The Mid-Season Lepidopteran Complex On Apple: How Complex Is It?

Lepidopteran Resistance Pest Management Strategies

New England Vegetable & Fruit Conference
2:30PM, December 17, 2013
Radisson Hotel in Manchester, NH

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Senior Extension Associate – Entomology
Presentations can be found at:
http://blogs.cornell.edu/jentsch/presentations/
Hudson Valley Lepidopteran pest complex overview

**Leafroller:**  
Obliquebanded leafroller, *Choristaneura rosaceana* (Harris)  
Sparganothis Fruitworm (*Sparganothis sulfureana*)  
Redbanded leafroller, *Argyrotaenia velutinana* (Walker)  
Variegated leafroller, *Platynota flavedana* (Clemens),  
Tufted apple bud moth, *Platynota idaeusalis*  
Fruit tree leafroller, *Archips argyrospila* (Walker),

**Internal Lepidopteran:**  
Oriental fruit moth  
Lesser apple worm  
Codling moth

**Green Fruitworm**

**Trunk Borers**

**Leafminers**
Hudson Valley Lepidopteran pest complex overview

Leafroller:
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Trunk Borers

Leafminers
### The Lepidopteran Complex in NYS Tree Fruit Resistance Management

<table>
<thead>
<tr>
<th>Fruit feeding</th>
<th>Foliar &amp; Cambium feeders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obliquebanded Leafroller</td>
<td>Spotted Tentiform Leafminer</td>
</tr>
<tr>
<td>Codling Moth</td>
<td>Dogwood Borer</td>
</tr>
<tr>
<td>Oriental Fruit Moth</td>
<td></td>
</tr>
<tr>
<td>Lesser Apple Worm</td>
<td></td>
</tr>
<tr>
<td>Red Banded Leafroller</td>
<td></td>
</tr>
<tr>
<td>Spotted Green Fruitworm</td>
<td></td>
</tr>
</tbody>
</table>

*(8 fruit feeding lepidopteran insects)*
Lep. Management & Insecticide Resistance Efforts Should Be Concentrated On Obliquebanded Leafroller & Codling Moth

Q. Life is Too Complicated........Why Manage Resistance?

A. When Insects Become Resistant To Insecticides Then Life Really Gets Complicated!!
Rejections of Apple Shipments From Western NY Processing Orchards Due to Increasing Internal Worm Infested Fruit

2001: 20 loads of infested fruit

2002: 80 loads of infested fruit from 42 growers in WNY¹

2005: 100 loads of infested fruit from 60 farms.

1. Rhode Island Greening (12 loads), Monroe (12 loads), Cortland (7 loads), Idared (7 loads), Jonagold (6 loads), Rome (4 loads)
Azinphos-methyl susceptibility levels

Azinphos-methyl LD90 Levels of Adult Codling Moth Populations in NY Orchards, 2009

NY Orchard

Eny Dressel
Eny Indian Ladder
Eny Truncali
Bazon Susceptible
Eny Morello
WNY Williamson
WNY Wolcott 1
WNY Wolcott 2
WNY Verbridge

More Susceptible
Less Susceptible
Codling Moth Larvae Bioassay (susceptible ‘Benzon’ Colony), NYSAES, Highland NY 2009

Warrior @ 0.16 fl. oz. /A

Interaction Bar Chart
Effect: Trt. Dependent: cm mortality With 95% Confidence error bars.

Trt.
Cell Means of cm mortality

Codling Moth Larvae Bioassay (susceptible ‘Benzon’ Colony), NYSAES, Highland NY 2009

1 Bioassay conducted on 1st instar codling moth larva topically treated with 1µL droplet of lamda-cyhalothrin at 0.0005 µg A.I./ 1000 mL or 0.0005 ppm [3% of the labeled field rate] placed in temperature controlled chambers over 24 hours. ( df = 3, F-value = 8.648, P-value = 0.0001).
**Obliquebanded Leafroller**
*Family: Tortricidae*

- OW as late instar larvae
- Damage to blossoms/clusters from TC to 1C
- Two summer broods
- Most damage by 1st brood through-out late June and July
Obliquebanded Leafroller
Family: Tortricidae

Overwintering larva damage to flowers, foliage and developing fruit

Overwintering

<table>
<thead>
<tr>
<th>GT</th>
<th>TC</th>
<th>P</th>
<th>Bloom</th>
<th>PF</th>
<th>1C</th>
<th>2C</th>
<th>3C</th>
<th>4C</th>
<th>5C</th>
<th>6C</th>
<th>7C</th>
<th>8C</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 March</td>
<td>21 April</td>
<td>27 April</td>
<td>3 May</td>
<td>13 May</td>
<td>28 May</td>
<td>10 June</td>
<td>25 June</td>
<td>5 July</td>
<td>15 July</td>
<td>1 Aug.</td>
<td>15 Aug.</td>
<td>1 Sept.</td>
</tr>
</tbody>
</table>
**Obliquebanded Leafroller**  
Family: Tortricidae

1st summer brood larva damage to foliage and developing fruit
Obliquebanded Leafroller

2nd summer brood occurs in Mid-August

Larval emergence gives rise to the over-wintering generation.

Pin hole feeding damage near harvest in mid-late season varieties (Jonagold)
Obliquebanded Leafroller
Family: Tortricidae

- The 1\textsuperscript{st} and 2\textsuperscript{nd} summer generation adults are monitored using pheromone traps.

- To use on-line NEWA models for management, dates for the first sustained flight using trap captures is necessary.

- Warm sites capture adults earlier.
‘Delta’ Trap

Species Specific Pheromone
1st sustained capture

1st Generation CM Emergence

1st sustained capture

2nd Generation Emergence
Species Specific Pheromone

‘Delta’ Trap

Species Specific Pheromone

Determine key biological events of the Lep. complex in orchards.
1. Presence of the insect in our orchard.
2. Determine the ‘Biofix’ or **start of a generation**.
3. Use NEWA\(^\text{\textregistered}\) to find the predicted date of larva emergence.
4. Make application based on optimum weather window on either side of larval hatch.
Insect Pest Management Success
And Management To Reduce The Resistance Potential =
Proper Insecticide Selection
Use Insecticides With Efficacy To Manage:

I. Overwintering OBLR At PF (specific insecticide)
Use Insecticides With Efficacy To Manage:

II. Plum Curculio 2\textsuperscript{nd} Application at 1\textsuperscript{st} or 2\textsuperscript{nd} cover (model)

+ CM Efficacy
Use Insecticides with efficacy to manage:

III. A Three Spray Program For OBLR + CM Efficacy)
Use Insecticides with efficacy to manage:

IV. OR Two Applications For OBLR + CM

PC / OBLR  PC / OBLR  PC  PC  OBLR  OBLR  AM  AM  AM/OBLR

TC-Pink  Bloom PF  1C-3C  4C-6C  7C-8C
Use Insecticides with efficacy to manage:

IV. One Application For AM / CM
The Lepidopteran Complex In NYS Tree Fruit Resistance Management

Using NEWA Weather Stations To Make Pest Management Decisions.

http://newa.cornell.edu/
The Lepidopteran Complex In NYS Tree Fruit
Resistance Management

Using NEWA Weather Stations To Make Pest Management Decisions.
The Lepidopteran Complex In NYS Tree Fruit Resistance Management

Using NEWA Weather Stations To Make Pest Management Decisions.

- Choose site based on your location
The Lepidopteran Complex In NYS Tree Fruit Resistance Management

Using NEWA Weather Stations To Make Pest Management Decisions.

- Choose site based on your location
- Obliquebanded leafroller
- Codling moth
NEWA Apple Insect Models

Select a pest: Obliquebanded Leafroller

Weather Station: Tyngsboro, MA

Accumulation End Date: 06/01/2013

Calculate

Trying to determine location...
NEWA Apple Insect Models

Select a pest: Obliquebanded Leafroller

Weather Station: Tyngsboro, MA

Accumulation End Date: 06/01/2013

Calculate

Obliquebanded Leafroller Results for Tyngsboro

Accumulated degree days (base 43°F) 1/1/2013 through 6/1/2013: 816 (0 days missing)

Phenological stage: Post Petal Fall

The phenological stage above is estimated. Select the actual stage and the model will recalculate recommendations.

Pest stage: First generation moths emerge

<table>
<thead>
<tr>
<th>Pest Status</th>
<th>Pest Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult flight begins. In western NY first flight usually occurs around the middle of June.</td>
<td>No control measures are recommended for adults. Sprays to control summer generation of larvae are timed to coincide with the first hatch of eggs.</td>
</tr>
</tbody>
</table>

Disclaimer: These are theoretical predictions and forecasts. The theoretical models predicting pest development or disease risk use the weather data collected (or forecasted) from the weather station location. These results should not be substituted for actual observations of plant growth stage, pest presence, and disease occurrence determined through scouting or insect pheromone traps.
Obliquebanded Leafroller Results for Tyngsboro

First Trap Catch: 6/10/2013

First Trap Catch date above is estimated based on degree day accumulations or user input. Enter the actual date for blocks of interest and the model will calculate the protection period after first trap catch more accurately.

Accumulated degree days (base 43°F) first trap catch through 6/24/2013: 353 (0 days missing)

Pest stage: Peak moth flight, first egg hatch

The pest stage above is estimated. Select the actual stage and the model will recalculate recommendations.

<table>
<thead>
<tr>
<th>Pest Status</th>
<th>Pest Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>First hatch of summer OBLR eggs. Adult catches in pheromone traps are near peak numbers.</td>
<td>In order to verify model predictions, monitor growing terminals at 600-700 DD base 43F after biofix to check for the detection of the first summer generation larvae. It is too early now to monitor populations of summer larvae at this time to determine if control sprays are necessary because most eggs will hatch later during the summer. However, applying protective sprays with the first spray timed to coincide with the first hatch of larvae at approximately 350 DD base 43F after biofix followed by a second spray 10-14 days later are recommended in orchards that have had a past history of severe OBLR fruit damage or if populations of overwintering larvae were high. Pesticide information</td>
</tr>
</tbody>
</table>
Pesticides for Obliquebanded leafroller

Every effort has been made to provide correct, complete, and up-to-date pest information. Searches for multiple pests may this occurs, narrow your pest selection and search again to find suitable material(s).

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Additional Summer Sprays</td>
<td>None: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>Note: &quot;Remarks&quot; Field Changes depending on Growth Stage</td>
<td>Moderate: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
</tr>
<tr>
<td>High: ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Program Type:</th>
<th>Key:</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ All Labeled Pesticides</td>
<td>AM - Apple Maggot</td>
</tr>
<tr>
<td>☐ Non-OP</td>
<td>FB - Fire Blight</td>
</tr>
<tr>
<td>☐ Conventional</td>
<td>AS - Apple Scab</td>
</tr>
<tr>
<td>☐ Reduced-Risk</td>
<td>CM - Codling Moth</td>
</tr>
<tr>
<td>☐ Organic</td>
<td>PC - Plum Curculio</td>
</tr>
<tr>
<td></td>
<td>Aph - Green Aphids</td>
</tr>
<tr>
<td></td>
<td>GFW - Green fruitworms</td>
</tr>
<tr>
<td></td>
<td>LH - Leafhoppers</td>
</tr>
<tr>
<td></td>
<td>OBLR - Obliquebanded leafroller</td>
</tr>
<tr>
<td></td>
<td>RAA - Rosy Apple Aphid</td>
</tr>
<tr>
<td></td>
<td>RBLR - Redbanded Leafroller</td>
</tr>
<tr>
<td></td>
<td>SJS - San Jose Scale</td>
</tr>
<tr>
<td></td>
<td>STLM - Spotted Tentiform Leafminer</td>
</tr>
<tr>
<td></td>
<td>TPB - Tarnished Plant Bug</td>
</tr>
</tbody>
</table>
**Common Name:** Bacillus thuringiensis (B.t.)

**Trade Name:** Agree 3.8WS

**Amount Per Acre:** 1.0-2.0 lb

**REI:** 4 Hours

**PHI:** 0 Days

**EPA Registration Number:** 70051-47

**Pesticide Type:** Insecticide

**Remarks:**
Recommended period for control of codling moth, lesser appleworm, obliquebanded leafroller [For Bt products, greater efficacy against summer brood larvae has been shown with 2–4 sprays at the low rate on a 7-day interval, starting 10–12 days after first adult catch], oriental fruit moth, redbanded leafroller.

**Effect on Beneficials:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Toxicity</th>
</tr>
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<tbody>
<tr>
<td>Amblyseius fallacis</td>
<td>L</td>
</tr>
<tr>
<td>Aphidoletes aphidimyza</td>
<td>L</td>
</tr>
<tr>
<td>Typhlodromus pyri</td>
<td>L</td>
</tr>
<tr>
<td>Stethorus punctum</td>
<td>L</td>
</tr>
</tbody>
</table>

**L - Low Toxicity**

**M - Moderate Toxicity**

**H - Highly Toxicity**

---

**Common Name:** Bacillus thuringiensis (B.t.)

**Trade Name:** Biobit XL 2.1FC

**Amount Per Acre:** 2.0-7.0 pt

**REI:** 4 Hours

**PHI:** 0 Days

**EPA Registration Number:** 73049-46

**Pesticide Type:** Insecticide

**Remarks:**
Recommended period for control of codling moth, lesser appleworm, obliquebanded leafroller [For Bt products, greater efficacy against summer brood larvae has been shown with 2–4 sprays at the low rate on a 7-day interval, starting 10–12 days after first adult catch], oriental fruit moth, redbanded leafroller, Sparganothis fruitworm, variegated leafroller.

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<td>L</td>
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<td>Stethorus punctum</td>
<td>L</td>
</tr>
</tbody>
</table>

**L - Low Toxicity**

**M - Moderate Toxicity**

**H - Highly Toxicity**

---

**Common Name:** Spinosad

**Trade Name:** Entrust 80WP

**Amount Per Acre:** 1.5-3.0 oz

**REI:** 4 Hours

**PHI:** 7 Days

**EPA Registration Number:** 62719-282

**Pesticide Type:** Insecticide

**Remarks:**
Recommended period for control of codling moth, obliquebanded leafroller.

**Effect on Beneficials:**

<table>
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<th>Toxicity</th>
</tr>
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<tr>
<td>Stethorus punctum</td>
<td>L</td>
</tr>
</tbody>
</table>

**L - Low Toxicity**

**M - Moderate Toxicity**

**H - Highly Toxicity**
## Pesticide

**Trade Name:** Entrust 80WP

### Basic Information

**Common Name:** spinosad  
**Pesticide Type:** Insecticide  
**EPA Registration Number:** 62719-282

### Chemical Information

**Chemical Class:** antibiotic  
**Amount Per Acre:** 1.5-3.0 oz  
**Amount Per 100:** 0.5-1.0 oz  
**REI:** 4 Hours  
**PHI:** 7 Days  
**Restricted Use:** § Potentially acceptable in certified organic programs
Spinosad (SpinTor, §Entrust) is a mixture of spinosyn A and spinosyn D molecules, a naturally derived group of toxicants from a species of Actinomycete bacteria. Spinosad, which acts as both a contact and a stomach poison, is available for use in apples, pears and stone fruits, primarily against obliquebanded leafroller, although activity against spotted tentiform leafminer is also exhibited. Spinosad is essentially nontoxic to birds, fish, aquatic invertebrates, and most beneficials. It has a low bee-poisoning hazard.

**Insecticide**

**IRAC ([Insecticide Resistance Action Committees]):** 5

**Toxicity To Bees:** Low

**Insecticide Type:** Organic, Non-OP, Reduced-Risk

**For Use on Apples**

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codling Moth</td>
<td>InsectsAndMites</td>
<td>Moderate</td>
</tr>
<tr>
<td>Apple Maggot</td>
<td>InsectsAndMites</td>
<td>Moderate</td>
</tr>
<tr>
<td>Spotted Tentiform Leafminer</td>
<td>InsectsAndMites</td>
<td>Moderate</td>
</tr>
<tr>
<td>Green fruitworms</td>
<td>InsectsAndMites</td>
<td>High</td>
</tr>
<tr>
<td>Obliquebanded leafroller</td>
<td>InsectsAndMites</td>
<td>High</td>
</tr>
<tr>
<td>Redbanded Leafroller</td>
<td>InsectsAndMites</td>
<td>High</td>
</tr>
</tbody>
</table>
Specimen Label

Dow AgroSciences

Entrust®

Naturalyte® Insect Control

Trademark of Dow AgroSciences LLC

A Naturalyte® insect control product formulated for control of lepidopterous larvae (worms or caterpillars), leafminers, thrips, and red imported fire ants.

| Group | 5 | INSECTICIDE |

Active Ingredient:
spinosad
(a mixture of spinosyn A and spinosyn D) .................................................. 80%
Other Ingredients................................................................. 20%
Total .................................................. 100%

Contains 80% active ingredient on a weight basis.
EPA Reg. No. 62719-282

OMRI Listed

Mixers/loaders must wear:
• An approved dust/mist filtering respirator (NSHA/NIOSH approval number prefix TC-21G), or NIOSH approved respirator with any N, R, P or HE filter.

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.
• Remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.

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 bees exposed to treatment for 3 hours following treatment. Do not apply this pesticide to blooming, pollen-shedding or nectar-producing parts of plants if bees may forage on the plants during this time period. This product is toxic to aquatic invertebrates. Do not apply directly to water, to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when 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.

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.
Use Insecticides with efficacy to manage:

Active Ingredient (AI) Rotational Strategies For Resistant Mgt.

Different IRAC Group For Each Generation

April
TC-Pink
May
Bloom PF
June
1C-3C
July
4C-6C
August
7C-8C
Sept.

PC / OBLR
PC / OBLR
PC
PC
OBLR
OBLR
AM
AM
AM/OBLR

CORNELL’S
Hudson Valley
LABORATORY
Use Insecticides with efficacy to manage:

Active Ingredient (AI) Rotational Strategies For Resistant Mgt.

For OBLR: 3 Different IRAC Groups
Use Insecticides with efficacy to manage:

Active Ingredient (AI) Rotational Strategies For Resistant Mgt.

For CM: 2 Different IRAC Groups
Use Insecticides with efficacy to manage:

Active Ingredient (AI) Rotational Strategies For Resistant Mgt.

For OBLR: 3 Different IRAC Groups

- PC / OBLR
- PC / OBLR
- PC
- PC
- OBLR
- OBLR
- AM
- AM
- AM/OBLR

Intrepid or Proclaim
Delegate
Delegate @ 14d
Altacor

April
TC-Pink
May
Bloom PF
June
1C-3C
July
4C-6C
August
7C-8C
Sept.
Oct.
Use Insecticides with efficacy to manage:

Active Ingredient (AI) Rotational Strategies For Resistant Mgt.

For OBLR: 3 Different IRAC Groups

Intrepid or Proclaim

Delegate + Delegate @ 14d

Assail

PC / OBLR PC / OBLR PC PC OBLR OBLR AM AM AM/OBLR

TC-Pink Bloom PF 1C-3C 4C-6C 7C-8C
Thank You…Questions??