Psylla and Mite IPM

Elizabeth H. Beers
Tree Fruit Research & Extension Center
1100 N. Western Ave.
Wenatchee, Washington
Pear IPM – a broken system

Insecticide Resistance

(More)
<table>
<thead>
<tr>
<th>Against us:</th>
<th>For us:</th>
</tr>
</thead>
<tbody>
<tr>
<td>No dwarfing rootstock</td>
<td>Induced pests (mites, psylla)</td>
</tr>
<tr>
<td>Excess vigor</td>
<td>MD for codling moth (and low susceptibility)</td>
</tr>
<tr>
<td>Highly susceptible cultivars</td>
<td>History of soft programs that work</td>
</tr>
<tr>
<td>Concentrated production areas</td>
<td>History of cooperation</td>
</tr>
<tr>
<td>Pesticide resistance</td>
<td>Adaptability</td>
</tr>
<tr>
<td>Non-selective pesticides</td>
<td></td>
</tr>
</tbody>
</table>
A tale of two regions

Wenatchee River Valley
- Pears
- Apples
- Cherries

Yakima Valley
Key vs Induced Pests

Codling moth

Pear psylla

Spider mites

How do we know it’s induced?
Kill its natural enemies, and an outbreak occurs
# Importance of Psylla in the Pear Program

<table>
<thead>
<tr>
<th>rust mites</th>
<th>rust mites</th>
<th>mealybug</th>
<th>codling moth</th>
</tr>
</thead>
<tbody>
<tr>
<td>scale</td>
<td>mealybug</td>
<td>psylla</td>
<td>mites</td>
</tr>
<tr>
<td>psylla</td>
<td>psylla</td>
<td>codling moth</td>
<td>mites</td>
</tr>
<tr>
<td>psylla</td>
<td>psylla</td>
<td>psylla</td>
<td>psylla</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dormant/ DD</th>
<th>Cluster Bud</th>
<th>Bloom</th>
<th>Petal Fall</th>
<th>250 DD (1st CM cover)</th>
<th>Late June/early July</th>
<th>Mid-summer</th>
<th>Preharvest</th>
<th>Postharvest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surround</td>
<td>Surround</td>
<td>Mating disr.</td>
<td>Neonicotinyl</td>
<td>Altacor</td>
<td>Delegate</td>
<td>(Miticide)</td>
<td>FujiMite</td>
<td>Surround</td>
</tr>
<tr>
<td>Oil</td>
<td>Neonicotinyl</td>
<td>Dithane/Manc</td>
<td>IGR</td>
<td>Neonicotinyl</td>
<td>Neonicotinyl</td>
<td>(Miticide)</td>
<td>Sulfur</td>
<td></td>
</tr>
<tr>
<td>Lime Sulfur</td>
<td>IGR</td>
<td>Agri-Mek</td>
<td>Centaur</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pyrethroid?</td>
<td>METI</td>
<td>(Miticide)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thiodan?</td>
<td>Ultor</td>
<td>(Miticide)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Resistance: Psylla
1965 – Burts – Morestan less effective
1965 – Dean – Guthion resistance noted
1965 – Madsen et al – malathion, parathion, dieldrin resistance
1965 – Westigard – signs of Guthion resistance
1965 – Westigard – signs of Guthion resistance
1967 – Burts – Perthane less effective than previous year
1967 – McMullen – DDT reduced predator complex, PP up 240%
1968 – Burts – Perthane resistance demonstrated 4-8x; Leavenworth
1968 - Batiste – Guthion resistance in San Jose CA
1970 – Burts – test population resistant to Guthion
1990 – van de Baan – widespread resistance to fenvalerate
2005 – Greenfield, Dunley, Madsen - Significant increase in resistance to imidacloprid and thiacloprid in pear psylla from Wenatchee River Valley – but, field rate still effective
2014/15 – Unruh et al.: high levels of resistance to pyrethroids, moderate to Agri-Mek/Admire, few problems with Nexter/Delegate
Resistance in Pear Psylla

Unruh et al 2016

Delegate

% Mortality at 1x field rate

Nexter

% Mortality at 1x field rate
Resistance in Pear Psylla

% Mortality at 1x Field Rate

Warrior

Unruh et al 2016
Resistance: Mites
<table>
<thead>
<tr>
<th>Trade name</th>
<th>Common name</th>
<th>Group</th>
<th>MOA</th>
<th>Bioassay type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agri-Mek</td>
<td>abamectin</td>
<td>avermectins</td>
<td>6</td>
<td>adulticide</td>
</tr>
<tr>
<td>Acramite</td>
<td>bifenazate</td>
<td>NA</td>
<td>unknown</td>
<td>adulticide</td>
</tr>
<tr>
<td>FujiMite</td>
<td>fenpyroximate</td>
<td>METI</td>
<td>21A</td>
<td>adulticide</td>
</tr>
<tr>
<td>Envidor</td>
<td>spirodiclofen</td>
<td>tetronic/tetramic acid derivatives</td>
<td>23</td>
<td>ovicide</td>
</tr>
<tr>
<td>Onager</td>
<td>hexythiazox</td>
<td>mite growth inhibitors</td>
<td>10A</td>
<td>ovicide</td>
</tr>
<tr>
<td>Zeal</td>
<td>etoxazole</td>
<td>mite growth inhibitors</td>
<td>10B</td>
<td>ovicide</td>
</tr>
</tbody>
</table>
What is a Resistance Ratio (RR)?

**RR** = \( \frac{LC_{50} (R)}{LC_{50} (S)} \)

**RR** = \( \frac{10}{1} \) = 10

**The higher the RR, the more resistant the population**

---

**Resistance “Rule of Thumb”**

(Flexner et al 1988):

- **RR** < 3  Not Resistant
- **RR** 3-7  Transitional
- **RR** > 7  Resistant
Miticides – Predicted % Mortality at the field rate (Adulticides)

**Agri-Mek 4.25 fl oz**

- C1-2013: Pred. % Mort. at Field Rate = 0
- C2-2013: Pred. % Mort. at Field Rate = 20
- C3-2013: Pred. % Mort. at Field Rate = 40
- Y1-2013: Pred. % Mort. at Field Rate = 60
- C1-2014: Pred. % Mort. at Field Rate = 80
- C2-2014: Pred. % Mort. at Field Rate = 100
- D1-2014: Pred. % Mort. at Field Rate = 0
- O1-2014: Pred. % Mort. at Field Rate = 0

**Acramite 1 lb**

- C1-2013: Pred. % Mort. at Field Rate = 80
- C2-2013: Pred. % Mort. at Field Rate = 40
- C3-2013: Pred. % Mort. at Field Rate = 20
- Y1-2013: Pred. % Mort. at Field Rate = 0
- C1-2014: Pred. % Mort. at Field Rate = 80
- C2-2014: Pred. % Mort. at Field Rate = 40
- D1-2014: Pred. % Mort. at Field Rate = 20
- O1-2014: Pred. % Mort. at Field Rate = 0

**FujiMite 2 pt**

- C1-2013: Pred. % Mort. at Field Rate = 100
- C2-2013: Pred. % Mort. at Field Rate = 100
- C3-2013: Pred. % Mort. at Field Rate = 100
- Y1-2013: Pred. % Mort. at Field Rate = 100
- C1-2014: Pred. % Mort. at Field Rate = 100
- C2-2014: Pred. % Mort. at Field Rate = 100
- D1-2014: Pred. % Mort. at Field Rate = 100
- O1-2014: Pred. % Mort. at Field Rate = 100
Miticides – Predicted % Mortality at the field rate (Ovicides)

**Onager 24 fl oz**

- C1-2013: 100%
- C2-2013: 100%
- C3-2013: 100%
- Y1-2013: 100%
- C1-2014: 100%
- C2-2014: 100%
- D1-2014: 100%
- O1-2014: 100%

**Zeal 3 oz**

- C1-2013: 100%
- C2-2013: 100%
- C3-2013: 100%
- Y1-2013: 100%
- C1-2014: 100%
- C2-2014: 100%
- D1-2014: 100%
- O1-2014: 100%

**Envidor 18 fl oz**

- C1-2013: 100%
- C2-2013: 100%
- C3-2013: 100%
- Y1-2013: 100%
- C1-2014: 100%
- C2-2014: 100%
- D1-2014: 100%
- O1-2014: 100%
Pesticide Management: Failure of a Strategy
Natural Enemies are your Best Friends!
Nontarget Effects
Nontarget Effects of Pesticides

...are the unintended (negative) consequences of a pesticide spray for a pest on beneficial insects

<table>
<thead>
<tr>
<th></th>
<th>Typhs</th>
<th>Lacewings</th>
<th>Deraeocoris</th>
<th>Lady Beetles</th>
<th>Earwig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warrior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assail</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imidacloprid</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actara</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agri-Mek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delegate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rimon</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ultor</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Sulfur</td>
<td></td>
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</tr>
<tr>
<td>Altacor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Esteem</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Nontarget Effects of Acaricides

**Female Survival**

<table>
<thead>
<tr>
<th></th>
<th>% Female Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>FujiMite</td>
<td>b</td>
</tr>
<tr>
<td>AgriMek</td>
<td>b</td>
</tr>
<tr>
<td>Acramite</td>
<td>a, a</td>
</tr>
<tr>
<td>Check</td>
<td></td>
</tr>
</tbody>
</table>

**Live Larvae**

<table>
<thead>
<tr>
<th></th>
<th>Live Larvae/female</th>
</tr>
</thead>
<tbody>
<tr>
<td>FujiMite</td>
<td>c</td>
</tr>
<tr>
<td>AgriMek</td>
<td>c</td>
</tr>
<tr>
<td>Acramite</td>
<td>b</td>
</tr>
<tr>
<td>Check</td>
<td>a</td>
</tr>
</tbody>
</table>
Lime Sulfur: Rates (bioassay)

% Mortality

- LS 10%
- LS 7.5%
- LS 5.0%
- LS 2.5%
- Check

Winterform psylla
### Pear IPM Trial – 2016: Soft vs Conventional

<table>
<thead>
<tr>
<th>Timing</th>
<th>Soft</th>
<th>Conventional</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delayed dormant Psylla</strong></td>
<td>Surround, Esteem, Microthiol Oil</td>
<td>Cobalt Advanced, Exponent Oil</td>
</tr>
<tr>
<td><strong>Popcorn Psylla, rust mites</strong></td>
<td>Centaur, Esteem, Vendex</td>
<td>Centaur, Assail, Rimon, Agri-Mek</td>
</tr>
<tr>
<td><strong>Petal fall Psylla + G1 ovicide</strong></td>
<td>Centaur, Vendex, Intrepid</td>
<td>Ultor, Rimon, Agri-Flex</td>
</tr>
<tr>
<td><strong>CM G1/C1</strong></td>
<td>Altacor</td>
<td>Altacor</td>
</tr>
<tr>
<td><strong>CM G1/C2</strong></td>
<td>Altacor+Oil</td>
<td>Altacor+Oil</td>
</tr>
<tr>
<td><strong>CM G2/ovicide</strong></td>
<td>Intrepid+Oil</td>
<td>Oil</td>
</tr>
<tr>
<td><strong>CM G2/C1</strong></td>
<td>Altacor+Oil</td>
<td>Delegate+Oil</td>
</tr>
<tr>
<td><strong>CM G2/C2</strong></td>
<td>Altacor+Oil</td>
<td>Delegate+Oil</td>
</tr>
<tr>
<td><strong>CM G3/ovicide</strong></td>
<td>Oil</td>
<td>Oil</td>
</tr>
<tr>
<td><strong>CM G3/C1</strong></td>
<td>Cyd-X+Oil</td>
<td>Imidan</td>
</tr>
<tr>
<td><strong>CM G3/C2</strong></td>
<td>Cyd-X</td>
<td></td>
</tr>
</tbody>
</table>
Pear IPM: Soft vs Conventional

Psylla Adults

- Anjou-Conv
- Bartlett-Conv
- Anjou-Soft
- Bartlett-Soft

Mar  Apr  May  Jun  Jul  Aug  Sep  Oct

Adults/tap

Pear IPM: Soft vs Conventional

Psylla nymphs

- DD pop
- PF/ovi
- G1/C1
- G1/C2
- G2/ovi
- G2/C1
- G2/C2
- G3/ovi
- G3/C1
- G3/C2

Threshold (0.3 nymphs/leaf)
Pear IPM: Soft vs Conventional

Psylla Nymphs

Conventional

Soft

Psylla Nymphs (CID)

0 5 10 15 20 25 30 35

Anjou  Bartlett

Anjou  Bartlett

Conventional

Soft
Natural Enemies

Spiders

<table>
<thead>
<tr>
<th>Spider CID</th>
<th>Anjou/Conv</th>
<th>Bartlett/Conv</th>
<th>Anjou/Soft</th>
<th>Bartlett/Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Conventional</td>
<td></td>
<td>Soft</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

![Spider Image]
Soft vs Conventional: Fruit Damage (Psylla)

Psylla damage

<table>
<thead>
<tr>
<th>Fruit Type</th>
<th>Conventional</th>
<th>Soft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anjou-Conv</td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
</tr>
<tr>
<td>Bartlett-Conv</td>
<td><img src="chart" alt="" /></td>
<td><img src="chart" alt="" /></td>
</tr>
</tbody>
</table>

Legend:
- **Green**: No damage
- **Gray**: 1-10%
- **Dark Gray**: 11-25%
- **Light Gray**: 26-50%
- **Black**: >50%
• Need for winter-hardy dwarfing rootstock
• Need for pruning/training systems to manage vigor
• Need for varieties that are less sensitive to insect damage
Selective Control Program for the Pear Pest Complex in Southern Oregon

P. H. WESTIGARD,¹ L. J. GUT,¹ AND W. J. LISS²

J. Econ. Entomol. 79: 250–257 (1986)

ABSTRACT  Selective chemical control programs were evaluated in four southern Oregon pear orchards with the goal of maximizing effect of biological control agents for suppression of pear pests. The programs used prebloom oil sprays for control of San Jose scale, Quadraspidiotus perniciosus (Comstock), and for ovipositional delay of pear psylla, Psylla pyricola Foerster; diflubenzuron for codling moth, Cydia pomonella (L.); suppression; Bacillus thuringiensis Berliner for leafrollers; and, where needed, half the usual rate of cyhexatin for spider mite control. Organophosphates, carbamates, pyrethroids, and amitraz were deleted from selective programs. Predator density increased in all selective plots and was sufficiently high in two of the four orchards to give commercially acceptable control of pear psylla and to lower acaricide use by 75%. Control costs were ca. $300 per ha and $700 per ha in selective and standard programs, respectively. Density and period of colonization of pests and predators varied from site to site and appeared to depend on previous treatment history within the study area, and on the nature and management of surrounding vegetation.
Effectiveness of a Soft-Pesticide Program on Pear Pests

EVERETT C. BURTS
Washington State University, Tree Fruit Research Center, Wenatchee, Washington 98801

J. Econ. Entomol. 76: 936–941 (1983)

ABSTRACT During 1980 and 1981, spray programs using soft pesticides were compared with programs using pesticides normally applied to commercial pear orchards in central Washington for the control of the insect-mite pest complex. In 1980, all pest species present except pear psylla, *Psylla pyricola* Foerster, were held below damaging densities by both soft and standard programs or by predators and parasites that survived. In the soft-pesticide plot, two prebloom sprays of petroleum oil and four postbloom tree washes failed to prevent serious fruit russetting by honeydew from pear psylla. In the standard program, fenvalerate and oxithioquinox sprays before bloom and three postbloom sprays of amitraz provided better control of this pest than did the oil sprays and tree washes. In 1981, both soft and standard programs controlled all pest species present. In the soft plot, pear psylla density was kept below damaging level by two prebloom petroleum oil sprays and four postbloom sprays of mancozeb. Codling moth, *Cydia pomonella* (L.), was controlled in the soft plot by four cover sprays each year of diflubenzuron in 1980 or Bay Sir 8514, 2-chloro-N-[(L4-trifluoromethoxy)phenyl]amino) carbonyl benzamide) in 1981. Azinphosmethyl applied on a similar schedule in the standard plot also provided good codling moth control. Densities of major predators of pear psylla were higher in the soft than in the standard plot, but not as high as those in the untreated check.

- Soft program worked in one year of a 2-year study
- Codling moth control with and IGR (Dimilin)
Psylla populations higher in soft blocks Year 1, declined thereafter.
GMB, mites less problems in soft blocks
PRM increased in soft blocks
NEs higher in soft blocks: *Deraeocoris*, *Campylomma*, lacewings, earwigs and *Terechnites*
Fruit marking (by psylla) was higher the first year in soft blocks, same as conventional in Years 2, 3
Pest control costs $150-200/acre/year lower in soft blocks.
Proximity to native habitat is important to pear orchards trying to attract and retain natural enemies.
Soft IPM in pear limited by t
  - Lack of critical numbers for pests and natural enemies (low thresholds)
  - Limited people to sample
  - Greater risk of fruit damage.
“Pear Psylla Spray Signals To Be Given This Spring”

Wenatchee World, 9 March 1969

“A cooperative effort between TFREC, Coop. Extension, and the North Central Washington Fieldmen’s Association…”

“If all pear growers cooperate with their neighbors by applying a dormant spray for this insect, the population numbers can be reduced to a minimum before they get started”.

**Spray Time Near?** -- Pear psylla overwintering adults are sought by Extension Agent F. A. (Bill) Rushmore, left, and Dr. Everett Burts of the Tree Fruit Research Center. When the flies reach the egg-laying stage, coordinated spraying will be signaled by field men making checks like this in all localities.