Building an Integrated CM and LR Program

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## Integrated Management Approach

### CM and LR Control

<table>
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<tr>
<th>Mating Disrupt</th>
<th>Larvicides</th>
<th>Ovicides</th>
<th>Cultural</th>
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### Monitoring

<table>
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<th>Models</th>
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### Biology
Biology

• Increase knowledge of key pest

• Life cycle
  ▪ Overwintering stage
  ▪ Damaging stage
  ▪ When susceptible to insecticides or biological control
  ▪ Number of generations

• Cause of outbreaks
  ▪ Hot, dry summers
  ▪ Borders, top of slopes, hotspots
Degree-Day Model

• Predict events difficult to see
  ▪ Egg hatch

• Predict size of third generation

• Important for timing insecticides
Monitoring

• Understand model predictions
• Consistent trapping program
  ▪ Measure relative densities
  ▪ Monitor adult movement
• Visual inspections
  ▪ Locate hot-spots
  ▪ Assess need for retreatment
Potential Problem With Models

![Graph showing Trap Catch against DD from biofix]
Potential Problem With Models

Trap Catch

DD from biofix

- Basin
- Prediction
Potential Problem With Models

Codling Moth Damage Evaluations

Insecticide Applications

- 250DD
- +21 d
- 1250DD

Total % CM damage

History Will Repeat Itself

Do you have a plan?

---

2nd Generation Flight

CM/Trap

Degree-Days

Prediction

2001

2002
Cultural Practices

Very few reports of control failures

“Guthion doesn’t work as well as it used to!”
Sprayer Calibration

How important is coverage?

Residual control

% Mortality

Days After Treatment

Guthion Handgun
Assail Handgun
Guthion Airblast
Assail Airblast
Building an IPM Program

- OPs
- OPs + Neonics
- OP + Neonics + Mat Disr. + IGR
- Neonics + Mat. Disr. + IGR
- Mat. Disr. + IGR
CM and LR Target Life Stages

CM Adults
CM Eggs
CM Larvae
LR Larvae

Bloom
May  June  July  Aug.  Sept.
0  100  300  500  700  900  1100  1300  1500  1700  1900  2100  2300
CM Degree-days
Standard Insecticide-based Program

- **CM Adults**: Applied at Bloom, May, June, July, Aug., Sept.

Insecticides:
- Guthion
- Imidan

Degree-days: 0, 100, 300, 500, 700, 900, 1100, 1300, 1500, 1700, 1900, 2100, 2300
Standard Insecticide-based Program

CM Adults
CM Eggs
CM Larvae
LR Larvae

M. prunae
B. thuringiensis
Guthion
Imidan
Lorsban
Success
Bloom

CM Degree-days

May
June
July
Aug.
Sept.

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

Bloom
Neonicotinyl Replacement

CM Adults
CM Eggs
CM Larvae
LR Larvae

Guthion
Neonic.
Guthion
Imidan
B.t.
B.l.

Lorsban
Success

Bloom

CM Degree-days

May
June
July
Aug.
Sept.

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

Bloom
Neonicotinyls

• Assail/Calypso - viable alternatives
• Clutch - shows little promise at this time

% Reduction From Control (Range)
Standard Insecticide Program

CM Adults

CM Eggs

CM Larvae

LR Larvae

Guthion
Neonic.
Guthion
Imidan
B.t.
Lorsban
Success

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

May June July Aug. Sept.

Bloom

CM Degree-days
Increased Pressure - What's Next?

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

Bloom

- Guthion
- Neonic.
- G. H. boll. (B.t.)
- Asana
- Imidan
- Neonic.
- Lorsban
- Success

May 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 June July Aug. Sept.

CM Degree-days
Mating Disruption As Foundation

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

- Guthion
- Neonic.
- B.t.
- Imidan

- Lorsban
- Success

- May 0-100
- June 300-700
- July 900-1100
- Aug. 1300-1500
- Sept. 1700-1900

CM Degree-days

Bloom

Success
Mating Disruption
CAMP and AWII Success Stories

Avg. moth capture per trap per year
Howard Flat, WA

Avg. percent traps capturing moths

Avg. percent codling moth damage

Avg. codling moth insecticides appl./acre
Howard Flat, WA
Hand Applied Pheromone

Release rate and longevity

mg codlemone remaining in dispenser

Age in days

CheckMate

Isomate CTT

Isomate C+

NoMate

2002

Washington State University
Tree Fruit Research and Extension Center
NoMate Fibers and Disrupt Flakes

Point Sources
Hand Applied<Fibers<Sprayable
Release Rate
Hand Applied>Fibers>Sprayable
NoMate Fibers and Disrupt Flakes
Attractiveness and Longevity

![Graph showing the attractiveness and longevity of NoMate Fibers and Disrupt Flakes compared to a 1X pheromone lure. The graph plots the proportion relative to L2 septa over days after trap placement.]
Mating Disruption As Foundation

Mating Disruption

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

Bloom

- Guthion
- Neonic.
- Guthion
- Imidan
- B.t.
- Lorsban
- Success

CM Degree-days

May 0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300 June
July
Aug.
Sept.
Mod. Pressure- Need For Ovicide

**Mating Disruption**

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

**Chemicals**
- Lorsban
- IGR
- Guthion
- Neonic.
- Guthion
- Imidan
- B.t.

**Timing**
- Bloom
- CM Degree-days
- May
- June
- July
- Aug.
- Sept.
- 0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300
Ovicidal IGRs
CM Management with Ovicides Only

% Reduction From Control (Range)

Intrepid
Esteem
Rimon
Ovicidal IGRs

Opportunity for LR Control

% Reduction From Control (Range)

Intrepid

Esteem

Control at 2nd generation

Rimon

Tree Fruit Research and Extension Center
Mod. Pressure - Need For Ovicide

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

IGR  Guthion  Neonic.

Lorsban  Bloom

Bloom
CM Degree-days

May  June  July  Aug.  Sept.
Highest Pressure- Need For Ovicide

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

IGR + IGR
Neonic.
Guthion
Imidan

Bloom

Guthion
Neonic.
B.t.

May
June
July
Aug.
Sept.

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

Bloom
CM Degree-days
Highest Pressure - Need For Ovicide

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

IGR + IGR Neonic.
Guthion + IGR Imidan

Bloom

May June July Aug. Sept.

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

Bloom CM Degree-days

IGR Guthion Neonic. Imidan

Guthion + IGR Neonic.
Stabilizing - Lower pressure/less input

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

IGR + IGR
Guthion
Neonic.
IGR + IGR
Guthion + IGR
Imidan

Bloom
May June July Aug. Sept.
0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300

CM Degree-days

Bloom
Stabilizing- Lower pressure/less input

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

Bloom

CM Degree-days

May
June
July
Aug.
Sept.

Guthion
Guthion + IGR
Imidan

IGR
IGR
Neonic.

Bloom

0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300
Stabilizing - Lower pressure/less input

Mating Disruption

CM Adults
CM Eggs
CM Larvae
LR Larvae

Bloom
CM Degree-days

May  June  July  Aug.  Sept.
0 100 300 500 900 1100 1300 1500 1700 1900 2100 2300

Guthion
IGR
Neonic.
Guthion + IGR
Imidan

IGR
Neonic.

Bloom

Guthion
IGR
Neonic.
Guthion + IGR
Imidan

LR Larvae

Neonic.
Stable CM and LR Control - AWII

Reduced rates (250 d/a)

CM Adults
CM Eggs
CM Larvae
LR Larvae

IGR
Neonic. or IGR
Neonic. or IGR

Bloom
May
June
July
Aug.
Sept.

CM Degree-days

Bloom
0
100
300
500
700
900
1100
1300
1500
1700
1900
2100
2300
## Cost of CM and LR Control?

<table>
<thead>
<tr>
<th>Program</th>
<th>CM</th>
<th>LR</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 Avg</td>
<td>$75</td>
<td>$53</td>
<td>$127</td>
</tr>
<tr>
<td>Most Intensive</td>
<td>$363</td>
<td>$0</td>
<td>$363</td>
</tr>
<tr>
<td>AWII Conv</td>
<td>$107</td>
<td>$44</td>
<td>$151</td>
</tr>
<tr>
<td>AWII Soft</td>
<td>$145</td>
<td>$0</td>
<td>$145</td>
</tr>
</tbody>
</table>
Neonicotinyls and Mites
Effects on Tetranychids

Oil not a factor
Increase Ai (# apps) = Increase in Mites

Corrected Cum. Mite Days
(tetranychids)

Total g Al/ha Applied
Neonicotinyls and Mites: Effects on Predators

Corrected Cum. Mite Days (Predators)

Oil not a factor

No effect on Predators

Total g Al/ha Applied
Organic CM - High pressure clean-up

Full Rate (400 d/a)

CM Adults

CM Eggs

CM Larvae

LR Larvae

May

June

July

Aug.

Sept.

Bloom

CM Degree-days

Oil

Bt

LR

Oil
Organic CM- High pressure clean-up

Full Rate (400 d/a)

CM Adults
CM Eggs
CM Larvae
LR Larvae

Bloom

Oil
Oil+ Entrust
Oil+ Entrust
Oil
Oil+ Entrust
Oil+ Entrust

May
June
July
Aug.
Sept.

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

Bloom
CM Degree-days

Oil
Oil+
Entrust

Bt

Oil
Oil+
Entrust
Oil
Oil+
Entrust

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust
Organic CM- High pressure clean-up

Full Rate (400 d/a)

CM Adults

CM Eggs

CM Larvae

LR Larvae

Oil
Oil+ Entrust
Oil
Oil+ Entrust
Oil+ Entrust

Bloom
May
June
July
Aug.
Sept.

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

Bloom
CM Degree-days
Organic CM - High pressure clean-up

Full Rate (400 d/a)

CM Adults

CM Eggs

CM Larvae

LR Larvae

May June July Aug. Sept.
0 100 300 500 700 900 1100 1300 1500 1700 1900 2100 2300
Bloom

CM Degree-days

Bloom

Oil

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust

Oil+
Entrust
Organic CM- Maintenance

Reduced Rate (300 d/a)

CM Adults

CM Eggs

CM Larvae

LR Larvae

Oil

Bt

May  June  July  Aug.  Sept.

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

Bloom  CM Degree-days
Organic CM- Maintenance

Reduced Rate (300 d/a)

CM Adults
CM Eggs
CM Larvae
LR Larvae

May
June
July
Aug.
Sept.

Bloom

Bt

Oil
Oil+
Entrust

Oil

Oil

Oil

Bt

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

Bloom
CM Degree-days
Organic CM- Maintenance

Reduced Rate (300 d/a)

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

Bloom

Oil
Oil + Entrust
Oil + Entrust

Bt

May
June
July
Aug.
Sept.

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

Bloom
CM Degree-days
Organic CM - Maintenance

Reduced Rate (300 d/a)

Bloom

May

June

July

Aug.

Sept.

CM Adults

CM Eggs

CM Larvae

LR Larvae

Oil

Oil Reduced Rate (300 d/a)

Bt

Entrust

Virus

Bloom

CM Degree-days
Organic CM - How low can you go?

Reduced Rate (300 d/a)

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

Bloom

CM Degree-days

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

Bloom

May June July Aug. Sept.
Organic CM - How low can you go?

Reduced Rate (300 d/a)

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

- Oil
- Oil+ Entrust
- Bt

May | June | July | Aug. | Sept.
---|---|---|---|---
0 | 100 | 300 | 500 | 700 | 900 | 1100 | 1300 | 1500 | 1700 | 1900 | 2100 | 2300

Bloom

CM Degree-days
Organic CM - How low can you go?

- CM Adults
- CM Eggs
- CM Larvae
- LR Larvae

Reduced Rate (300 d/a)

Bloom

May

June

July

Aug.

Sept.

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

CM Degree-days

Bloom

- Oil
- Oil + Entrust
- Virus
- Oil + Entrust

- Bt

- Oil
Frenchman Hills trap catch

• Virus started 2003
Best Chance for Success

• Be creative, don’t keep doing the same thing if it is not working!
• Establish a consistent monitoring program
• Use mating disruption as a base to your CM control program
Lessons learned from AWII

- Cost of CM control increases with softer programs
  - Less toxic, shorter residual = more apps
- Overall cost and control of soft and conventional programs are equal
  - IGRs, chloronicotinyls control multiple pests
  - Biocontrol likely reducing need for some sprays
- Use oil whenever possible (CM control)
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
Lacanobia subjuncta
Management

Mike Doerr
WSU-TFREC
Wenatchee
Insecticide Options

• Long list of viable alternatives
• Definite “Nos”
  ▪ B.t., Sevin, Assail, Calypso, Guthion
• Esteem- ??? No information
Insecticide Options
all very effective

• Intrepid
• Rimon
• Success
• Entrust
• Avaunt
• Surround
Insecticide Options

*Only if you must*

• Thiodan
• Asana
• Lannate
### Lacanobia Treatment Period

**Bloom**

- **May**
  - 400

- **June**
  - 700
  - 1000
  - 1300
  - 1600
  - 1900
  - 2200
  - 2500
  - 2800
  - 3100
  - 3400

**Ls Degree-days**

- **May**
- **June**
- **July**
- **Aug.**
- **Sept.**

**Treatment Period**

- **Rimon**
  - Eggs
  - Larvae
  - Adults

**Dates**

- **Bloom**
- **LR Larvae**
- **CM Larvae**
- **CM Eggs**
- **LS Larvae**
- **LS Adults**
Lacanobia Treatment Period

- LS Adults
- LS Larvae
- CM Eggs
- CM Larvae
- LR Larvae

Avaunt

- Bloom

May
June
July
Aug.
Sept.

Ls Degree-days

400 700 1000 1300 1600 1900 2200 2500 2800 3100 3400
Lacanobia management summary

• Degree-day model available
  ▪ 44/90°F thresholds, No Biofix reset
  ▪ Target 80% hatch and small larvae
    • 1100DD and 3000DD

• Many selective insecticides
  ▪ Opportunity for multiple pests

• One application/gen should be enough