprayer efficiency while continuing to use equipment they are comfortable with.

Quantum Mist (below left) and Proptec (below right) sprayers were originally designed for high-tech vineyards. Both sprayers utilize adjustable axial fans that move a large volume of air at lower velocities (Quantum Mist – 7,000 cfm/fan at 20 mph; Proptec - <10,000 cfm at <60 mph). Custom built towers and adjustable fans allow growers to precisely deposit insecticides while reducing drift. Research trials indicated that the Proptec sprayer could match airblast efficiency at lower volumes of water per acre while driving at higher ground speeds.

*Windspeed, nozzle pressure, and droplet size are based on best knowledge and may vary based on manufacturer and sprayer set up.