Apple Pest Management Using an Organic Approach

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Fruit pest management

• Part 1: Overview of strategies & tactics
• Part 2: Putting tactics together in a seasonal program for apples
Pest Management

• **Strategies**
  – Do nothing
  – Eradication
  – Prevention **
  – Suppression *

• **Tactics**
  – Cultural
  – Mechanical *
  – Biological
  – Behavioral
  – Microbial *
  – Chemical
Cultural Controls

- Minimize infestations by choosing appropriate crop management practices

- Categories:
  - Crop location
  - Crop selection
  - How crop is maintained
Cultural Controls

• **Crop location**
  
  – Do not plant near alternate hosts (or remove alternate hosts)
    
    Example: blackberry psyllid

    • Winter hosts: pines, spruces, cedars, hemlocks

    • Do not plant blackberries within 1/8 mile of conifers; mile better
Cultural Controls

• Crop selection
  – Choose resistant varieties
    • Not many examples for insects
    • Aphid resistant raspberries
  – Ground cover (between tree rows in orchards)
    • Broadleaf covers better refuge for predatory mites
    • For better biocontrol, use broadleaf rather than grass ground cover
Cultural Controls

• **Crop selection**
  – Intercropping with a refuge planting for natural enemies
    • Adult parasitoids need nectar
    • Adult predators need pollen
    • Plant flowering border at field edge to enhance biocontrol
    • E.g. sweet alyssum by cabbage
Cultural Controls

• How crop is maintained
  – Pruning
  – Mowing
  – Sanitation (‘clean culture’)
  – Fertilizer
  – Plant growth regulators
  – Weed control
  – Irrigation/hosing
Cultural Controls

• How crop is maintained
  —Pruning
    • E.g. pears, summer pruning of water sprouts helps control pear psylla
    • E.g. raspberries: prune out raspberry cane borer and rednecked cane borer in larval stage (in stems)
Cultural Controls

• How crop is maintained
  – Sanitation or ‘clean culture’
    • Collect and compost dropped fruit to destroy pests inside fruit
Cultural Controls

• How crop is maintained
  –Sanitation or ‘clean culture’
  • Collect and compost dropped fruit to destroy pests inside fruit
Cultural Controls

• How crop is maintained
  — weed management
  — E.g.: Tarnished plant bug on strawberry
    • Weeds are also host plants
    • Especially weeds that flower early (before strawberries bloom)
    • Do not disturb (pull, mow) the weeds while your plants are in the susceptible stage
Cultural Controls

• How crop is maintained
  – Mowing between rows

_Tarnished plant bug on peach:_
  – Move from grassy ground cover & weeds into fruit trees when grass mowed
  – Where insecticides are used, better to spray then mow, not mow then spray
Cultural Controls

• How crop is maintained
  – Fertilizer
    • Some pests like plants with excess nitrogen (e.g. some aphids)
  – Plant growth regulators (PGR)
    • If succulent plant growth is suppressed by PGR, can limit pests (e.g. aphids on apple trees)
Mechanical Controls

• Use mechanical tactics to prevent or delay pests from infesting a site; use tools not needed for purposes other than pest management

• Exclusion

• Removal
Mechanical Controls

• Exclusion by barriers
  – Netting, screening
  – Paper bags
  – Localized shields
  – Copper barrier
Mechanical Controls

• Exclusion by netting
  – Periodical cicada
  – Birds
Mechanical Controls

- Exclusion by paper bags
  - Apples
  - Grapes
Mechanical Controls

- Exclusion by localized shields
  - Wrapping tree trunk with paper to prevent attack by flatheaded borers
Mechanical Controls

• Exclusion by copper barrier
  – Slugs, snails
Mechanical Controls

• Removal trapping
  – Shelter traps
  – Visual traps
  – Scented traps
• Removal by hand
• (Removal by vacuum)
Mechanical Controls

- Removal by shelter traps
  - Tree bands for caterpillars

Gypsy moth

Codling moth
Mechanical Controls

• Removal by scented traps
  – Japanese beetle
Mechanical Controls

• Removal by Visual traps + Scented traps

• Apple maggot:
  – Red sphere
  – Fruit volatile lure
  – Attracts female A.M. flies
  – Use 1 trap per 100 real fruit
Mechanical Controls

• **Hand Removal**
  – For conspicuous pests
  – For pests not too active
  – In relatively restricted area
  – Labor available

• **Limb-jarring (Beating)**
  – Plum curculio
Biological Control

= control of pest by other organisms that act as natural enemies

• 2 main categories:
  — Parasitoids
  — Predators
Natural enemies of pests

• Parasitoids
  – Some wasps
  – Some flies
Predatory Beetles

- Lady beetles
- Ground beetles
- Rove beetles
- Soldier beetles
Lacewings

• Green lacewings

• Brown lacewings
Predatory Bugs

• Stink bugs
  – Spined soldier bug
  – Twospotted stink bug

• Flower bugs
  – Minute pirate bug
  – Insideous flower bug

• Damsel bugs

• Assassin bugs

• Big-eyed bugs
Predatory Flies

• Hover flies (flower flies)

• Aphid midges

• Robber flies
Predatory mites in orchards

- White mites (Family Phytoseiidae)
  - *Neoseiulus fallacis* (=*Amblyseius fallacis*)
  - *Typhlodromus pyri*

- Yellow mites (Family Stigmaeidae)
  - *Zetzellia mali*
  - *Agistemus fleschneri*
Categories of Biological Control

• ‘Natural’ (local species)
• Importation (exotic species)
• Conservation (local species) **
• Augmentation (local species)
Behavioral Control

• Control a pest population by interfering with its normal behavior

• Pheromone mating disruption
  — Male confusion technique
  — Attract-and-kill technique
  — General rule: 5 acre minimum
  — Being used for:
    • Oriental fruit moth (peach)
    • Peachtree borers (peach)
    • Codling moth (apple)
Normal mate finding

Male confusion
Types of Products for Mating Disruption

- Manual dispensers
  - Twist tie (‘rope’)
  - Patch
  - Clip
  - Spiral
- Puffers
- Sprayable micro-encapsulated
Attract-and-kill technique

Example:

• Product ‘Last Call CM’
• Codling moth
• Apple, pear
• Made by IPM Tech
• Manual dispenser pump
• Rate: 1200 droplets per acre
• Claims to work well in small or irregular orchards
Microbial Control

• Control by micro-organisms that cause disease in insect

• **Bacteria**
  — BT sprays
  — (Transgenic BT plants)

• **Viruses**

• (fungi)

• (nematodes)

• (protozoans)
Chemical control

• OMRI-approved insecticides
  – spinosad (Entrust)
  – kaolin (Surround)
  – Soaps
  – Oils
  – Pyrethrins
Tactics that involve products applied in orchard

• Some tactics...
  — Behavioral controls
  — Microbial controls
  — Chemical controls

• Some on OMRI list, some not
OMRI-approved products

• Behavioral control
  – Pheromone mating disruption
• Microbial control
  – virus
  – B.T. (DiPel)
• Chemical control
  – spinosad (Entrust)
  – kaolin (Surround)
  – Soaps
  – Oils
  – Pyrethrins
Part 2
Fruit Crops: Insect/Disease Problems

• Require **least** inputs
  — Blueberries
  — Raspberries
  — Strawberries
  — Grapes

• Require **most** inputs
  — Peaches
  — Apples
Stages of Apple Growth

1. Suckers
2. Green Tip
3. Half-Rich Green
4. Tight Cluster
5. First Rin
6. Full Pink
7. First Bloom
8. Full Bloom
9. Post Bloom
# Apple Pest Calendar

<table>
<thead>
<tr>
<th>Month</th>
<th>1C</th>
<th>2C</th>
<th>3C</th>
<th>4C</th>
<th>5C</th>
<th>6C</th>
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- **CodlingMoth**
- **Apple Maggot**
- **Aphid (rosy)**
- **Scale (SJS)**
- **Leafroller (RB)**
- **Plum Curculio**
- **Tarn. Plant Bug**

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- **European Red Mite**
- **Leafminer (ST)**
- **Leafhopper (WA)**
- **Aphid (green)**
Biological control of apple pests by naturally occurring predators & parasitoids

<table>
<thead>
<tr>
<th>Pest</th>
<th>Enemy</th>
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<tbody>
<tr>
<td>European red mite</td>
<td>Predatory mites</td>
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<tr>
<td>Green apple aphid</td>
<td>Cecidomyid fly (orange maggot)</td>
</tr>
<tr>
<td>Rosy apple aphid</td>
<td>Hover flies, lady beetles</td>
</tr>
<tr>
<td>Spotted tentiform leafminer</td>
<td>Parasitoid wasps</td>
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</table>
Apple Pest Management Tactics

• Integrated control
  – Chemical control
    • Needed for codling moth
    • Use selective insecticide
  – Biological control of mites & other foliar pests
    • Conserve natural predators
Codling Moth in Apples

- The key pest in apple fruit
- Young larva enters fruit, tunnels to seeds at core
Codling Moth Life cycle

1st generation in May/June

2nd generation in July/August
Codling Moth Management Overview

- **Cultural**
  - Sanitation: Clean bins
  - Cut down abandoned orchards

- **Behavioral modification**
  - Pheromone mating disruption

- **Microbial sprays**
  - Virus sprays

- **Chemical sprays**
  - Insecticides
Codling Moth in Apples

• Mechanical controls:
  — Trunk bands
  — Fruit bagging
Codling moth management

Factors affecting insecticide efficacy:

• Timing
• Choice of materials
• Spray volume
Insecticide timing for codling moth

• Use 2 sprays per generation
• First spray when eggs begin to hatch
• Second spray 14 days later
Predicting Codling Moth Egg Hatch

- Eggs begin to hatch:
  - About 2 to 3 weeks after moths begin to fly (often Memorial Day +/- 1 week)
  - More exactly, 250 degree-days (base 50F) after moths begin sustained flight
- Rule developed ~30 years ago (Mich. ‘76)
Traps for Codling Moth

• Trap choices:
  — Sticky trap
  — Multi-Pher (bucket) trap

• Use pheromone lure

• ‘Biofix’ is the date that sustained flight begins
Degree-Days (DD)

• Common way to summarize development time
• Can be used to predict insect activity
• For one day, $DD = (\text{average temp}) - (\text{threshold temp})$
• Accumulate DD over consecutive days
# Degree-Days Example

<table>
<thead>
<tr>
<th>Day</th>
<th>Temp. max</th>
<th>Temp. min</th>
<th>Temp. avg</th>
<th>DD (base 50)</th>
<th>DD Cumul.</th>
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<td>62</td>
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<td>70</td>
<td>56</td>
<td>63</td>
<td>13</td>
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</table>
Insecticide timing for codling moth

• Use 2 sprays per generation
• First spray when eggs begin to hatch (250 degree-days after biofix)
• Second spray 14 days later
Codling Moth, 1996
Pheromone Trapping at O.S.U. Orchard, Columbus

Mean number of moths per trap per day

- April 22
- May 3
- May 15
- May 27
- June 7
- June 19

- pink 4/24
- bloom 5/2
- petal fall 5/9
- 1st cover 5/17
- normal 2nd cover 5/31
- delayed 2nd cover 6/4
- optimal spray 6/4
- 3rd cover 6/14

250 DD
Products for control of apple pests

• OMRI approved products
  – spinosad (Entrust)
  – virus for codling moth (Virosoft CP4; Cyd-X; Carpovirusine)
  – kaolin (Surround)
  – B.T. for caterpillars (DiPel)
  – Pheromone mating disruption if >5 acres
Codling moth granulosis virus

• **Products**
  — ‘Cyd-X’
  — ‘Carpovirusine’
  — ‘Virosoft CP4’

• **Action**
  — Only limited fruit protection
  — Significantly reduces surviving population
CpGV = *Cydia pomonella* Granulosis Virus (or Granulovirus)

- Granules are viral occlusion bodies
- Applied when eggs are hatching
- Granules ingested by young larvae before or during entry into fruit
- Host death within 3-7 days
- Breaks down in UV light
- Half-life 4-8 days
### CpGV Orchard Trials: on pears in California 2003 (very high pest pressure)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% CM infested fruit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imidan/Guthion (3 ap.)</td>
<td>3.7 a</td>
</tr>
<tr>
<td>Entrust (11 ap.)</td>
<td>3.9 a</td>
</tr>
<tr>
<td>Cyd-X (11 ap.)</td>
<td>26.9 b</td>
</tr>
<tr>
<td>Carpovirusineine (11 ap.)</td>
<td>30.5 b</td>
</tr>
<tr>
<td>untreated</td>
<td>70.2 c</td>
</tr>
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</table>
CpGV Orchard Trials: apple in NC 2004

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% of fruit with entries</th>
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<tbody>
<tr>
<td>Rimon</td>
<td>0.5 a</td>
</tr>
<tr>
<td>Cyd-X</td>
<td>0.8 ab</td>
</tr>
<tr>
<td>Rimon/Guthion</td>
<td>1.3 ab</td>
</tr>
<tr>
<td>Assail/Intrepid</td>
<td>2.3 ab</td>
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<tr>
<td>Intrepid/Calypso/Spintor</td>
<td>2.8 ab</td>
</tr>
<tr>
<td>Danitol/Guthion</td>
<td>3.0 ab</td>
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<tr>
<td>Calypso/Intrepid</td>
<td>4.0 ab</td>
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<tr>
<td>Imidan/Guthion</td>
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<tr>
<td>Guthion/Rimon</td>
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<tr>
<td>Experimental/Intrepid</td>
<td>5.8 abc</td>
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<tr>
<td>Assail/Intrepid</td>
<td>6.0 bc</td>
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<tr>
<td>Calypso/Intrepid</td>
<td>9.8 cd</td>
</tr>
<tr>
<td>untreated</td>
<td>14.5 d</td>
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For all: 2 applications for 1<sup>st</sup> generation, 3 applications for 2<sup>nd</sup> generation; 14-day interval
‘Surround’
<table>
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<tr>
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<th>Event</th>
<th>Product</th>
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<tr>
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<td>PlumCurc.</td>
<td>Surround</td>
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<td>1C</td>
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<td>CodMoth-1</td>
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<tr>
<td>3C</td>
<td>-</td>
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<td>4C</td>
<td>CodMoth-2</td>
<td>Pyganic</td>
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<td>7C</td>
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<tr>
<td>8C</td>
<td>-</td>
<td>virus</td>
</tr>
</tbody>
</table>
San José Scale

- Sucking pest
- Injures fruit & bark
- Overwinters on bark
- Disperses to fruit in crawler stage (starts mid-June)
San José Scale
San José Scale

Insecticide spray options:

• Dormant
  – Oil
  – Lime sulfur

• Post-bloom
  – Insecticidal soap
San José Scale

Management at dormant stage, in late winter or early spring:

• Use oil to smother the overwintering population on bark

• Or use lime sulfur
San José Scale

Oil spray:

• Best control of scale if applied before buds swell

• Prevent damage to tree by applying when temperature above freezing within a day of application

• Apply dilute (2 oz oil in 100 oz water; spray to run-off), cover all bark
San José Scale

• Post-bloom control options that target crawler stage
  – Insecticidal soap
San José Scale

When are crawlers crawling?
• Start about 4-6 weeks after bloom
• Usually in mid-June
• Emergence lasts several weeks
San José Scale

When are crawlers crawling?

• Use black sticky tape (electrical tape)
• Wrap sticky-side out around branch
• Look for tiny bright yellow crawlers
Apple Maggot

- A key pest in northern USA
- Not a pest in southern USA
- Variable in Ohio
Apple Maggot

• Adult fly lays egg on fruit
• Larva tunnels through fruit
• Pupation in soil
Apple Maggot

- Adult female fly attracted to round red object
- Sticky ball trap for mechanical control: 1 trap per 100 real fruit
Plum curculio

• External damage on apples from egg-laying
• Internal damage on plum, peach, cherry, blueberry from larvae tunnelling
Plum curculio

• Not many effective tactics
• Mechanical control:
  – Limb jarring (beating) on first warm humid nights near petal-fall
• Chemical control:
  – Kaolin (‘Surround’) at petal-fall
Cultural control of peachtree borers

• Train trees to form wide angles
• Promote healthy trees
• Avoid practices that injure bark
  – Over load of fruit
  – Improper pruning
  – Mowing injury
  – Fertilizing
  – Damage during harvest
Mechanical control of peachtree borers

- ‘Worming’
- Effective
- Insert knife or wire into entry hole
- Smash the larvae!
- Do in early spring or late fall
- Practical in small plantings