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
  - —Mechanial *
  - —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’
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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***

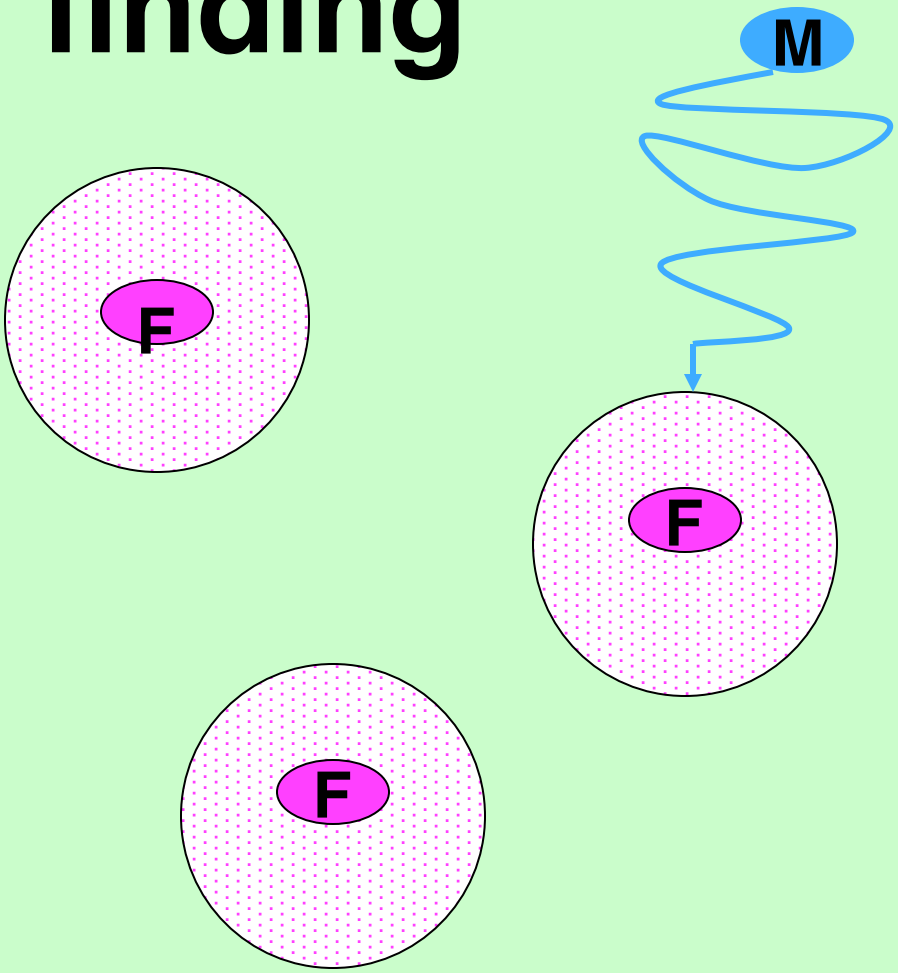
Categories of Biological Control

- ‘Natural’ (local species)
- Importation (exotic species)
- Conservation (local species) **
- Augmentation (local species)

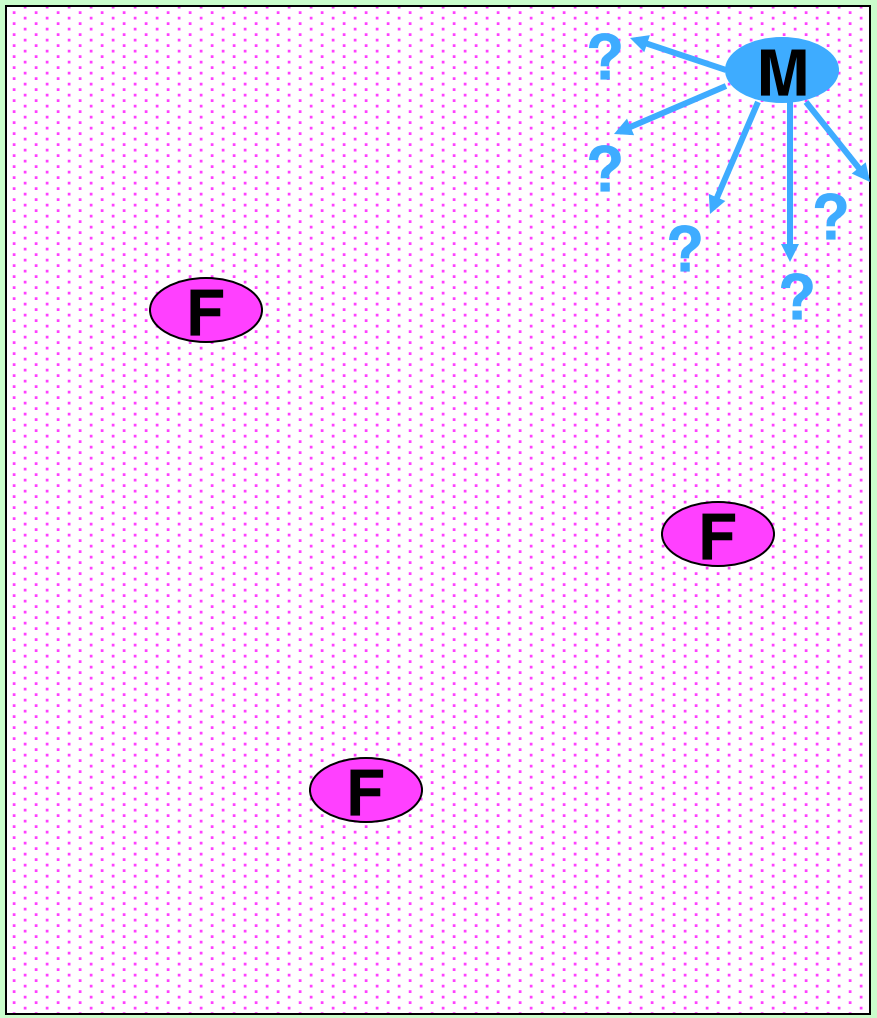
Behavioral Control

- 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

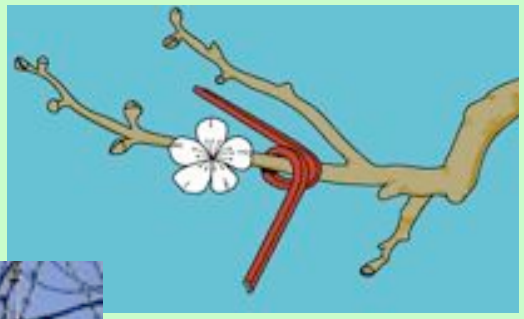


Male confusion



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

Apple Pest Calendar

HIG	PK	PF	1C	2C	3C	4C	5C	6C	7C
April		May		June		July		August	

-CodlingMoth- -CodlingMoth-

--AppleMaggot----------

-aphid(rosy)-

-scale(SJS)- ---scale(SJS)----------

-Leafroller (RB)- -Leafroller (RB)-

-PlumCurculio-

-Tarn.PlantBug-

--EuropeanRedMite----------

-Leafminer(ST)- -Leafminer- -Leafminer-

-Leafhopper(WA)- -Leafhop.-

-Aphid(green)--------

Biological control of apple pests by naturally occurring predators & parasitoids

Pest	*Enemy*
European red mite	Predatory mites
Green apple aphid	cecidomyid fly (orange maggot)
Rosy apple aphid	Hover flies, lady beetles
Spotted tentiform leafminer	Parasitoid wasps

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**

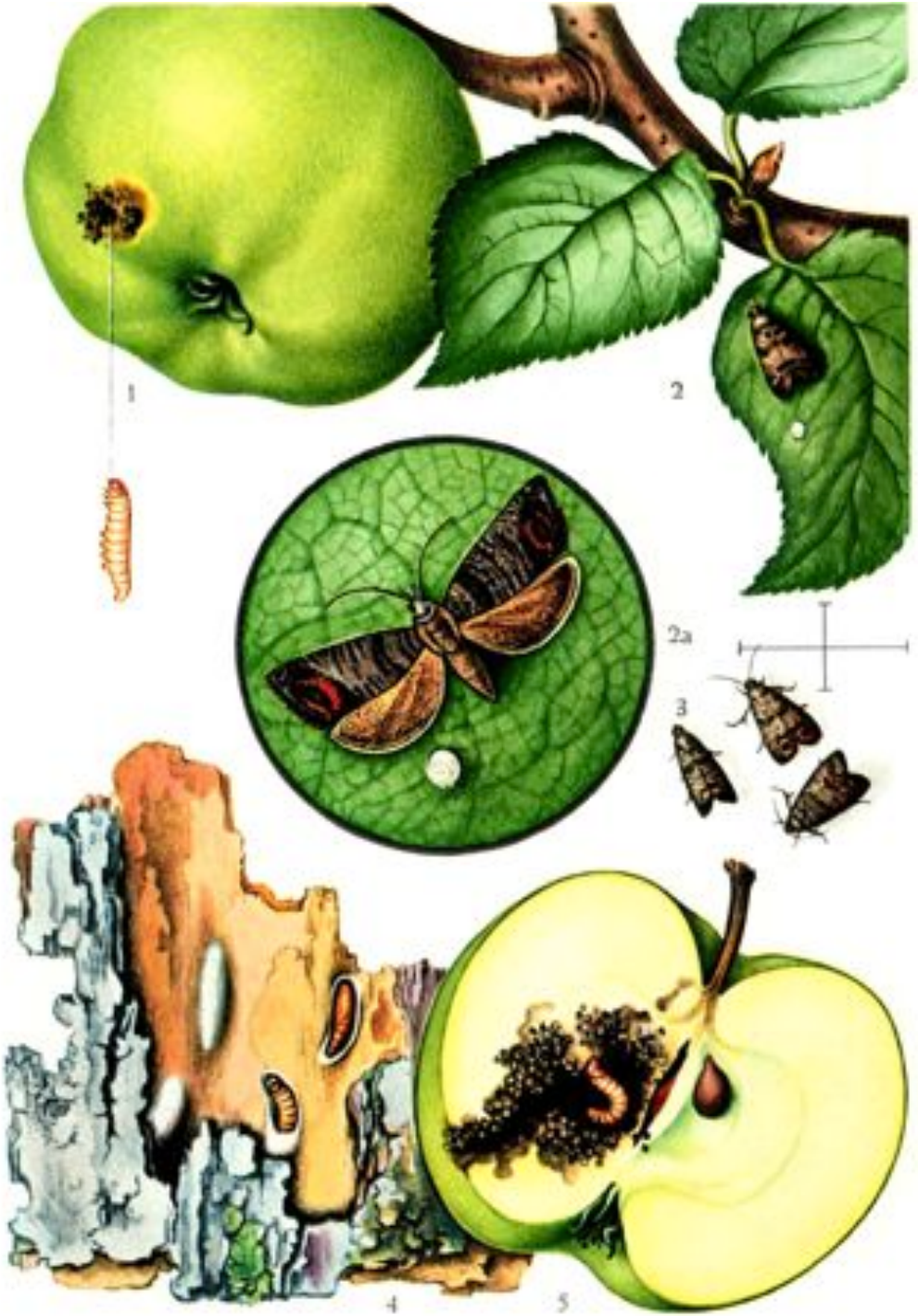
Codling Moth in Apples

- 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

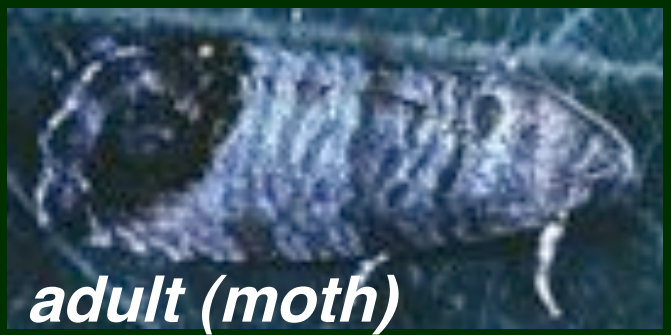
Factors affecting insecticide efficacy:

- **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 = (average temp) minus (threshold temp)
- Accumulate DD over consecutive days

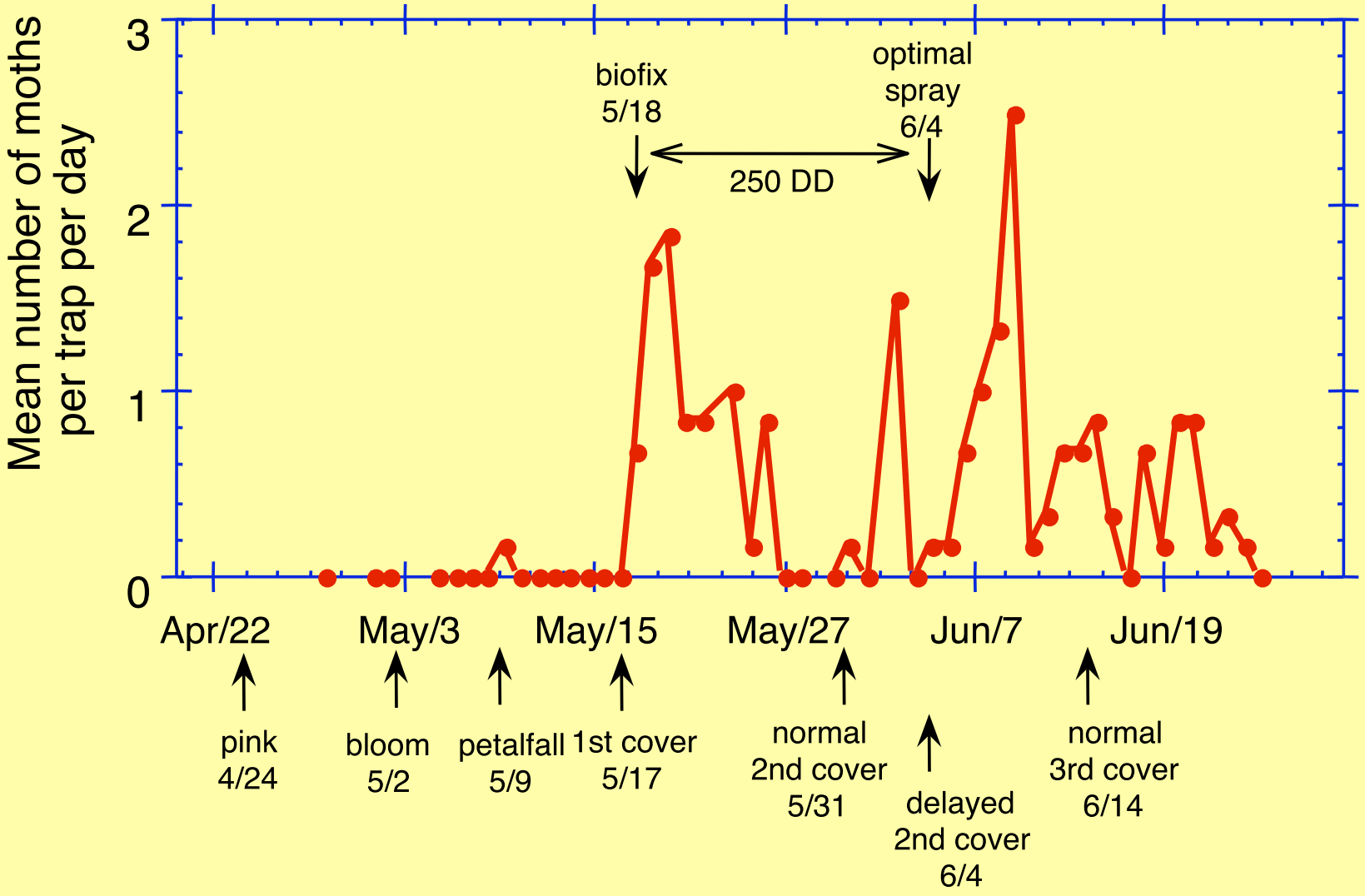
Degree-Days Example

Day	Temp. max	Temp. min	Temp. avg	DD (base 50)	DD Cumul.
1	62	52	57	7	7
2	66	50	58	8	15
3	58	54	56	6	21
4	70	56	63	13	34

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



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)

Treatment	*% CM infested fruit*
Imidan/Guthion (3 ap.)	**3.7 a**
Entrust (11 ap.)	**3.9 a**
Cyd-X (11 ap.)	**26.9 b**
Carpovirusine (11 ap.)	**30.5 b**
untreated	**70.2 c**

CpGV Orchard Trials: apple in NC 2004

Treatment	*% of fruit with entries*
Rimon	0.5 a
Cyd-X	0.8 ab
Rimon/Guthion	1.3 ab
Assail/Intrepid	2.3 ab
Intrepid/Calypso/Spintor	2.8 ab
Danitol/Guthion	3.0 ab
Calypso/Intrepid	4.0 ab
Imidan/Guthion	4.5 abc
Guthion/Rimon	4.8 abc
Experimental/Intrepid	5.8 abc
Assail/Intrepid	6.0 bc
Calypso/Intrepid	9.8 cd
untreated	14.5 d

For all: 2 applications for 1st generation,
3 applications for 2nd generation; 14-day interval

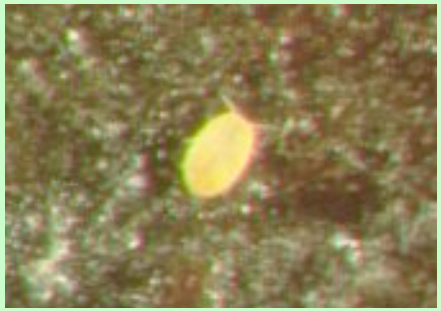
‘Surround’

Suggested Program for Apple

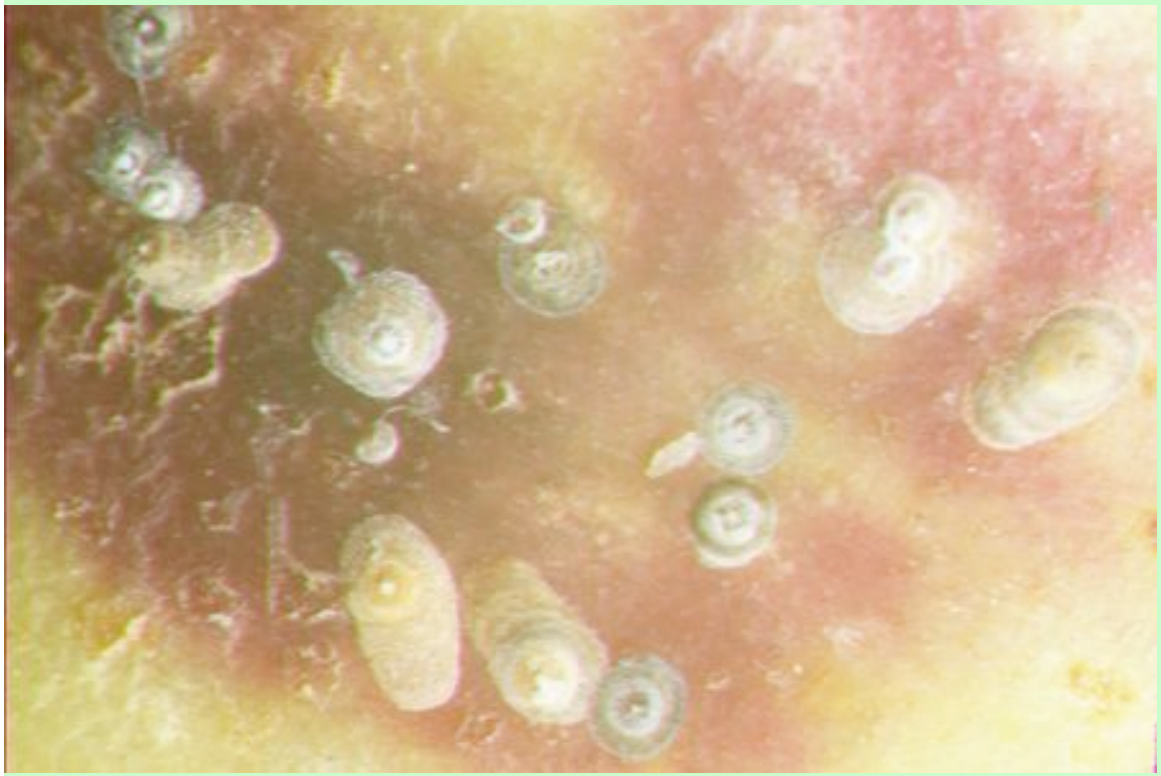
Time	Event	Product
PF	PlumCurc.	Surround
1C	CodMoth-1	Entrust
2C	CodMoth-1	Entrust
3C	-	virus
4C	CodMoth-2	Pyganic
5C	CodMoth-2	Pyganic
6C	-	virus
7C	-	virus
8C	-	virus

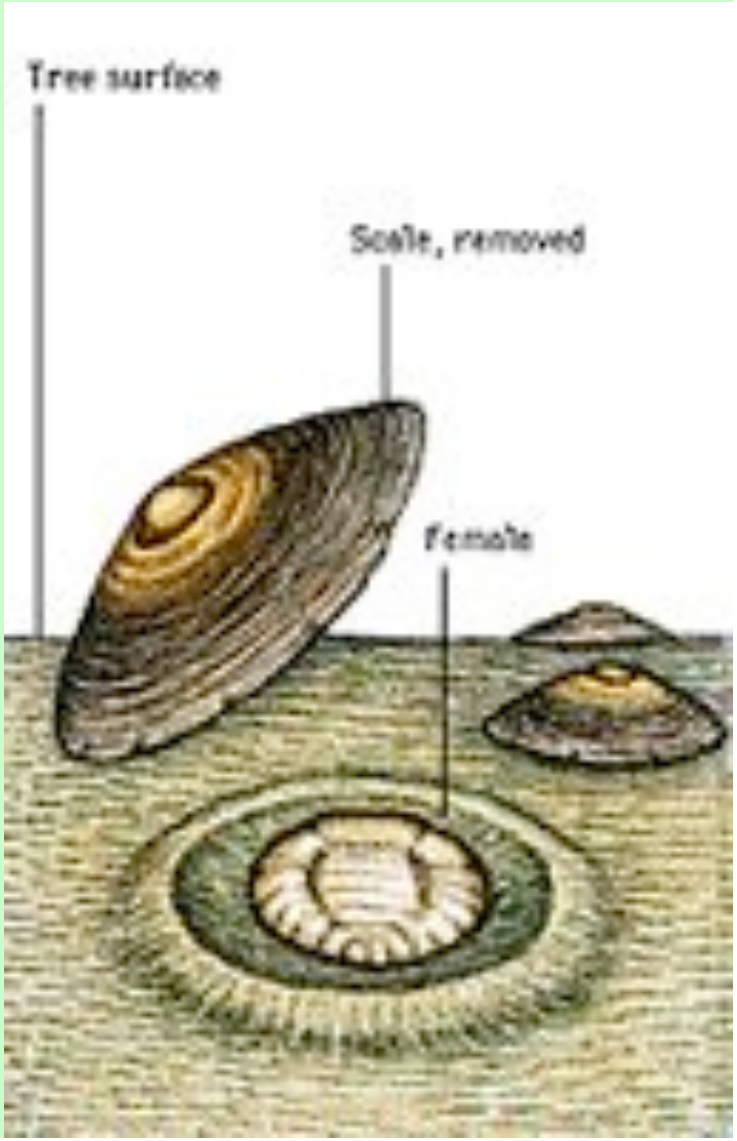
San José Scale

- 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:

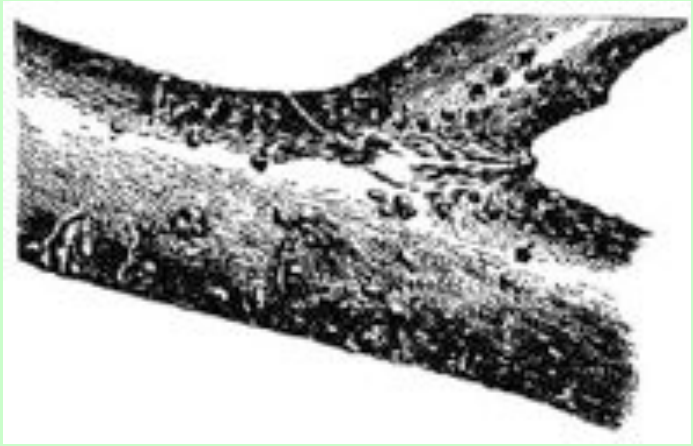
- **Dormant**
  - **—Oil**
  - **—Lime sulfur**
- **Post-bloom**
  - **—Insecticidal soap**

San José Scale

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

- **Use oil to smother the over-wintering population on bark**
- **Or use lime sulfur**

San José Scale



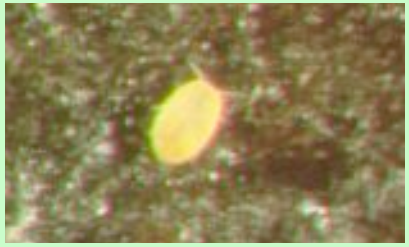
Oil spray:

- 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?

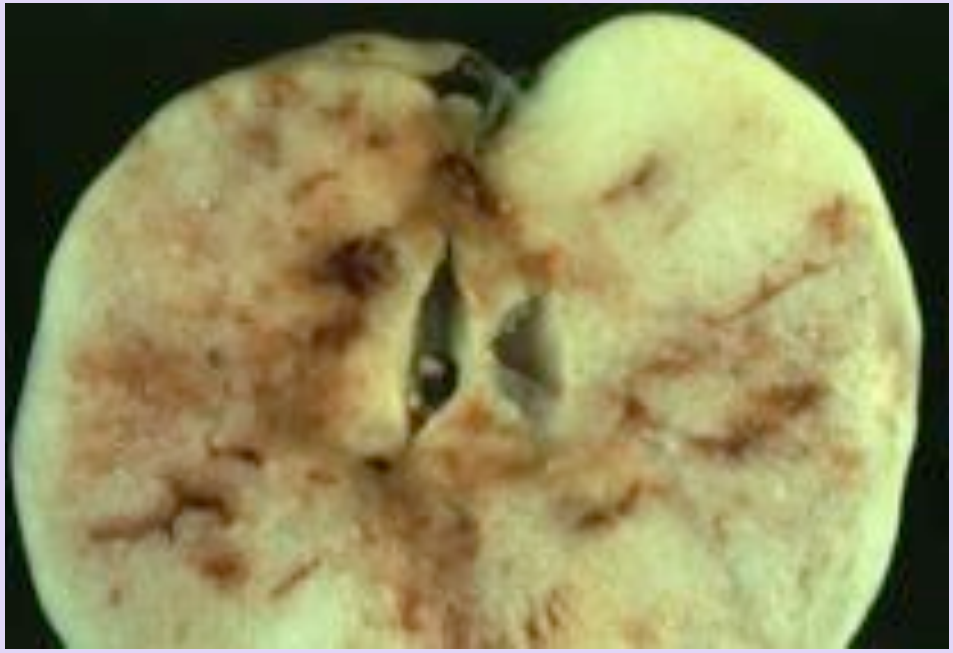
- **Start about 4-6 weeks after bloom**
- **Usually in mid-June**
- **Emergence lasts several weeks**

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

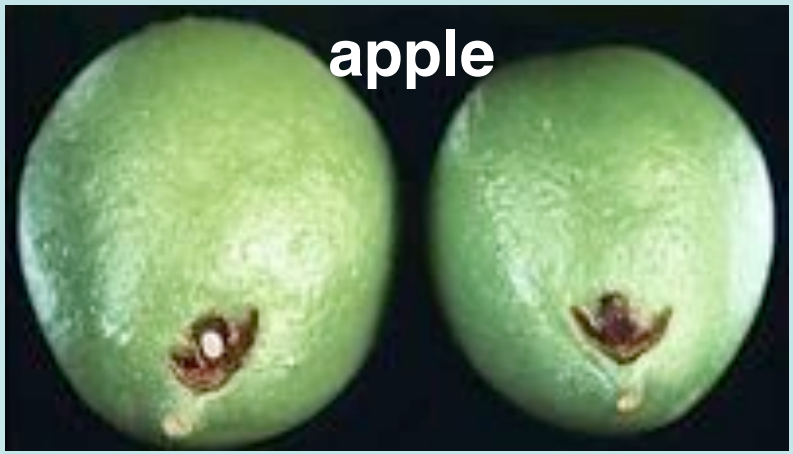
- Adult fly lays egg on fruit
- Larva tunnels through fruit
- Pupation in soil

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