New Insecticide Options for Integrated Pest Management:

Keith Granger, Jay Brunner, John Dunley and Mike Doerr
Pear Psylla Biology

Life History

- **Overwinter as winterform adults**
  - Reproductive diapause

- **Eggs when buds begin to swell**
  - Deposited around base of buds
  - Midveins and stalks of leaves

- **Winterform lay eggs through petal fall**
  - Wide age distribution of 1st gen nymphs

- **2 - 3 generations of summerform**
  - Eggs on terminals
  - Nymphs feed on new growth
Pear Psylla Biology

Life Stages

**Winterform**

1\textsuperscript{st} and 2\textsuperscript{nd} instar nymphs

**Summerform**

3\textsuperscript{rd} — 5\textsuperscript{th} instar nymphs
Pear Psylla Management: Target Life-Stages

- **Winterform adults**
  - Sulfur, Thiodan

- **Eggs**
  - Surround, oil

- **Nymphs**
  - Esteem, Novaluron
  - Agri-Mek, Neonicotinyls, Azadirachtin, Fujimite

- **Summerform adults**
Field Trials 2004

**kaolin - Surround**

- **Target winterform adult**
- **Limit oviposition**
- **Delay egg laying** = Synch 1\(^{st}\) gen. nymphs

3 Applications Pre-Bloom

**Coverage** more important than rate
**Field Trials 2004**

**thiacloprid - Calypso**

- Effective against 1\(^{st}\) and 2\(^{nd}\) instar nymphs
- Neonicotinyl Class of Chemistry
- Pear Psylla & Grape Mealybug
- Also Codling Moth Activity
- Use with 0.25% oil

**Nymphs/Leaf Clusterbud April 5**

- Check
- Agri-Mek
- Calypso 8 oz
- Calypso 6 oz
- Calypso 4 oz

Cumulative Nymph Days (1st gen)

- Check
- Agri-Mek
- Calypso 8 oz
- Calypso 6 oz
- Calypso 4 oz

This

NOT this
Field Trials 2004

**clothianidin - Clutch**

- Neonicotinyl Class of Chemistry
- Registration Pending
- Pear Psylla & Grape Mealybug
- Use with 0.25% oil

**Effective against 1\textsuperscript{st} and 2\textsuperscript{nd} instar nymphs**

- **Check**
- **Agri-Mek**
- **Clutch 6 oz**
- **Clutch 4 oz**

**Cumulative Nymph Days (1st gen)**

- This
- NOT this
Field Trials 2004

\textit{fenpyroximate} - FujiMite

\textbf{Good Psylla Activity}

\textbf{Coverage} Very Important

\textbf{Short PHI (14d)}

Good late season material

Use only once / season

- METI (like Pyramite/Nexter)
- Registered late last season
- TSSM, ERM, \textit{PRM}??
- Use with 0.25% oil

\begin{itemize}
  \item Cumulative Nymph Days (1st gen)
  \item Nymphs/Leaf Petal fall April 22
  \item Check
  \item Agri-Mek
  \item FujiMite
\end{itemize}
Pear Psylla Management: Neonicotinyl Programs

- **Clusterbud:** Assail, Calypso or Clutch
- **Petal fall:** Actara or Provado
- **Oil, Sulfur**
- **Oil, Thiodan (Carzol)**
- **Surround**
- **Agri-Mek or FujiMite**

**Development Stages:**
- **Eggs**
- **Nymphs**
- **Summerform adults**
- **Winterform adults**

**Timeline:**
- Feb: Oil, Sulfur
- Mar.: Oil, Thiodan (Carzol)
- April: Surround
- May: Clusterbud, Assail, Calypso or Clutch
- June: Petal fall, Actara or Provado
- July: Summerform adults
- Aug.: Winterform adults
- Sept.: Agri-Mek or FujiMite
- Oct.: Nymphs
Pear Psylla Management: *Peshastin Creek* - Soft Program

- **Eggs**
- **Nymphs**
- **Winterform adults**
- **Summerform adults**

- **February**: Oil, Sulfur
- **March**: Oil, Thiodan (Carzol)
- **April**: Surround, Esteem CB, PF
- **May**: Azadirachtin
- **June**: Esteem CB, PF
- **July**: Oil, Sulfur, Surround, Esteem CB, PF
- **August**: Oil, Thiodan (Carzol)
- **September**: Surround, Esteem CB, PF
- **October**: Oil, Sulfur, Surround, Esteem CB, PF

**Note**: Azadirachtin is effective against Summerform adults.
# Miticides

Many effective options

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<th>PRM</th>
<th>ERM</th>
<th>TSSM</th>
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**activity**
- none
- moderate
- high
Codling Moth Management: Interrupt the Life Cycle

1st generation

2nd generation

3rd gen.

DD from biofix

Mating Disruption

Egg laying periods

Egg hatch periods

Adult flight periods

Ovicides

Larvicides

Mating

Disruption

Egg laying periods

Egg hatch periods
Ovicides (egg killers)
How do they work?

Codling moth eggs are laid on the leaf upper surface near fruiting clusters and on fruit - both generations.

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)
Ovicides

How they work against CM

Some ovicides work if applied over the top of the egg (oil, Assail, Calypso)

Some ovicides work only when the egg is laid on top of a residue (Esteem)

Some ovicides work when applied before OR after the egg is laid (Intrepid/Rimon)
Larvicides (larval killers)

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)

Coverage is very important with new insecticides.
Ovicidal bioassays
Novaluron

High toxicity ratio = High acute toxicity

Diamond Bioassay – ovicide

<table>
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<tr>
<th>Method</th>
<th>Field Rate</th>
<th>LC&lt;sub&gt;50&lt;/sub&gt;</th>
<th>Toxicity Ratio</th>
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<td>Topical</td>
<td>74.2</td>
<td>0.07&lt;sup&gt;a&lt;/sup&gt;</td>
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Rimon Bioassay – ovicide

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<tr>
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<td>6.97&lt;sup&gt;b&lt;/sup&gt;</td>
<td>10.6</td>
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<tr>
<td>Topical</td>
<td>74.2</td>
<td>0.18&lt;sup&gt;a&lt;/sup&gt;</td>
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# Ovicidal bioassays

## Neonicotinyls

## Assail Bioassay – ovicide

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<tr>
<td>Topical</td>
<td>44.1</td>
<td>0.50a</td>
<td>88.2</td>
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## Calypso Bioassay – ovicide

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<td>281.0b</td>
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<tr>
<td>Topical</td>
<td>75.0</td>
<td>2.0a</td>
<td>37.5</td>
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## Clutch Bioassay – ovicide

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<th>Toxicity Ratio</th>
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<td>62.0</td>
<td>62.3b</td>
<td>1.0</td>
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<tr>
<td>Topical</td>
<td>62.0</td>
<td>27.1a</td>
<td>2.3</td>
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High toxicity ratio = High acute toxicity
Field Trials 2004

novaluron - Diamond/Rimon

% CM Injured Fruit
- 85 g Ai/a
- 113 g Ai/a

Apple

No difference between formulations relative to CM efficacy

Pear

No difference between rates relative to CM efficacy
Rimon 0.83EC applied at 2 X the suggested use rate (80 fl oz/a) marked fruit on developing D’Anjou pears.

More research will be necessary to determine the significance of fruit marking noted in 2004 trials.
Field Trials 2004

clothianidin - Clutch

Clutch has not provided adequate CM control in trials conducted over the past two seasons.

Avg. 28-48% reduction in % CM injured fruit

Fruit injury composed of entries and stings
Field Trials 2004

**acetamiprid - Assail**

![Graph showing % CM Injured Fruit for Apple and Pear](image)

**Apple**
- Assail 70WP 3.4oz
- Assail 30SG 8oz
- Assail 70WP 2.3oz
- Guthion 50WP
- Check

**Pear**
- Assail 70WP 3.4oz
- Assail 30SG 8oz
- Assail 70WP 2.3oz
- Guthion 50WP
- Check

Lower rate at 14d interval is an effective alternative

No difference between formulations relative to CM efficacy
Field Trials 2004

thiacloprid - Calypso

Apple

% CM Injured Fruit

- Calypso 250dd, +21
- Guthion 1250dd, +21

Low end of rate range can be effective on pear in low-mod pressure

Replace a Guthion application with neonic. when worker safety is important

Pear

% CM Injured Fruit

95% reduction
Codling Moth Management: Traditional

1st generation
- April
- May
- June

2nd generation
- July
- Aug.
- Sept.

Target the larval stage
- Guthion
- Guthion
- Imidan

Egg laying periods

Leafroller Control

Success

Adult flight periods

Egg hatch periods

Long REI = 14 days
Codling Moth Management: Substitutions

Egg hatch periods

1st generation

April  May  June

2nd generation


Success

Leafroller Control

Adult flight periods

Egg laying periods

Target the larval stage

Egg hatch periods

Guthion

Assail or Calypso

Short REI

Guthion

Imidan
Codling Moth Management: Substitutions

1st generation
- Egg laying periods
- Egg hatch periods
- 1st generation

2nd generation
- Egg laying periods
- Egg hatch periods
- 2nd generation

- Adult flight periods
- Leafroller Control
- Target the larval stage
- Guthion
- Assail or Calypso

- Short REI
- Imidan

-的成功

- Also controls leafrollers
- Intrepid

- May
- June
- July
- Aug.
- Sept.
Egg hatch periods

Adult flight periods

1st generation

April
May
June

2nd generation

July
Aug.
Sept.

Guthion
Assail or Calypso

Guthion
Imidan

Short REI

Intrepid

Also controls leafrollers

Success

Leafroller Control

Egg laying periods

Guthion

Assail or Calypso

Intrepid

Imidan

Success

Leafroller Control
Egg hatch periods
Adult flight periods
Egg laying periods
Also controls leafrollers

1st generation
2nd generation

April May June July Aug. Sept.

0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300

Target two life stages

ovicide
larvicide

Assail or Calypso
Rimon or Esteem
Intrepid

Short REI

Codling Moth Management: NO-OP Programs

Also controls leafrollers
Codling Moth Management: NO-OP Programs

1st generation
- Egg hatch periods
- Adult flight periods

2nd generation
- Egg laying periods
- Also controls leafrollers

Target two life stages
- ovicide
- larvicide

Short REI

Products:
- Oil (1%)
- Rimon
- Rimon Oil (1%)
- Assail (2.3 oz)
- Intrepid

Also controls leafrollers
Codling Moth Management: Interrupt the Life-Cycle

Rimon kills CM eggs laid on top of residues – oil kills eggs topically – Assail kills eggs topically and kills CM larvae
Codling Moth Management: Tank-Mix Modes of Action

- Tank mixing two insecticides to target two life-stages with a single application

- Mixing ovicidal activity with larvicidal activity

- Tank-mix possibilities
  - Guthion + Intrepid
  - OP + Rimon

NO-OP Tank Mixes
  - Calypso + Intrepid
  - Assail + Rimon
Codling Moth Management: Tank-Mix Concept

1st generation

April  May  June
DD from biofix
0      100   300   500   700   900
adult flight

eggs laid

oil

eggs hatch

Larvicide + Ovicide Activity

Assail or Calypso plus Rimon or Intrepid

Tank mixes of different modes

May  June
1st generation

April 1st generation

Tank mixes of different modes

Larvicide + Ovicide Activity

Assail or Calypso plus Rimon or Intrepid

Tank mixes of different modes
Field Trials 2004
NO-OP Tank Mix Trials - Apple

Oil (1%) @ 200/1200dd
Neonic + IGR @ 350/1350dd

85-90% reduction
Tank-mix
Same timing No tank-mix

85-90% reduction
No significant difference

Tank-mix 6 apps
Tank-mix 4 apps

110-90% reduction
No significant difference
The tank-mix program performed at least as good as programs where the materials were applied separately.
Codling Moth Management: NO-OP Tank-Mix

1st generation
- April
- May
- June

2nd generation
- July
- Aug.
- Sept.

Egg laying periods
- Assail or Calypso
- plus
- Rimon or Intrepid

Egg hatch periods
- Oil (1% v/v)

Leafroller Control

Success

Soft approach in 2nd generation possible

Target two life stages

Larvicide Ovicide

CM Virus or Intrepid or Rimon
Codling Moth Management: NO-OP Tank-Mix

1st generation
- April
- May
- June

2nd generation
- July
- Aug.
- Sept.

Egg laying periods
- 1st generation
- 2nd generation

Egg hatch periods
- 1st generation
- 2nd generation

Adult flight periods
- LR & CM Control

LR & CM Control
- Rimon or Intrepid

Target two life stages
- Assail or Calypso plus Rimon or Intrepid
- Assail or Calypso

Soft approach in 2nd generation possible
- CM Virus or Intrepid or Rimon

Rimon or Intrepid

Assail or Calypso

0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300

May
June
July
Aug.
Sept.

April

NO-OP Tank-Mix
Problems with mite increases observed

- DOES NOT ALWAYS OCCUR
- No decrease in predator numbers
- Possible effects of hormoligosis?

2005 Publication (coming soon…)

- Journal of Insect Science
  Role of Neonicotinyl Insecticides in Wa. Apple Nontarget Effects on Integrated Mite Control

http://www.insectscience.org/
Neonicotinyls and Mites
Effects on Tetranychids

Corrected Cum. Mite Days
(tetranychids)

<table>
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<tr>
<th>Applications</th>
<th>Total g AI/ha Applied</th>
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<tbody>
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<tr>
<td>2</td>
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<tr>
<td>4</td>
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Oil not a factor

Increase Ai (# apps) = Increase in Mites
Neonicotinyls and Mites
Effects on Predators

Oil not a factor
No effect on Predators
Codling Moth Management: Using New Products

Resistance Management

- Do not use the same class of product against more than one generation.

- Use mating disruption to reduce use of new insecticides.

- Monitor orchards and only apply insecticides when necessary.
Codling Moth Management: Why Use New Products?

Worker safety issues
   Eliminate cholinesterase testing

Worker management
   Re-entry periods short (4-12 hours)

Environment
   Conservation of bio-control agents
   Avoid stream buffer zone issues
   No or negligible effects of wildlife

Prepare for a NO organophosphate future