Principles of Mating Disruption In New York Apple Production
Two general mechanisms of mating disruption

(Objective: Suppression of sexual communication with synthetic pheromones)

Inhibition of the male’s ability to respond to pheromone
Non-competitive
(e.g., desensitization, exhaustion, camouflage)

Competition between dispensers and “calling females”
Competitive
(e.g., competitive attraction, induced allopatry, induced arrestment)
Formulations of Pheromone Products used for Mating Disruption (Miller & Gut 2014)

Considerations behind the development of pheromone products
- release of pheromone over an extended period of time
- protection of active ingredient from degradation
- ease of application
- affordability
- extent to which finding of females by males is impeded

Strategies of pheromone dispenser distribution
- Densely distributed point sources
  - can range from 120-400/A (hand-applied reservoir dispensers) to several hundred million release points/A (sprayable microcapsules, flakes or fibers)
- Sparsely distributed point sources
  - can range from only a few units/A (mega dispensers such as puffers) to approximately 20 devices/A (meso dispensers such as plastic sachets)

Differences in application density, emission rate, & pheromone distribution
- higher deployment density → lower pheromone emission from individual point source
- dense formulations distributed via application process; sparse sources rely on wind
Examples of Pheromone Formulations

Hand-applied reservoir dispensers
- pheromone enclosed in plastic or dispersed in synthetic polymers
  - slowly diffuses from these reservoirs for up to 180 days
- hand-applied at rates of 200-400/A
- each releases up to several µg pheromone/hr
- limitations: high labor requirement for application ➔ associated cost
- disruption relies mainly on competitive attraction
  - disruption strongest when the competing sources greatly outnumber females
- efficacy is greatly affected by (high) number of point sources, and (low) population density
- despite high degree of orientation disruption, complete efficacy has been elusive
  - the most ‘bang for the buck’ is obtained at lower application rates
  - growers often opt to use fewer dispensers & apply supplemental insecticides as needed
Examples of Pheromone Formulations

Meso dispensers
• Attempt to combine best qualities of reservoir dispensers, yet reduce application effort
• release substantially more pheromone than std hand-applied reservoirs
• can allow for much lower densities (8/A), less labor
• competitive attraction mechanism, but possibly also could operate by desensitization

Sprayable dispensers
• pheromone encapsulated in microscopic polymer capsules (20 µm avg. size)
• sprayed on crop at 100 million+/A
• deliver 8-40 g pheromone/A over 3-4 weeks
• easy to apply, reduced labor costs
• BUT short field life; inconsistent efficacy
• rapid decline in release rate, can be washed off
• frequent low-dose applications more effective
• non-competitive mechanism (desensitization or camouflage)
Examples of Pheromone Formulations

Mechanically applied dispensers
- Examples: flakes, fibers, wax droplets
- Designed to release pheromone at about the same rate as calling females (“female-equivalents”)
- Competitive disruption mechanism
- Ease of application
- May only divert males’ attention away from calling females for short period, allowing more opportunities to search for actual females

Mega dispensers
- Ultra-sparingly distributed pheromone sources: 1-2/A
- Aerosol devices release large amounts of sex attractants
- mg quantities released every 15-30 min over 6-12 hr
- Controlled constant release rate, stable environment for pheromone prior to its release
- Male captures within plume inhibited for considerable distances downwind of device
- Low deployment density leaves areas with little pheromone coverage where mate finding can occur
- Edges a problem; supplemental border treatment advised
Strategies for Reducing MD Failures

• Location, Location, Location!
  • Block size, shape, and pest pressure

• Product selection
  • Release rate, number of point sources

• Monitoring
  • Trap design, placement, management
  • Lure selection (longevity, release rate)

• Supplemental treatments
  • Follow trapping thresholds
  • Focus on border controls
Location！Location！Location！

Best choice

Good choice

Bad choice

AREA WIDE
Pheromone Disruptants Available

- **Isomate CM/OFM TT**
  - (200 ties/A)

- **Checkmate Sprayable**
  - OFM-F
  - CM 2.0

- **Cidetrak**
  - CMDA Meso-A
  - or OFM Meso-L
  - (18-36 dispensers/A)

- **Checkmate Puffer**
  - (1-2 units/A)

- **Isomate CM/OFM Mist**
Management Approaches for Problem Blocks with CM or OFM

- Monitor closely with pheromone traps
- Time sprays according to DDs and trap captures
- Use higher insecticide rates
- Tighten up spray intervals
- Rotate insecticide chemistries between generations to prevent resistance
- Supplement with mating disruption
  - Hand-applied dispensers or mechanicals/sprayables
- Incorporate granulosis virus as long-term tactic
NEWA Apple Insect Models

Select a pest:
- Codling Moth

State:
- New York

Weather station:
- Sodus (Lake)

Accumulation End Date:
- 06/01/2017

Calculate
Codling moth results for Sodus (Lake)

First Trap Catch: 5/22/2017

Accumulated degree days (base 50°F) first trap catch through 6/1/2017: 135 (20 days missing)

<table>
<thead>
<tr>
<th>Date</th>
<th>Past</th>
<th>Past</th>
<th>Current</th>
<th>Ensuing 5 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>May 30</td>
<td>May 31</td>
<td>Jun 1</td>
<td>Jun 2</td>
</tr>
<tr>
<td>Daily Degree Days (Base 50°F)</td>
<td>16</td>
<td>17</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Accumulation since January 1</td>
<td>395</td>
<td>412</td>
<td>419</td>
<td>426</td>
</tr>
</tbody>
</table>

Pest stage: Moths flying & first eggs laid

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

Pest Status | Pest Management
--- | ---
First eggs are laid at about 50 DD and the first eggs usually hatch after about 220 DD. | Apply insecticides that need to be present before egg laying at about 50-75 DD. Apply insecticides that target early egg laying period at 100-200 DD. Pesticide information
Moths start to fly the 1st or 2nd week of June

Eggs laid immediately; young larvae begin feeding on foliage

Eventually move to fruits; can web a leaf to fruit surface and feed underneath, or in area protected by clustered fruits

Don’t burrow into apple, but excavate along surface

This larval generation can be found through July
• Moths start to fly the 1st or 2nd week of August
• Foliage is hardened off, so move preferentially to fruits
• Normally don’t get too big before going into diapause
• Fruit damage is very subtle, can easily be overlooked
• Necrotic spots show up while fruit is in storage
Important OBLR Life Events

(*start at 600 DD [base 43°F] after 1st adult catch)

Relative % Activity
(1st Summer Brood)

Optimum Treatment Period
Male flight
Egg Hatch
V Instar Larvae
Sampling Times*

6/7 6/20 7/3 7/16 7/29 8/11 8/25

Cornell Cooperative Extension provides equal program and employment opportunity.
Monitoring 1st Summer Brood OBLR

• Delta or wing-type pheromone trap
• June 1 - hang at head height in each of 2-3 randomly chosen trees in block (edge and interior)
• Check traps 2-3 times/week until 1st moth caught; wait 600 DD (base 43°F) after this date
• Sample foliar terminals for larval infestations using sequential sample chart.
• If below threshold, sample again after 100 DD more have accumulated (approximately 3-5 days)
• Preferred products: Delegate, Altacor, Exirel, Proclaim, B.t., Intrepid; some pre-mixes (Besiege, Minecto Pro, Voliam Flexi)
Dormant TC (Macs)

Pink Petal Fall Fruit Set mid-June

Early August

overwintered eggs; bases of buds, spurs

eggs hatch; nymphs, larvae

1st summer eggs

mixed stages, 7-8 generations

1st winter eggs

EUROPEAN RED MITE LIFE HISTORY
SEQUENTIAL SAMPLING CHART FOR MITES

MITE SAMPLING CHART -
Threshold = 2.5 mites/leaf
(June 1 - 30)
## Thresholds for Sampling Mites During the Summer

<table>
<thead>
<tr>
<th>Period</th>
<th>Mite Threshold</th>
<th>Corresponding % of Leaves with mites</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 1 – 30</td>
<td>2.5 mites per leaf</td>
<td>62%</td>
</tr>
<tr>
<td>July 1 – 31</td>
<td>5.0 mites per leaf</td>
<td>76%</td>
</tr>
<tr>
<td>August 1 – 15</td>
<td>7.5 mites per leaf</td>
<td>85%</td>
</tr>
<tr>
<td>After August 15</td>
<td>10.0 mites per leaf</td>
<td>91%</td>
</tr>
</tbody>
</table>
• Can be considered a 2-phase process:
  - Early season program, against overwintering generation
  - Summer program, against new populations

• Usually, a preventive approach (i.e., without need to sample) is advised for early season, depending on previous year's pressure:
  - Delayed dormant oil, an ovicide-larvacide (Apollo/Savey/Onager/Zeal) applied prebloom or (for Agri-Mek) after petal fall.

• For summer populations, scouting/sampling advised to pick up rapid mite increases on new foliage, especially during early summer when trees are most susceptible.
  - Thresholds increase as the summer goes on:
    June: 2.5 ERM/leaf;  July: 5.0 ERM/leaf;  Aug: 7.5 ERM/leaf
  - When numbers of motiles (everything but eggs) reach or approach threshold, a "rescue" material can be recommended:
    Acramite, Apollo, Envidor, Kanemite, Nealta, Nexter, Onager, Portal, Savey, Zeal
• Commercial apple orchards generally have no internal infestations of AM.
• AM management programs are designed to control flies immigrating into orchards from outside sources.
• Broad-spectrum organophosphate insecticides have historically been extremely effective in controlling AM.
• Unfortunately, it is normally not possible to remove all potential hosts for AM in close proximity to many commercial orchards.
• If possible, improved control can be obtained by removing all apple and hawthorn trees within 100 m of the borders of a commercial apple orchard.
• Softer, earlier ripening varieties are most preferred for AM oviposition and favorable for larval survival: Ginger Gold, Jonagold, McIntosh, Wealthy, Cortland.

• Harder, late ripening varieties are least preferred: Rome, Red Delicious, Golden Delicious, Northern Spy.
Apple Maggot Monitoring Traps

Yellow Board

Sphere

Combination ("Ladd")

Disposable Volatile-Baited AM Sphere Trap
Evolution of Apple Maggot Sampling Procedures

Before Calendar-based sprays after catch of 1st fly on yellow board trap.

1987 Unbaited red sphere traps, checked 1-2x per week. Threshold: 1 fly caught

After Volatile-baited sphere traps, same monitoring method. Threshold: 5/trap
Assumptions in Apple Maggot Monitoring Programs

- AM traps are attractive only over a relatively short range (20-25 m).
- Protective residues from an insecticide (organophosphate) control spray will last only 10-14 days under typical Northeastern summer conditions.
Common Deviations from AM Monitoring Protocol

• AM traps used only for timing the first spray. Additional sprays are applied at regular intervals, regardless of trap catch.
• Entire farm’s AM treatment program is based on catches in 1 or 2 monitored blocks.
• The recommended treatment threshold (avg. of 5 flies/trap) is ignored.
1. The main goal of mating disruption is:

A – to repel all the male moths away from the females

B – to trick the male moths into mating with other moth species

C – to “turn off” the males’ searching behavior

D – to interfere with the males’ ability to find the females
2. Obliquebanded leafroller late season feeding damage is often not visible in the field.

A – True

B – False
3. The purpose of sampling for European red mites several times during the season is:

A – They’re so small it could take more than one sample to get an accurate count

B – The treatment threshold changes according to the time of the season

C – It’s necessary to count the adults in the spring and compare it with the immatures later in the summer

D – They change their appearance as the season progresses
4. Which of the following statements about apple maggot is true?

A – The main threat of attack comes from AM adults emerging from the orchard floor

B – AM control sprays should target alternate host volunteer apple and hawthorn trees near the orchard

C – Volatile-baited sphere traps have a higher threshold than yellow cards because they’re more efficient at catching incoming adults

D – AM adults only attack trees on the edge of the block