Organic Apple Pest Management
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Not Your Granddad's Orchard...

- Gone are the days of big trees
- Old style orchard density: >500/acre
- Modern density: 600, 1000, 1200 /acre
- Orchards over the years...
Small is Beautiful....
Pests of Apples

Insects

Disease

Weeds

Orchard Lifespan

Year 1

Year 5

Year 20
The first question...

- Where/How do I sell my apples
- Local-Direct vs. Regional
- Fresh market vs. Processing market
- Whole vs. Value added (e.g. juice, crunch packs, cider)
The second question...

- How do I know what to do?
- SCOUTING: of ultimate importance in apple PM
- Many, Many pests
- The worst are well described
- Use phenological models to guide scouting and PM tactics

![Pheromone Trap](image)

![Graph of egg laying and hatch](image)
Weeds: Friend, Enemy, or Neighbor?
WVC Mulch Trial

Weed control by mulches – June 2000

Gravenstein et al. 2006
Weed Management: Young Trees

- Site preparation: multiple years of cover crops
- Mulches: Wood, Straw, Synthetic
- Cover crops: "CHOOSE YOUR WEED"

*Sandwich system with Galium odoratum*
Weed Management: Older Trees

- Mowing: 2-3 times per season
- Light tillage
- Grazing
- Flaming
Weed Management: Complications

- Rodents like cover
- Weeds or Mulches
- Girdle and kill trees
Weed Management: Complications

- Arthropod diversity tied to plant diversity
- NE’s and pollinators
- Also some pests: Stinkbugs, Mites, Aphids
Diseases of Apples

- Two major pathogens:
  - Apple Scab
  - Fire Blight
- Many minor pathogens: Flyspeck, sootybloch, blossom blast, powdery mildew, rusts......

Sooty Blotch and Flyspeck
Apple Scab: *Venturia inaequalis*
Apple Scab

- Primary infection
- Sexual cycle
- Infects leaves
- Secondary infection
- Asexual cycle
- Infects leaves and fruit
Apple Scab Management: Bottom Up

- Resistant Varieties
- Liberty, Crimson Crisp, Empire
- Most effective tactic
- Problem??
Apple Scab Management: Bottom Up

- Sanitation: Clean up leaves
- Competitive/antagonistic BC Mechanism?
- Predation by earthworms and other shredders
- Fall fertilizer applications (High N)

Flail Mowing Leaves
Apple Scab Management: Top Down

- Copper is the most effective fungicide
  - Cannot be used on soils with high Cu
- Sulfur is also effective
- Bicarbonates not as effective (e.g. Kaligreen, Armicarb, Baking Soda)
  - Short residual activity
  - Less disruptive??
Apple Scab Management: Top Down

- Cu and S have broad activity
- Kill beneficial fungi and bacteria
- Kill/Repel Earthworms
- Disrupt predatory mites
- Disrupt other NE's?
Fire Blight: *Erwinia amylovora*

- Bacterial pathogen
- Infects shoots, blossoms, wood
- Can rapidly kill trees
- May be carried by pollinators
- Like scab is tied to humidity and temperature conditions
Many Insect/Arthropod Apple Pests!!

- Moths/Worms
- Beetles
- Flies
- Aphids
- Mites
A Survey of Direct Apple Pests and Top Down PM

- Codling Moth (CM) and Oriental Fruit Moth (OFM)
- Plum Curculio (PC)
- Apple Maggot (AM)
Monitoring insects in orchards

Pheromone traps for moth pests

Tower traps for plum curculio

Sphere traps for apple maggot

Traps tell us if we have a problem!
Codling and Oriental Fruit Moths

- Small brown moths native to Eurasia
- Larvae (worms) develop inside fruit
- CM: apples, pears, walnuts, quince
- OFM: stone fruits, apples, and pears
CM/OFM General Life History

- Adult moths lay eggs on or near fruit
- Larvae emerge and bore into fruit
- Larvae emerge from fruit and seek place to pupate
- Moths emerge and cycle begins anew
Both pests are serious in MI apple production

CM are larger than OFM

CM have copper band on wings

Phenology is slightly different
CM Phenology

- Two flights per season

Diagram:
- Bloom
- Egg laying
- Hatch
- Adults
- Degree-days (base 50 F° post-biofix)

Months:
- Apr
- May
- Jun
- Jul
- Aug

Graph intervals:
- 0 100 250 500 1000
• Three flights per season
• Chemical tactics target eggs and larvae
• Behavioral tactics target adults
• Biological tactics target all stages
• Physical tactics target late larvae
CM Chemical Pest Management

- Cover sprays are applied to egg or early larval stage of each generation
- Granulosis Virus (CM only)
- Entrust (Spinosad)
- Horticultural Oils (during egg laying)

Air Blast Sprayer
CM Behavioral Pest

- Mating disruption with synthetic sex pheromones
- Easy for OFM, Harder for CM
- Very specific and provides season long management
- Cornerstone of organic CM and OFM management
CM/OFM Mating disruption

- Females produce a unique odor that attracts males
- Mating disruption adds lots of synthetic odor sources
- This confuses males, prevents mating, and infested fruit
CM/OFM Biological Pest Management

- Release natural enemies
  - Trichogramma
  - Parasitic nematodes
  - $$$Expensive!!!

- Conserve natural enemies
  - Encourage diversity
CM/OFM Physical Pest Management

- Sanitation: Debris provides pupation sites
- Banding: Cardboard or burlap bands as pupation sites
- Bands are destroyed prior to next generation emergence
- Can also be used as a means of sampling the population
Plum Curculio

- Small dark weevil
- Native insect adapted to apples
- Attacks stone and small fruit
- Larvae feed within the fruit
- Especially difficult for Organic apples
Plum Curculio General Life History

- Adults emigrate into orchard in Spring
- Females cut crescent and lay eggs in flap
- Fruit drop from trees
- Larvae pupate in soil and emerge in late Summer
- Adults feed on apples
PC Chemical Tactics

- Cover sprays applied in Spring or at Harvest
- “Surround” Kaolin clay
- “Pyganic” Pyrethrum
Apple Maggot

- Small fruit fly
- Native insect adapted to apples
- Attacks apples, hawthorne, some native berries

Adult Fly

Maggot Damage
Apple Maggot Life History

- Females emerge late June-September
- Lay eggs in fruit
- Larvae feed and develop
- Larvae pupate in soil and emerge following year
AM Chemical Tactics

• Cover sprays/gel baits applied for active period
• Pyganic, Entrust
• Kaolin clays

Kaolin Treated Apples

GF-120 Sprayer
AM Cultural Tactics

- Mass trapping using sphere traps
- Can be combined with insecticides
- Requires multiple traps per tree
- Very effective but labor intensive
AM Biological Tactics

- Spiders
- Predatory Bugs
- Earwigs
- Ground Beetles

- Conservation of natural enemies
Apple Pest Management: The Future

- Quantify “suppressive” potential of soils
- Quantify impact of Fungicides on soil ecology and insect pest management
- Development of scab specific OMRI approved fungicides
- Refinement of Swiss Sandwich systems
- Reintegration of animals into orchards.....
Pest Management with Hogs

- Young hogs grazed on dropped apples
- 5-fold decrease in summer PC damage
- 3-fold decrease in CM damage
- Major reduction of weed stands
- Impact on Scab, AM, Rodents?
Pest Management with Fowl

- Weeder Geese in Orchards Clark and Gage 1996
- Marginal impact on Insect damage over a single year