Apple Arthropod Management - Summer

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Most Important Internal Fruit Feeding Lepidoptera

Codling moth,
Cydia pomonella

Oriental fruit moth,
Grapholita molesta

Lesser appleworm,
Grapholita prunivora

Fruit Injuries by Various Internal Lepidoptera Larvae

CM

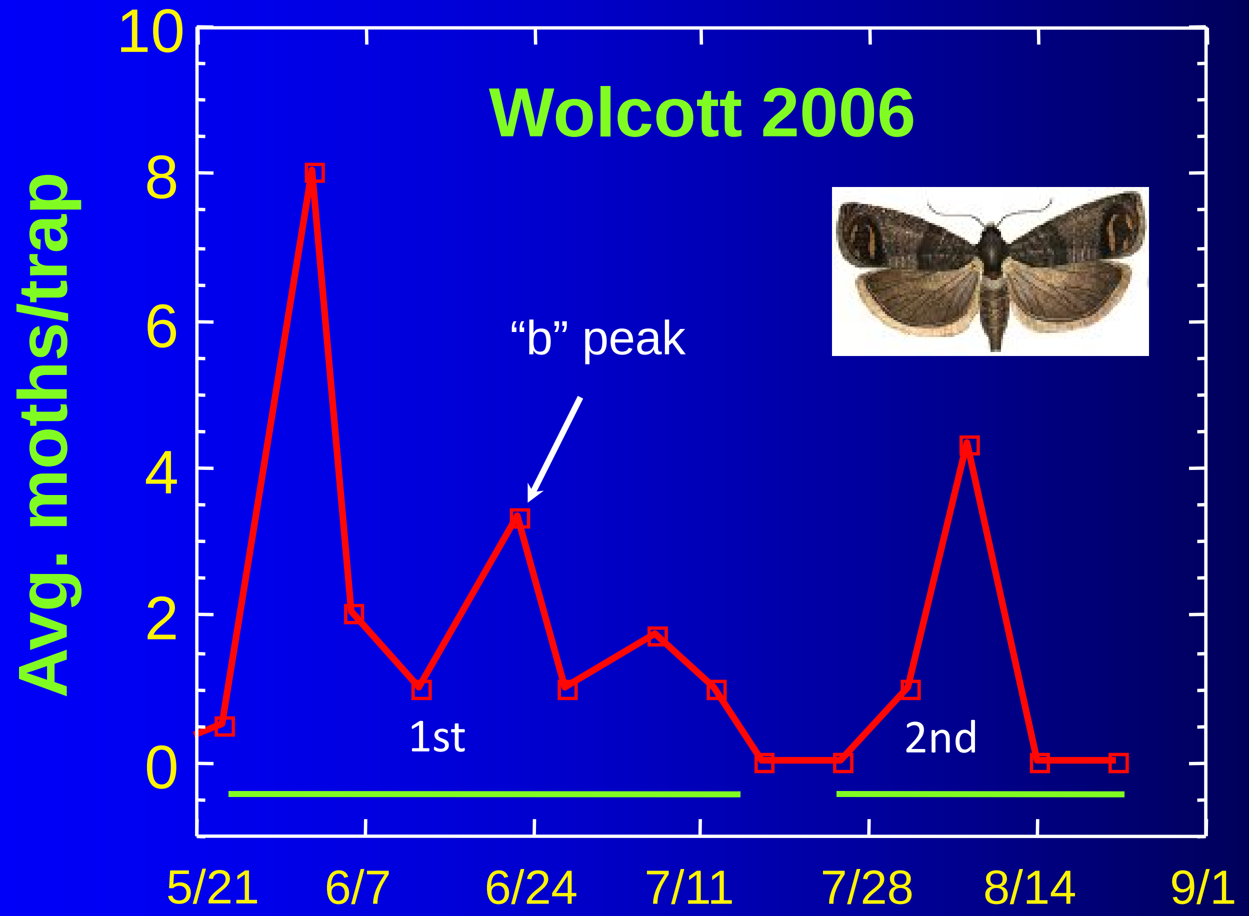
OFM

LAW

Codling Moth Biology...

- Native to Asia, in quince, apple and pear
- Brought to US by first colonists
- Hosts: apple, pear, quince; also hawthorn, crab apple; sporadic pest of apricot, peach, and plum (if planted adjacent to high population in apples)
- May be a different strain in walnut
- Larvae can overwinter in bin piles from infested crop

CM Flight Timing



- 2010 - Early season; first catch May 6-10
- Biofix generally corresponds with date of Red Delicious king bloom

CM
Egg Stage

- Egg-laying starts ~100 $DD_{50° F}$ after biofix
- Single, flat, oval, 1/20 inch; mid “red ring” and later “black head” stages
- Laid mostly on upper (apple) or lower (pear) leaf surfaces, and on fruit
- About 100 eggs/female; 90% laid in first 5 days
- Hatch in 6-14 days (starting ~250 $DD_{50° F}$ after biofix)

CM
Larval Stage

- Newly hatched: 1/10 inch; matu
- Creamy white to pinkish
- Head capsule black (young) to b
- No anal comb (differs from OFM
- Feeds for 3-4 weeks in fruit

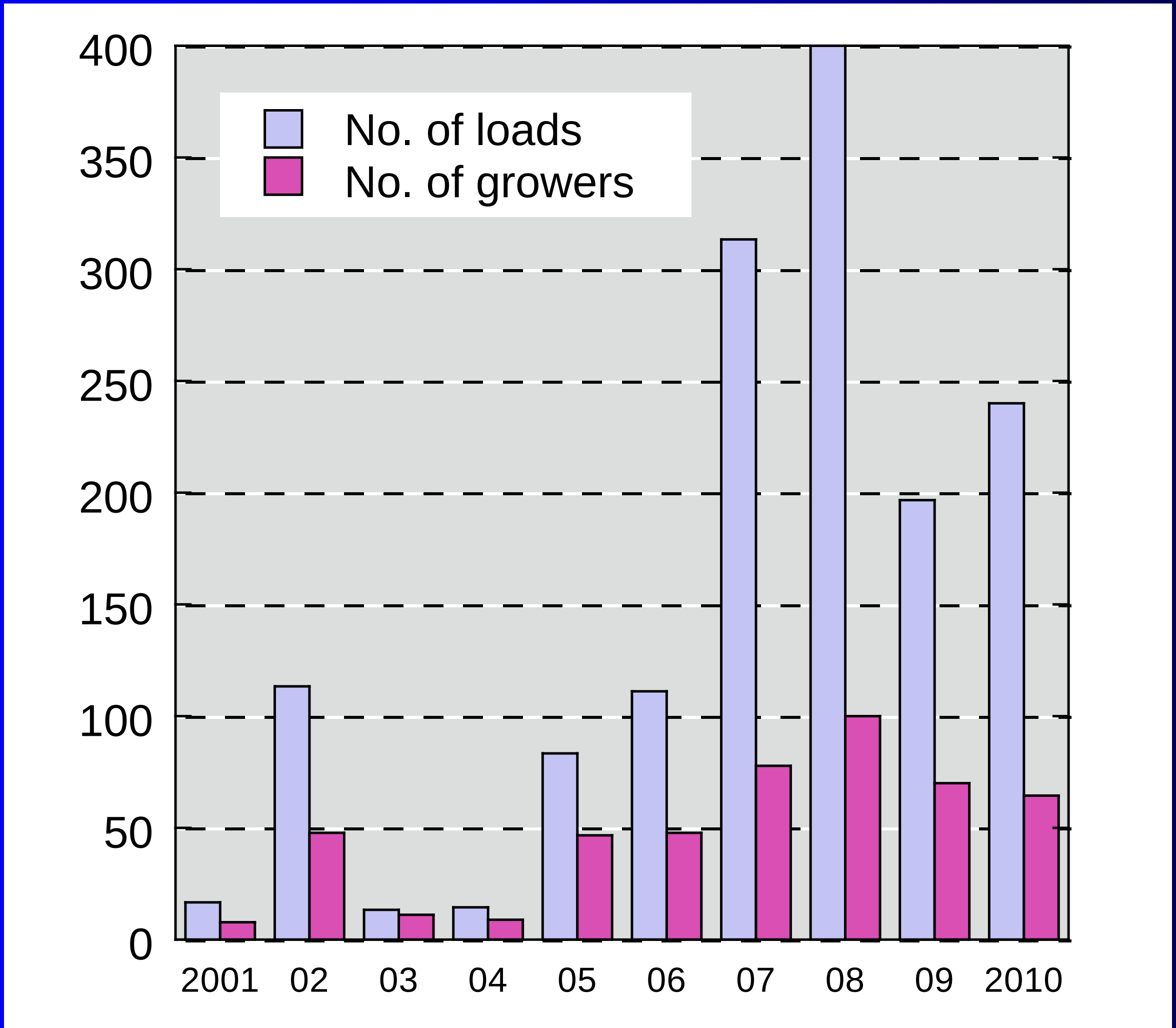
CM
Larval Stage

- Injury (internal):
- “Stings”: shallow entries, larvae killed or exited from fruit
- “Deep entries”: to core, leads to fruit rot
- Commonly feed on seeds
- May find multiple larvae in single fruit

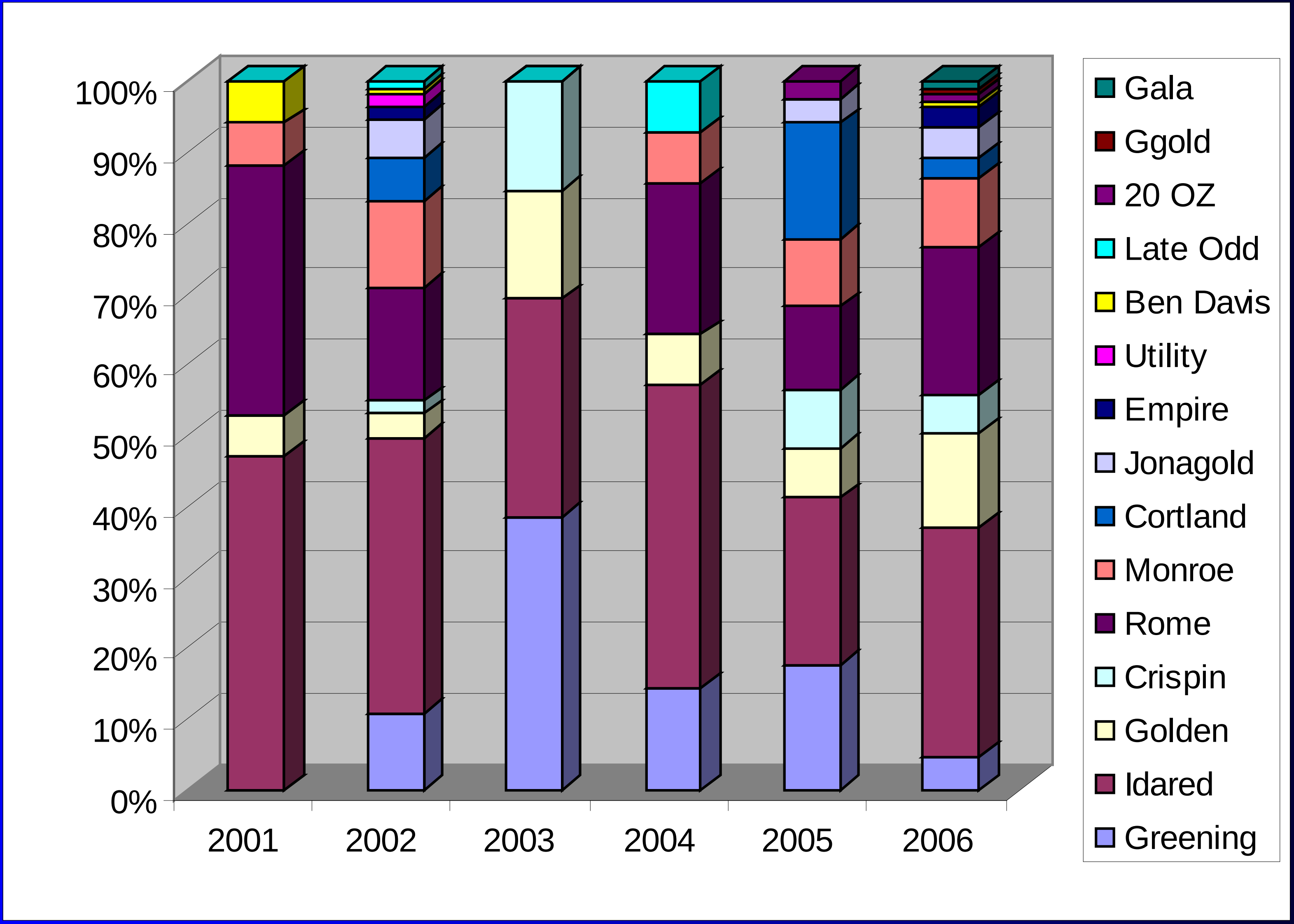
Codling Moth Problems in the 1990s to the Present

- In the early 1990s, outbreaks of codling moth occurred in commercial apple orchards throughout the world.
- First outbreaks of CM occurred in apple orchards in Washington & California apple growing regions
- Within the last 10 years, outbreaks of internal Lepidoptera have occurred in commercial apple orchards in all major production areas in the USA.
- Most of these outbreaks have been associated with the development of insecticide resistance, often to multiple classes of compounds.

Summary of Processing Apples Recently Rejected from Cadbury Schweppes ("Motts") in NYS



Trends by Variety



Why Are CM Controls Not Effective?

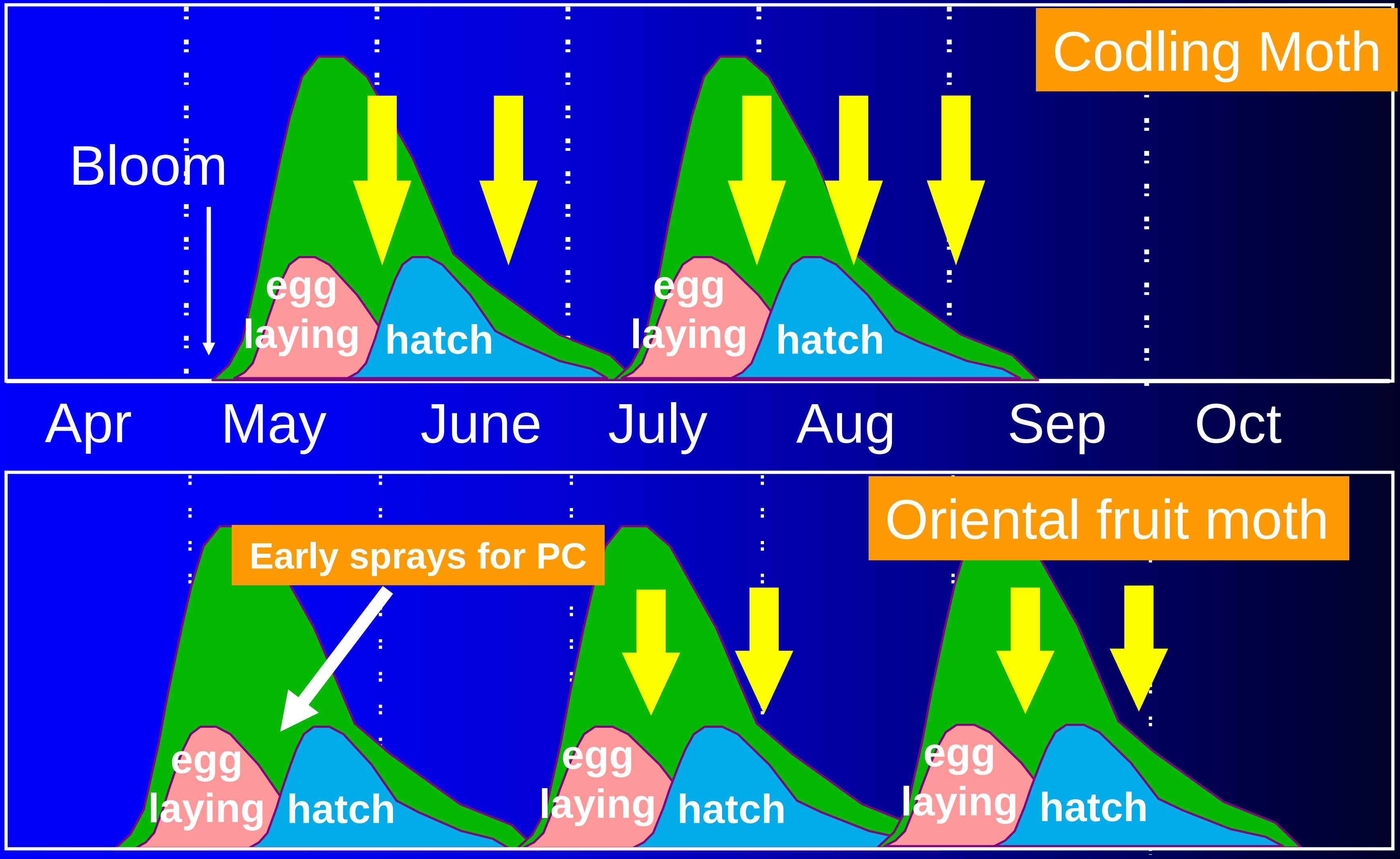
- Resistance to standard insecticides
- Biological factors, such as overwintering survival or changes in generation timing or duration

- Less than adequate performance of new materials – changes in spray programs
- Poor timing or stretching of spray intervals → gaps of opportunity

- Use of rates that are too low
- Inadequate spray coverage
- Rain events

Differences in Life Histories and Spray Timings

Critical protection windows for Internal Lepidoptera



Control Recommendations for Apple Orchards with <u>No Previous History</u> of Internal Lep Damage

- Continue to maintain normal spray schedules using conventional pesticide programs.
- Set up pheromone monitoring traps for CM (and, as necessary, OFM and LAW) in key orchard blocks.
- Monitor fruit at harvest for internal worm damage.

Use of pheromone traps to assist in decision-making, to tell you:

- What? - Detection (presence)/species ID
- When? - Establishment of biofix
- How many? - Determination of pest level
- Weak points? - Chart developmental progress (e.g., 1st flight, peak flight, hatch period)

Density of traps - How many to use?

- 1 trap/5 acres (idealistic)
- 1 trap/10-20 acres (realistic)
- no traps - ("asking for trouble")

CM/OFM Adult Monitoring

What type of trap to use?
options:

- Pherocon IIB
- Pherocon VI
- Pherocon 1C
- Multipher

What type of lure to use?

- Red septum - cheap, but short field life (3-6 weeks)
- Gray septum (L2) - more expensive, but longer life
- CM-DA - pheromone + pear essence (more useful in MD blocks)

Control Recommendations for Orchards with Trace Amounts (<2%) of Internal Lep Damage

- Apply two sprays against both the first and second generation of CM and/or OFM, on the basis of trap catches or DD model predictions.
- Avoid OPs or pyrethroids; prefer Calypso, Avaunt, Proclaim, Intrepid.
- Apply additional spray in August or early September using a material with a shorter pre-harvest interval (e.g., Assail, B.t.) to protect fruit until picking.

Chemical Control Strategies for Problem Blocks (>5% Internal Lep Damage)

- Internal orchard infestation levels or pressure from nearby sources may be high.
- Populations may be resistant to OP insecticides.
- Non-OP materials available that are effective against CM, OFM, and LAW: Delegate, Altacor, Belt, Rimon (1st gen, ovicide), Assail, Calypso, Proclaim, Intrepid (ovicidal).
- Optimize timing for each brood (2 sprays timed according to trap catches or DD models) and protect fruit in late season until harvest.
    - Ovicides: 100 DD; Larvicides: >250 DD after biofix
- Use each chemical class against only <u>one</u> generation (Altacor = Belt; Assail = Calypso; Delegate = Spintor)

Integrated Control Programs for Management of Resistant Internal Leps

- Apply alternative chemicals for control of 1st generation (Avaunt, Calypso, Rimon, Intrepid).
- Apply selective chemicals for control of 2nd generation (Altacor/Belt, Delegate, Assail), timed according to pheromone trap catches or DD models.
- Use pheromone ties for second and later generations. OR
- Apply low rates of sprayable pheromone to protect fruit from late June until harvest.

Use of CM & OFM Pheromone Trap Catches for Apple in New York

Use pheromone traps to:

1. Establish biofix (1st trap capture) for Degree Day accumulations — must calculate (CM: base 50° F, OFM: base 45° F)
2. Determine need/timing for spraying
   CM: If >5/week, 250 DD after start of each flight
   OFM: If >10/week, 170 DD after start of each flight
   a) 1st broods: PF-1C sprays
   b) if have both species => use either or both trap catch thresholds

Pheromone Disruptants Available

Isomate CM/OFM TT
(200 ties/A)

OR

Isomate-M 100
(OFM) (100 ties/A)

Isomate C-TT
(200 ties/A)

Checkmate Sprayable
OFM-F
CM-F

Checkmate
CM-OFM Duel
(150-200/A)

Management Approaches for Problem Blocks 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 sprayables

Woolly Apple Aphid Natural History

- Hosts include American elm, apple, hawthorn, mountain ash
- Overwinter as eggs in bark cracks and crevices, or as nymphs on roots underground and various protected locations on trees
- Attracted to the base of root suckers and around pruning wounds and cankers on limbs and trunks

- Unmated females give birth in aerial parts of trees to dark reddish-brown nymphs with a bluish-white waxy covering
- The nymphs migrate up or down the trunk of infested trees during summer and fall.

Woolly Apple Aphid Damage

- The main injury to young and mature trees is stunting due to the formation of root or twig galls.
- If populations are high, honeydew and sooty mold will also be a problem.

- Aphids may also enter the calyx end of the fruit.
- Can transmit perennial apple canker.

Woolly Apple Aphid Damage

Aerial colonies are found most frequently on succulent tissue, such as:

- current season's growth
- base of water sprouts growing from the tree crown
- unhealed pruning wounds
- cankers

Biological Control of WAA

- *Aphelinus mali* is a parasitic wasp that can completely control aerial colonies.
- Parasitized aphids appear as black mummies in the colony.
- It does not provide sufficient control in commercial orchards because of its sensitivity to many commonly used insecticides.

Parasitized WAA “Mummies”

Resistant Varieties

- Winter Banana is one of the most susceptible varieties to aerial galls.
- The Malling rootstock series with numbers over 100 are generally resistant (MM.106, MM.111, also G.202).
- Susceptible rootstocks include: M.9, M.26, M.7, Mark, G.65, G.16, G.41, G.11, G.5935.
- Resistance <u>not</u> passed on to scion.

WAA Management

- No chemical control for underground infestations
- For aerial colonies, monitor rootsuckers and pruning cuts between petal fall and 1st cover
- Cultural controls:
  - Remove root suckers to eliminate an early colonization site
  - Remove water sprouts on major scaffold limbs early in the season (June)
  - Paint large pruning cuts to discourage aphid colonies
  - Summer pruning in August can remove larger colonies
- Insecticide sprays when aerial colonies start to appear (could be early summer)

WAA Insecticide Recommendations

- Pennsylvania:
  - Diazinon (excellent)
  - Movento (good)
- West Virginia:
  - Diazinon, Thiodan, Movento (good)
- Washington:
  - Diazinon (excellent)
  - Endosulfan (excellent)
  - Movento (acceptable/ early season
  - Assail (suppression only)
  - horticultural oil (suppression)
- New York:
  - Diazinon (good)
  - Movento (good)
  - Thiodan, Assail, Beleaf (fair)

[Lorsban trunk spray for borers]

Woolly Apple Aphid Management Guidelines

- Be aware of rootstock susceptibility; MM series is more resistant
- Use of older broad-spectrum insecticides (OPs, carbamates, pyrethroids) will have a negative impact on biocontrol agents
- June: begin periodic inspection of pruning scars, water sprouts, and cankers for first occurrence of aerial (cottony white) colonies
- Insecticide treatments are more effective the earlier they are applied:
  - capable of decreasing the population before it becomes widespread
  - insects' waxy covering is less extensive earlier in the season
- Insecticide efficacy is improved when applied in higher-volume sprays
- Continue inspections for infestations in mid- and late summer, even if a treatment was applied earlier

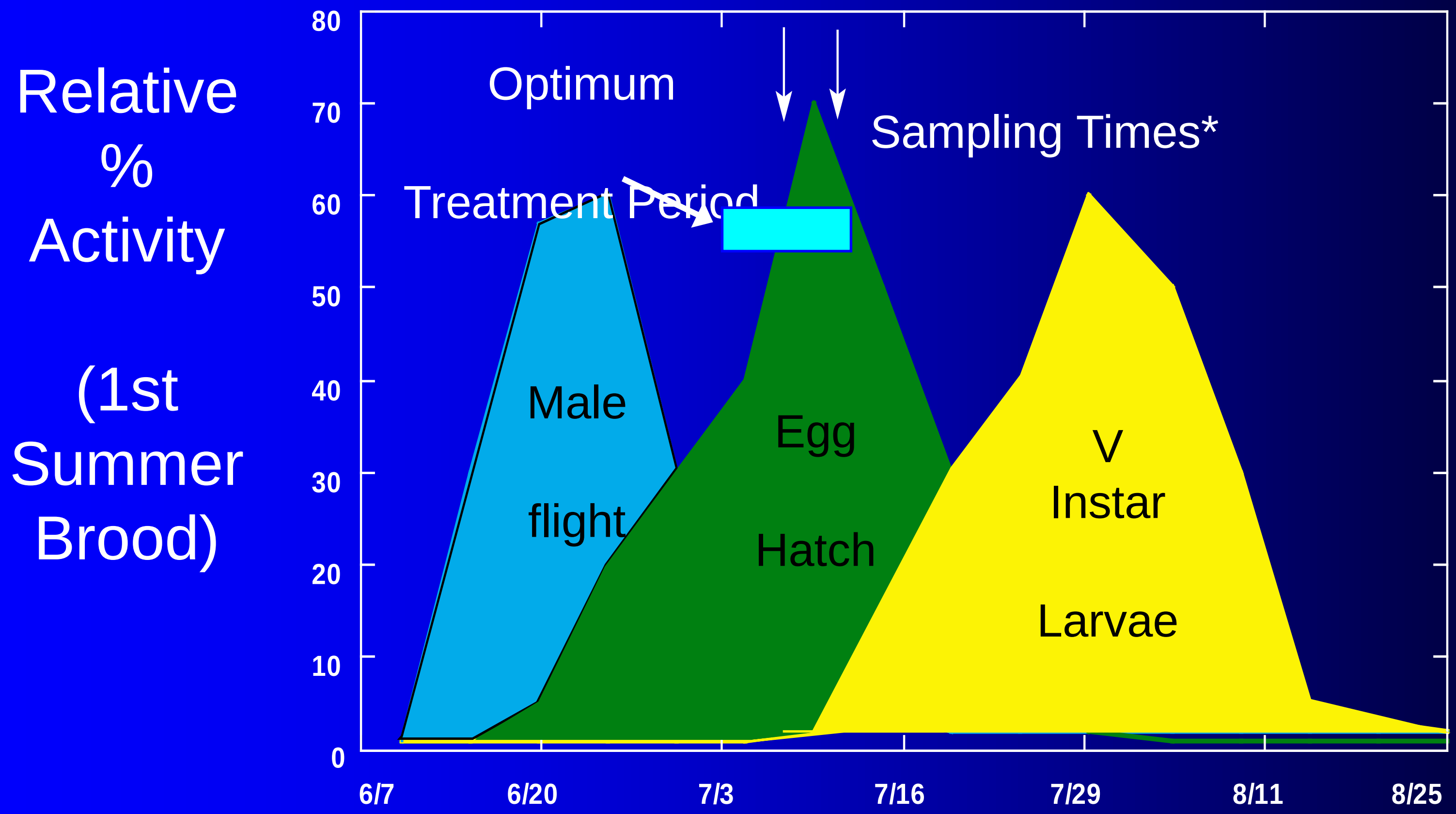
OBLR 1st Summer Brood

- 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

OBLR 2nd Summer Brood

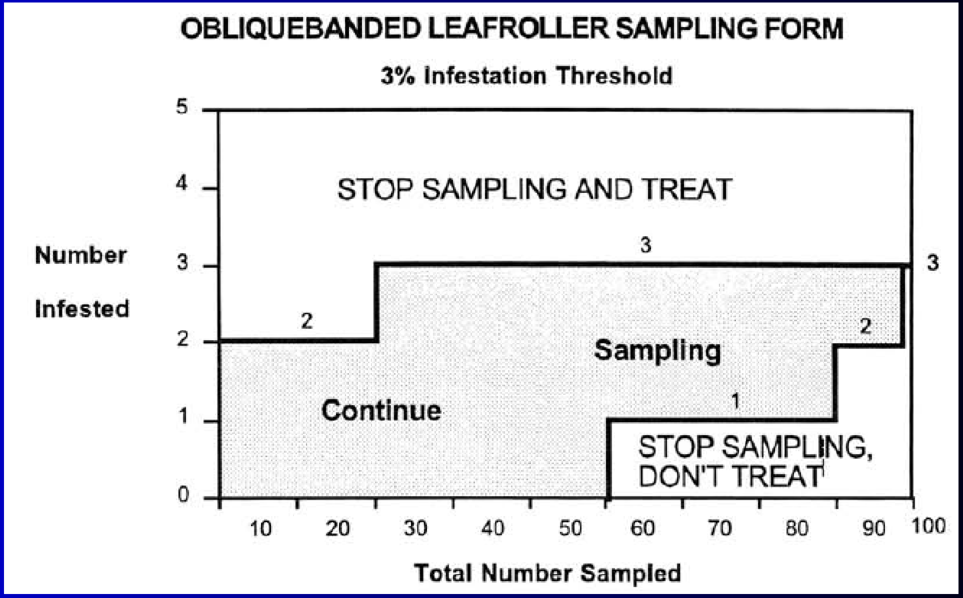
- Moths start to fly the 1st or 2nd week of August
- Foliage is hardened off, so move preferentially to fruits
- Normally don't get too big before going into diapause
- Fruit damage is very subtle, can easily be overlooked
- Necrotic spots show up while fruit is in storage

Important OBLR Life Events



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

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, Belt, Proclaim, Intrepid

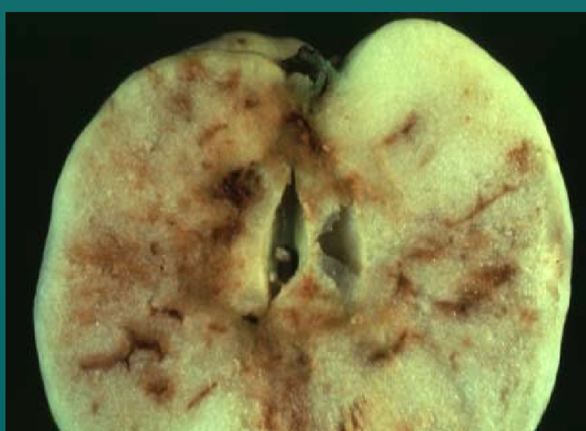
APPLE MAGGOT

Adult

Oviposition damage

Larva

Larval feeding trails



Severe tunnelling, bacterial decay

Principles of Apple Maggot Management

- Commercial apple orchards generally have no internal infestations of AM.
- AM management programs are designed to control flies immigrating into orchards from outside sources.
- Organophosphate insecticides have been extremely effective in controlling AM.

Host Removal for Management of 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.

Crataegus holmesiana

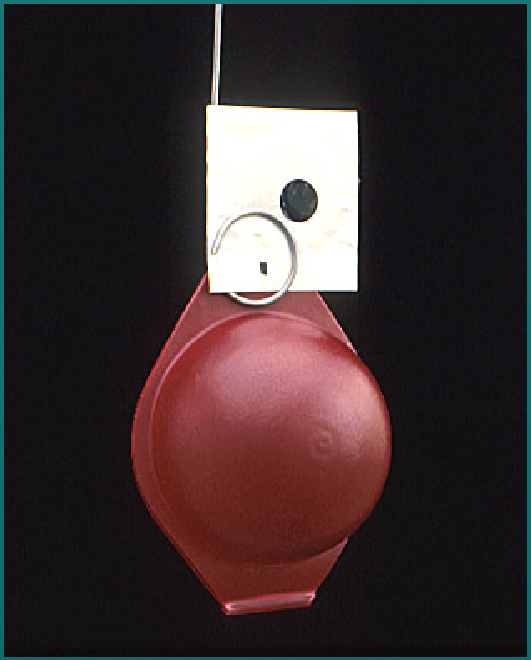
AM Preferences for Different Apple Varieties

- 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

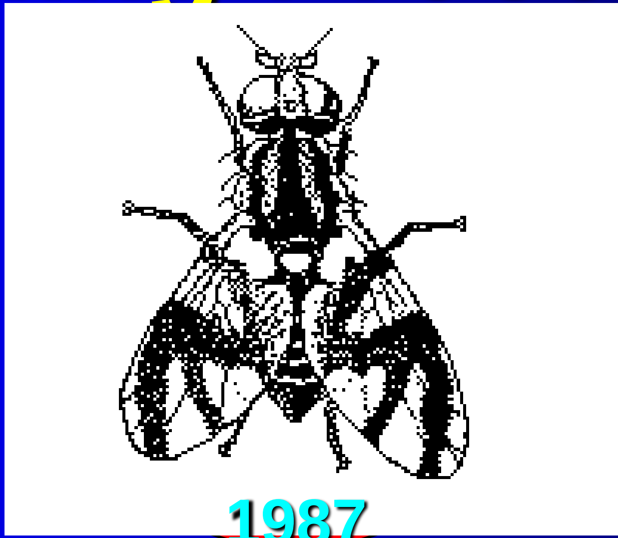
Sphere



Disposable Volatile-Baited AM Sphere Trap

Combination ("Ladd")

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.

AM Monitoring, Border Row Treatment

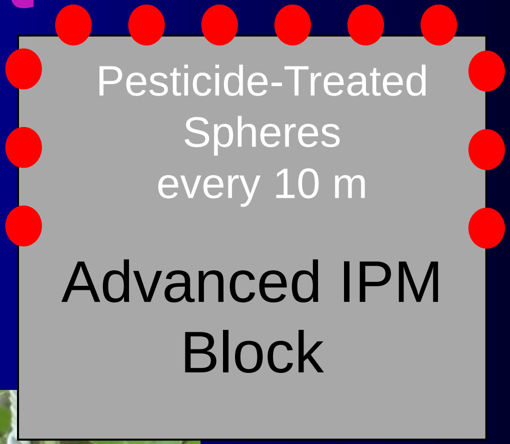
- Strategy similar to regular monitoring program except that only the border rows and the ends of rows are sprayed when threshold is reached.
- Strategy can be used in blocks with “less preferred” varieties that are not next to outside sources of infestation.

Newer & Alternative Insecticides for Control of Apple Maggot

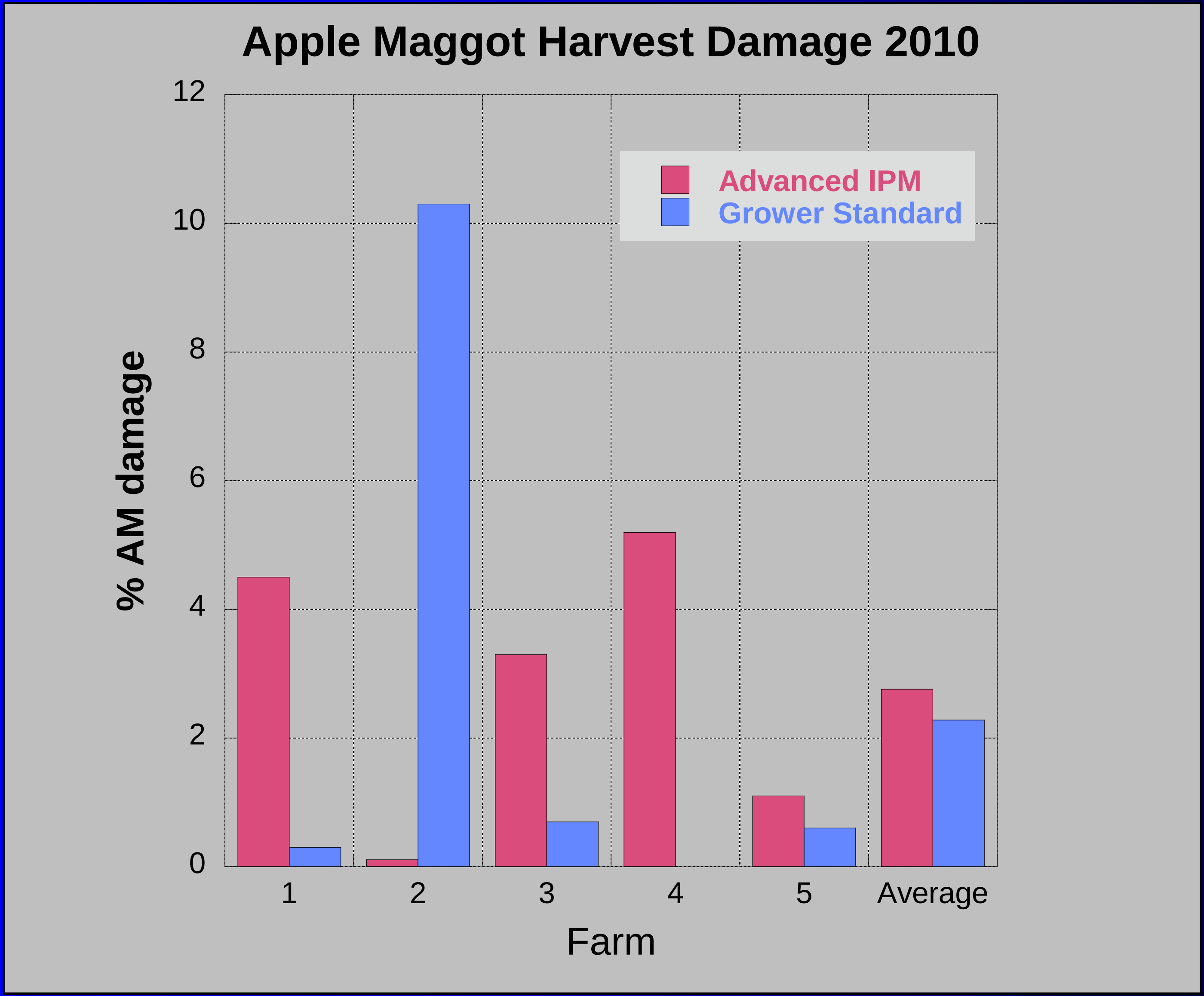
- Assail (7d PHI), Calypso (30d PHI) - neonicotinoids; selective insecticides, but with broader activity; best of the new products
- Delegate - variant of Spintor; bacterial fermentation product; suppressive action
- Avaunt - selective insecticide; suppressive action
- Altacor, Belt - diamides, mostly lep products; suppressive action
- Surround - coverage/reapplication critical

"Advanced IPM" Tactics for Apple Maggot

- Perimeter placement of Pesticide-Treated Spheres (PTS) to attract and kill immigrating AM females; spinosad + sugar
- Fruit volatile odor bait used with PTS
- Unbaited sticky spheres in interior checked for "escapes" weekly



Results



Apple Maggot Harvest Damage 2010
% AM damage
0
2
4
6
8
10
12
Advanced IPM
Grower Standard
1
2
3
4
5
Average
Farm

Possible Seasonal Programs Using Reduced-Risk or OP-Replacement Products

Pink

- Rosy Apple Aphid: Actara, Assail, Calypso, Beleaf
- Leafminers: Actara, Altacor, Assail, Calypso

Petal Fall

- Plum Curculio: Actara, Avaunt, Calypso
- Internal Leps: Assail, Avaunt, Calypso, Delegate, Intrepid, Rimon, Altacor, Belt
- OBLR: B.t., Delegate, Intrepid, Proclaim, Rimon, Altacor, Belt
- European Apple Sawfly: Actara, Assail, Avaunt, Calypso, Altacor

Summer

- Leafminers, Leafhoppers, Aphids: Assail, Avaunt, Calypso, Provado, Movento
- Internal Leps: Altacor/Belt, Delegate, Calypso, Assail, Intrepid
- OBLR: Altacor/Belt, Delegate, Proclaim, Intrepid, B.t.
- Apple Maggot: Assail, Calypso, Delegate, Altacor