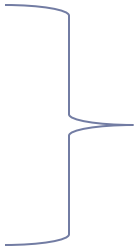
Organic Approaches to Insect Pest Management in Fruit Crops

Rick Weinzierl
Department of Crop Sciences, University of Illinois

Presentation Overview

- Resources on fruit insects, diseases, and weeds
- Overall cultural practices
- Biological controls
- Organic pesticides
- Specific management recommendations for apples (and peaches)



Reduced and targeted

Information Sources

- Midwest Small Fruit Pest Management Handbook
  - http://ohioline.osu.edu/b861/index.html
- 2011 Midwest Commercial Small Fruit and Grape Spray Guide
  - http://www.hort.purdue.edu/hort/ext/sfg/
- Midwest Tree Fruit Pest Management Handbook
  - http://www.ca.uky.edu/agc/pubs/id/id93/id93.htm
- 2011 Midwest Commercial Tree Fruit Spray Guide
  - http://www.extension.iastate.edu/Publications/PM1282.pdf
- Illinois Fruit and Vegetable News
  - http://ipm.illinois.edu/ifvn/
  - 20 issues per year, with links to newsletters and fruit and vegetable production guides from other states

- A Grower's Guide to Organic Apples
  - http://www.nysipm.cornell.edu/organic_guide/apples.pdf
- 2010 Production Guide for Organic Blueberries
  - http://www.nysipm.cornell.edu/organic_guide/blueberry.pdf
- 2010 Production Guide for Organic Grapes
  - http://www.nysipm.cornell.edu/organic_guide/grapes.pdf
- 2010 Production Guide for Organic Grapes
  - http://www.nysipm.cornell.edu/organic_guide/strawberry.pdf

- Disease management guidelines for organic apple production in Ohio
  - http://www.caf.wvu.edu/kearneysville/organic-apple.html
- Organic small fruit disease management guidelines (Ohio)
  - http://www.oardc.ohio-state.edu/fruitpathology/organic/PDF/OSU-Organic-Blueberry-Diseases.pdf
- Tree fruits: Organic production overview (ATTRA)
  - http://attra.ncat.org/attra-pub/fruitover.html
- 2011 MOSES Organic Farming Conference
  - http://www.mosesorganic.org/conference.html

Cultural practices, in general …

- Rotate crops, isolate sequential plantings
- Plant on multiple dates; plant multiple varieties … diversify and spread the risk
- Plant resistant varieties (and resistant crops)
- Plant extra; accept some loss
- Rogue out and destroy infested (infected) plants, and destroy infested crop residues
- Use tillage, mowing, soil solarization, pruning, and thinning … against weeds, plant diseases, and insects

Plant resistant varieties

- Strawberries resistant to root and foliar diseases
- Grapes resistant to foliar and fruit diseases
- Apples resistant to apple scab, fire blight, cedar apple rust, and/or powdery mildew
  - See the Midwest Small Fruit Pest Management Handbook and the Midwest Tree Fruit Pest Management Handbook for listings. Don't assume heirloom varieties are more resistant.
  - Use rootstocks resistant to fireblight and woolly apple aphid.
- In general, blueberries and brambles are easier to grow organically than other fruit crops

Destroy infested plants and crop residues

- Clean-pick strawberries and brambles and destroy over-ripe (and molding) fruit
- Renovate strawberries to remove foliage and prevent continuation of disease and insect life cycles
- Pick up and destroy summer drops in apples
- (Mowing/chopping dropped leaves also reduces primary inoculum for apple scab)

Exclusion and repellency

- Bird netting over grapes, blueberries, and brambles
- Rodent guards around trunks of apples and peaches
- Remay-like floating row covers mostly for vegetables, not fruits, but maybe grapes … and?
- Bagging apples shortly after bloom excludes insects and diseases
  - http://www.uky.edu/Ag/Entomology/entfacts/fruit/ef218.htm#bag

Natural enemies, biological control

- Predators, parasites, and pathogens
- To enhance their success ...
  - Recognize them; know what they do
  - Minimize insecticide use
  - Use selective insecticides in selective ways
  - Maintain favorable habitats
  - Provide alternative foods (pollen, nectar, etc.)

http://www.nysaes.cornell.edu/ent/biocontrol/index.php

- Biological Control: A Guide to Natural Enemies in North America.
  - A Shelton, Cornell University

Alternatives in Insect Management

Biological and Biorational Approaches

- http://www.ag.uiuc.edu/~vista/abstracts/aaltinsec.html

Flowers used by beneficial insects:

- **Flowers used by beneficial insects:**

- **Early blooming**

- Basket of Gold *Aurinia saxatilis*
- Rocky Mountain penstemon *Penstemon strictus*
- Native potentilla *Potentilla verna*
- Creeping thyme *Thymus serpyllum*
- Sweet alyssum *Lobularia maritima*
- Columbine *Aquilegia x hybrida*
- Carpet bugleweed *Ajuga reptans*

- **Midseason blooming**

- Common yarrow *Achillea filipendulina `Coronation Gold'*
- Dwarf alpine aster *Aster alpinus*
- Spike speedwell *Veronica spicata*
- Wine cups (Poppy mallow) *Callirhoe involucrata*
- Cilantro (Coriander) *Coriandrum sativum*
- English lavender *Lavandula angustifolia*
- Sulfur cinquefoil *Potentilla recta `Warrenii'*
- Edging Lobelia *Lobelia erinus*
- Mint *Mentha sp.*
- Stonecrop (various) *Sedum sp.*

- **Late blooming**

- Fernleaf yarrow *Achillea millefolium*
- Lavender globe lily *Allium tanguticum*
- Dill *Anethum geraveolens*
- Dyer's camomille *Anthemis tinctoria*
- Fennel *Foeniculum vulgare*
- Sea lavender *Limonium latifolium*
- Wild bergamot *Monarda fistulosa*
- European goldenrod *Solidago virgaurea*

Insecticides for organic production

- Microbials
- Botanicals
- Soaps and Oils
- Abrasives
- Pheromones
- Elemental compounds

Insect pathogens as microbial insecticides

- Viruses
  - Cyd-X is a microbial insecticide containing the virus that infects codling moths
- Bacteria
  - *Bacillus thuringiensis* (various subspecies)
    - Many formulations of Bt are sold for control of caterpillars
- Fungi
  - *Beauveria, Entomophthora,* and *Metarrhizium* spp.
    - Mycotrol is a microbial insecticide containing *Beauveria bassiana*
- Nematodes
  - *Steinernema* & *Heterorhabditis*

Microbials

- *Bacillus thuringiensis kurstaki* and *aizawai*
  - Toxic only to Lepidopteran larvae (caterpillars)
  - Must be ingested to be effective
  - Degraded by ultraviolet light ... short residual activity on treated foliage
  - Good targets in fruits: leafrollers
  - Not effective against: larvae that bore or tunnel into plants without much feeding on the surface (such as codling moth and oriental fruit moth)
  - Dipel, Agree, XenTari, and many others

Microbials

- Spinosads … Entrust ™ by Dow
  - Derived from a soil actinomycete
  - Effective against a range of insects, including apple maggot (fair), oriental fruit moth, and codling moth

Botanicals – derived from plants

- Pyrethrins
  - From pyrethrin daisies
  - Axonic poisons
  - Low in toxicity to mammals
  - Very rapid breakdown ... no residual action
  - Used to kill fleas and lice on humans and pets; labeled for use on many fruits and vegetables
- Neem
  - From all parts of *Azadirachta* and *Melia* spp.
  - Mode of action unknown
  - Low toxicity to mammals; used medicinally
  - Very short persistence
  - Labeled on many crops and landscape plants, especially against soft-bodied insects

Botanicals

- NOT approved or NOT effective for application to plants
  - Rotenone
  - Nicotine
  - Sabadilla
  - Ryania
  - Hot pepper oil
  - Garlic oil
  - Citronella
  - Pennyroyal

Oils

- Dormant oils
- Stylet oils
  - reduce virus transmission, may suppress powdery mildew
- Summer oils
  - Against mites, aphids, other soft-bodied pests
- Coverage is essential (upper and lower leaf surfaces); oils kill by suffocating pests that are sprayed directly

Insecticidal soaps

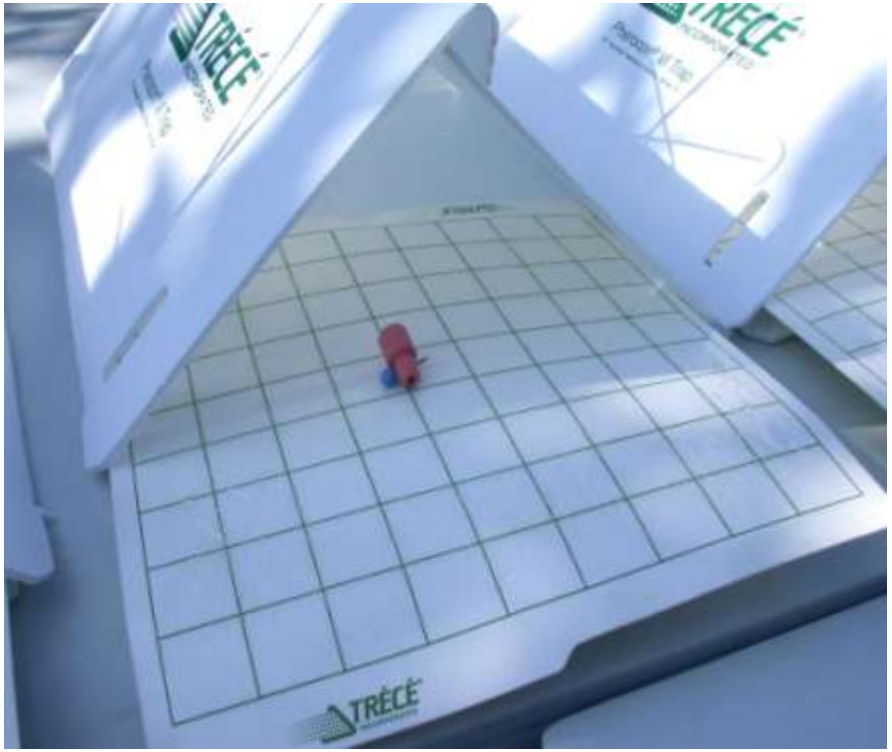
- Salts of fatty acids
- Kill insects by disrupting membranes (including tracheal linings)
- Work only against those insects that are wetted by the spray ... no residual action
- Effective against aphids, whiteflies, mites, and other soft-bodied, not-too-mobile pests
- Best-known brand names are Safer's and M-Pede
- Make your own? Generally ... NO

Absorbents and abrasives

- Clays, diatomaceous earth, silica aerogels
  - disrupt the insect's cuticle and kill by dehydration
- Kaolin ... "Surround"

Pheromone trapping in codling moth management

- Pheromone: An intraspecific message-carrying chemical
  - In Lepidoptera, females emit a mating pheromone to attract males
    - (And yes, other species may detect pheromones and use them to locate hosts or prey … the same chemical then acts as a "kairomone" to the benefit of the receiver.)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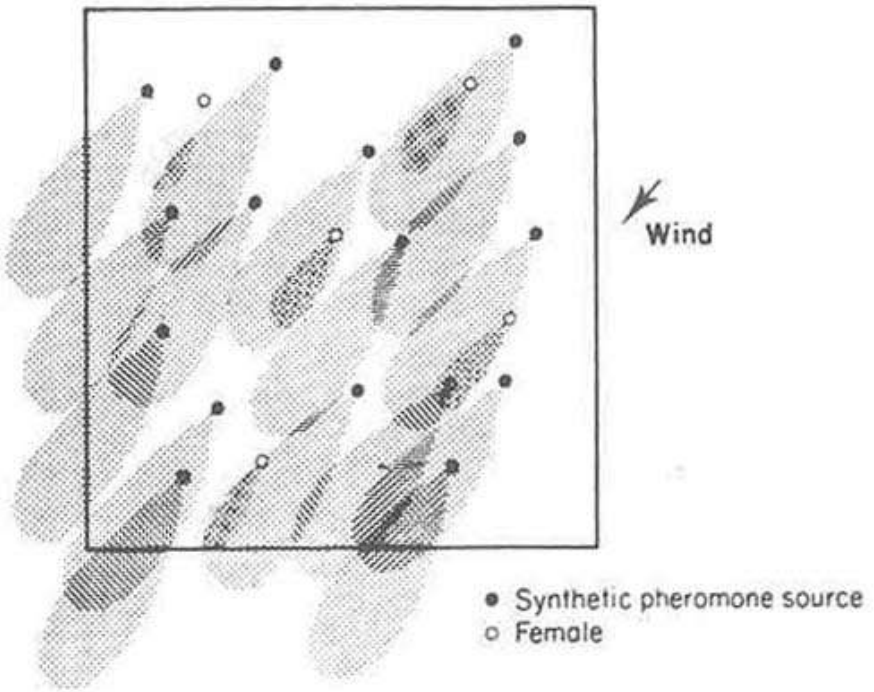

Wind
Synthetic pheromone source
Female

Elemental and naturally occurring chemicals

- Sulfur
  - effective miticide (may cause plant injury)
- Copper
- Arsenic

Lead arsenate and copper arsenite were among the earliest widely used insecticides

So you're growing apples or peaches, and these are the insecticidal tools you have …

- Codling moth virus (Cyd-X, Carpovirusine, Virosoft)
- Bt – many products; use against leafrollers if needed)
- Entrust (against CM, OFM, and apple maggot) (limit 3X per year)
- Kaolin (Surround) – against plum curculio
- Dormant oil – against San Jose scale, rosy apple aphid, Eu. Red mite
- Summer oils – against mites (not with sulfur-containing compounds)
- Pyrethrins – against plum curculio, Japanese beetle
- Neem – against aphids, maybe Japanese beetle
- Mating disruption – for CM, OFM, and peachtree borers
- Insecticidal soaps – against aphids and mites
- Sulfur – against mites
- Bags and spun polyester row-cover material – against fruit pests
- Pruners, mowers – to increase spray penetration, discourage stink bugs and plant bugs

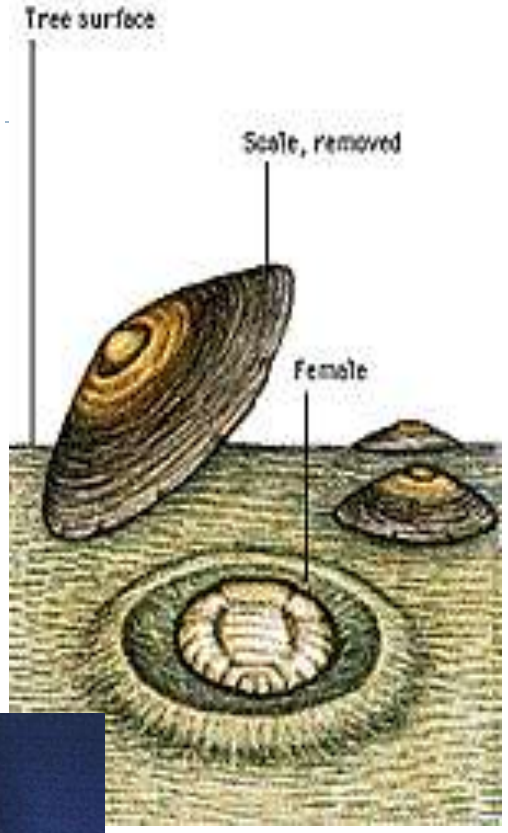
Nothing in this list is highly effective against stink bugs or Japanese beetle. Insect management tools are more effective than organic fungicides.

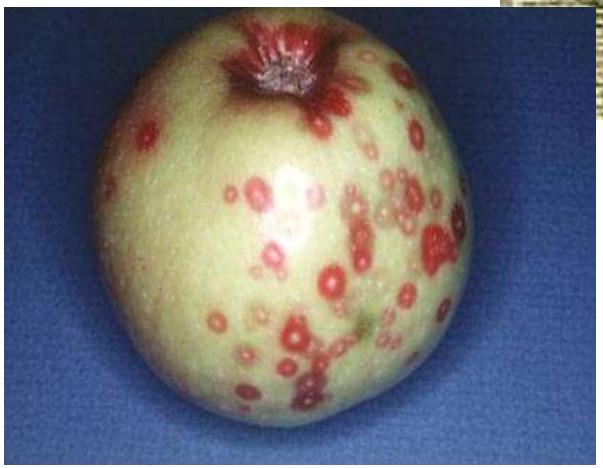
- New planting? Use varieties resistant to scab, fire blight, cedar apple rust, and/or powdery mildew
  - Midwest Tree Fruit Pest Management Handbook
    - http://www.ca.uky.edu/agc/pubs/id/id93/id93.htm
  - (and other sources)
- Prune and thin for disease management and yield
- Weed mats, mowing, and grass cover crops for weed control

Prebloom

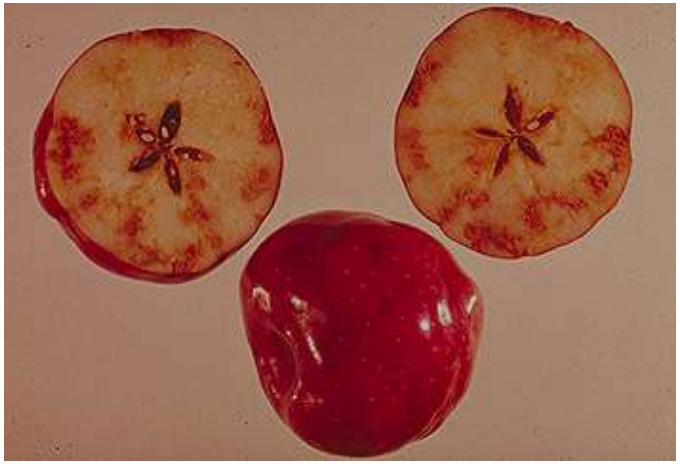
- Dormant oils applied from green tip to pink control San Jose scale, rosy apple aphid, and European red mite
- 2% by volume at green tip; ½ % by pink
- Coverage is essential
- Apply more than once if possible

Always apply prebloom dormant oils!



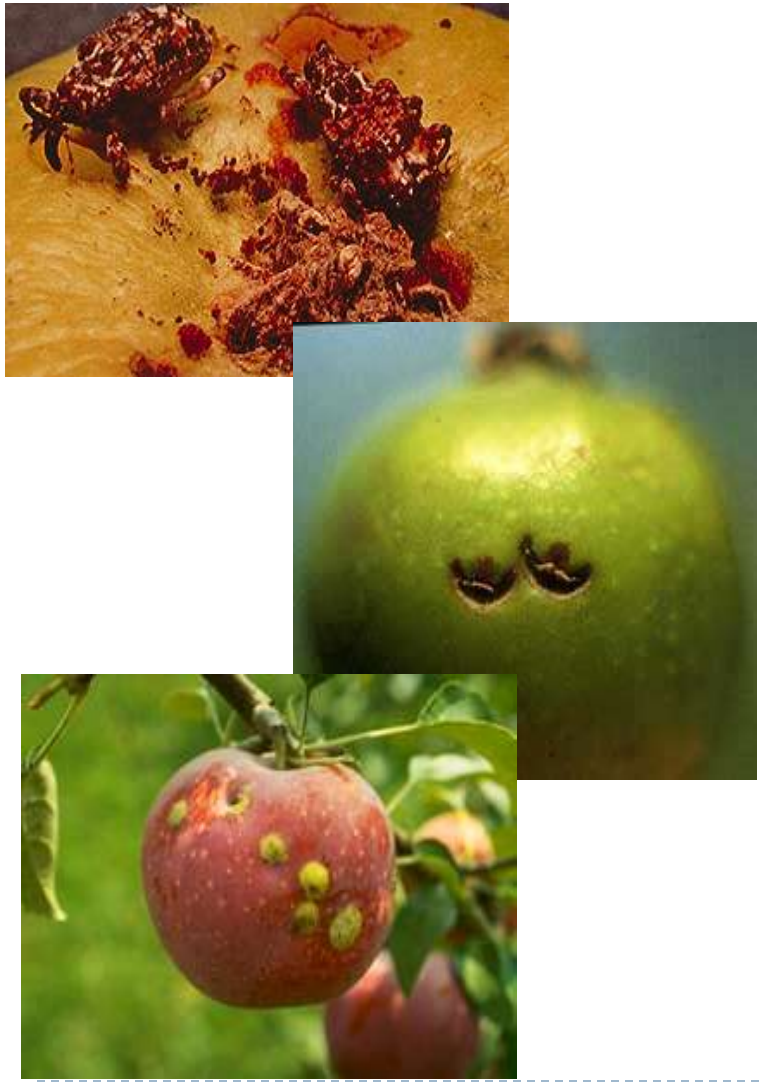


Key direct pests of fruit are plum curculio, codling moth, and apple maggot



Apple maggot is almost never a pest in IL south of US 40

Plum curculio



- Adults chew slit in fruit just after petal fall, deposit egg; surface scar and larval tunneling (usually unsuccessful) follow
- A second generation occurs in far southern IL
- Cultural controls: pick up and destroy summer drops; birds and pigs do eat pupating stages, but …
- Repeated applications of Surround + pyrethrins are needed beginning immediately after petal fall
  - (funnel trap on trunk is partially effective for monitoring … available from Great Lakes IPM)

Codling moth

- Sticky traps baited with CM female's sex pheromone can be used to monitor flights and time insecticide sprays

Codling moth life cycle

- Overwinter as mature larvae in hibernacula in bark crevices on tree trunks and branches
- Pupate in spring, adult moths appear at bloom and petal fall
- Females lay eggs on fruit, twigs, and leaves

Codling moth life cycle

- 2 to 4 generations per year in Illinois
- From initial moth flight, first generation moths emerge over a period of 700 F degree days (base 50 F) (California & Washington, Beers, WSU)
  - Middle 80 percent spans 400 DD … over 3 weeks for first generation
- 900 DD from first moths of one generation to first flight of next
- Second, third and fourth generations overlap

Degree-day Calculator: http://ipm.illinois.edu/degreedays/index.html

Codling moth management

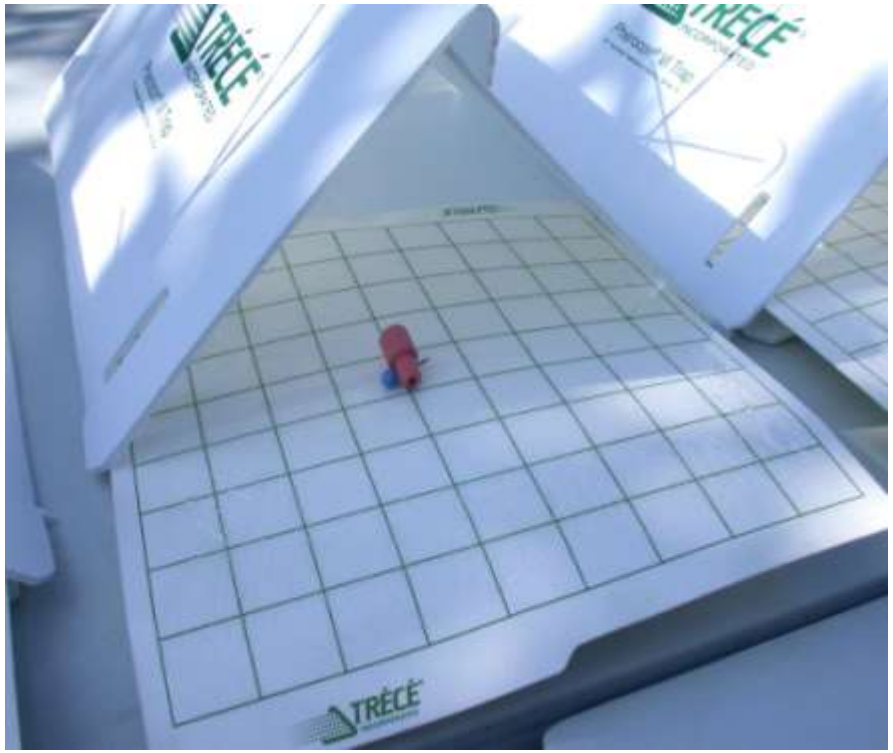
- Cultural practices
  - Destroy infested fruit, including drops (also recommended for plum curculio and apple maggot control)
  - "Band" trunks with corrugated cardboard; remove and destroy after larvae have formed hibernacula in the fall
- These steps will NOT provide anywhere near adequate control

Codling moth management

- Natural enemies, biological control
  - *Trichogramma* spp. egg parasites
  - Codling moth granulosis virus
  - *Bacillus thuringiensis*
- Use codling moth virus in two or more sprays during early stages of hatch of first and second generations

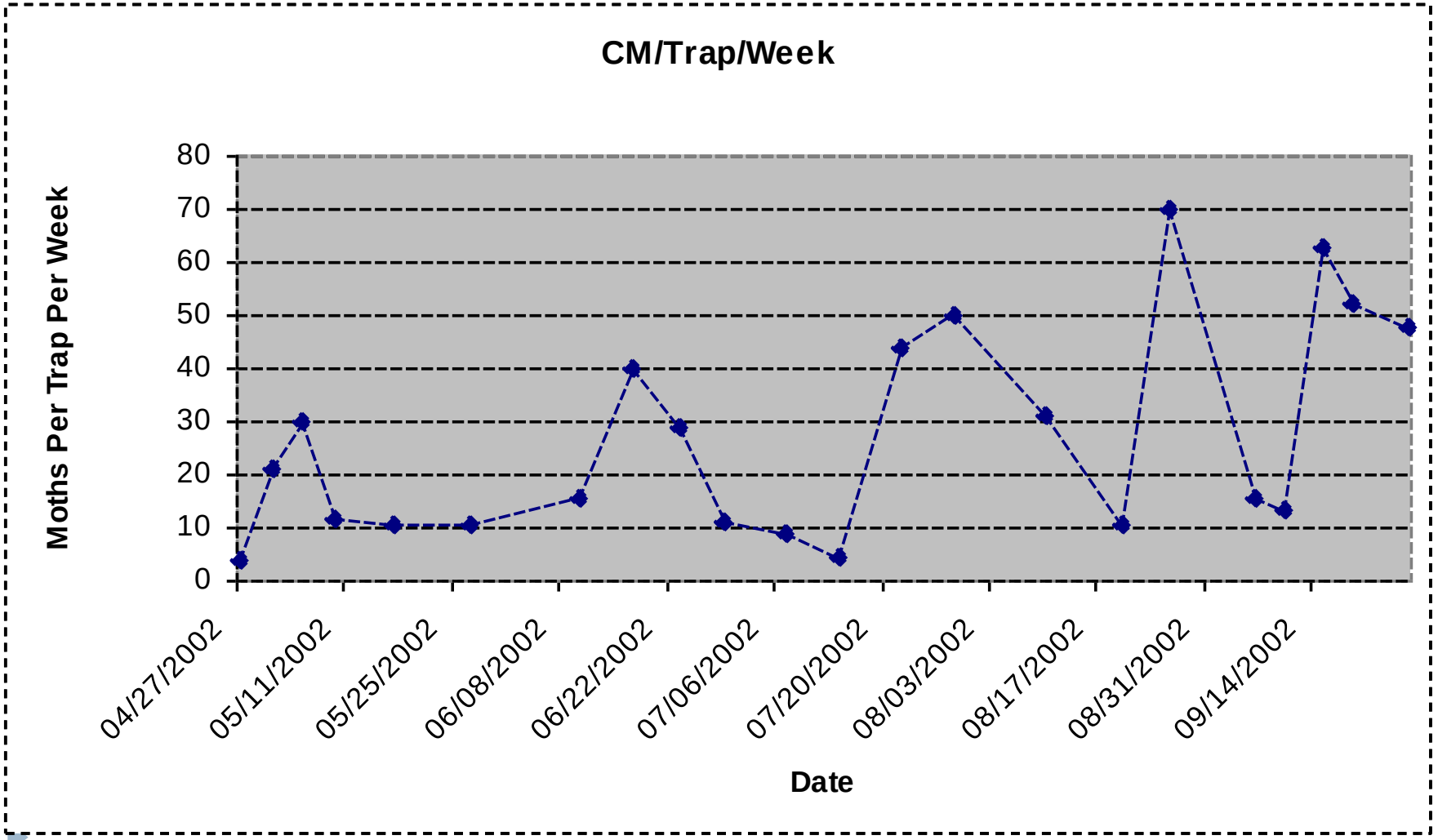
Interpreting trap counts

- Biofix = first sustained capture
  - Egg hatch begins at 240 DD (base 50 F)
  - First generation egg hatch ends at ~900 DD
  - 3 to 5 moths per trap per week represents a threshold warranting treatment
  - Insecticide applications are timed to kill larvae hatching from eggs ("cover sprays")



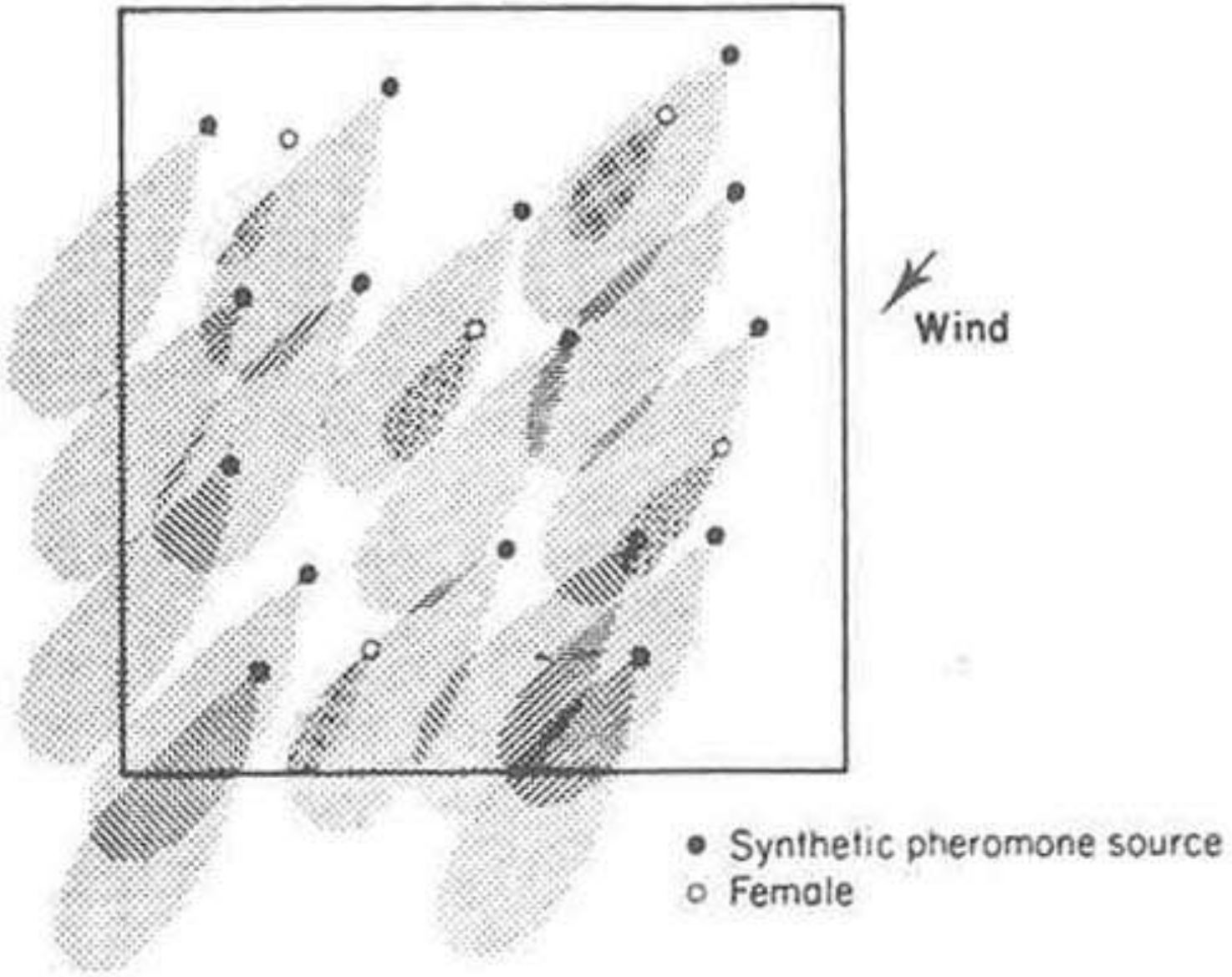
If you use mating disruption, you can not monitor flights to time additional sprays … consult the Illinois Fruit and Vegetable News for phenology info.

Codling moth pheromone trap counts, southwestern IL, 2002



Codling moth management

- Larvae hatch 10 – 14 days (240 dd, base 50 F) after flight / egg-laying … time sprays accordingly
- Use available organic insecticides at 7- to 10-day intervals
  - Entrust, Cyd-X (virus)
  - (Not Surround; BT not really effective)
- Mating disruption works in orchards – partially effective at back-yard scale
- Bagging fruit shortly after bloom prevents infestation by codling moth and apple maggot and injury by other pests


Wind
Synthetic pheromone source
Female

- "Dispensers" for mating disruption
  - Twist ties, etc.
    - Isomate C-Plus, NoMate CM, CheckMate CM
  - Spray formulations
    - CheckMate CM-F and 3-M's sprayable CM pheromone marketed by Certis
  - "Puffers" on timers
  - ~~Attract-and kill baits~~
    - ~~Last Call CM~~

Use Isomate C-Plus ties at 400/acre; apply early in bloom … will last 4 months.

Mating disruption for CM

- Best suited for
  - Regular-shaped orchards of at least 2 to 3 acres (1 ha) in size
  - Separation from "non-mating disruption" blocks
  - Low to moderate codling moth densities
  - Low to moderate need for regular insecticide applications for other pests
- Evaluation methods
  - "Shut-down" of traps baited with standard-rate lures and 10-x lures
  - Low incidence of fruit infestation at harvest in comparison with nearby blocks

Mating Disruption How-To …

- Make / begin applications at bloom
- Dispensers: Use recommended rate of dispensers for season-long mating disruption
  - Follow directions re: portion to be placed near the top of the tree
- Sprayable pheromone: Split rate over 4 sprays applied every 2 weeks; also re-spray after rainfall
- Attract-and-kill: Use as dispensers; probably 2 applications per season
- Monitor with 10-x lures (replace every 2 weeks)
- Apply insecticide sprays if 10-x lures consistently catch codling moth males
- Treat as needed for other insect pests

Apple maggot

- Adults lay eggs on fruit surface; larva (maggot) feeds in fruit.
- No really open tunnel; no frass (= droppings)
- Monitor with red ball trap and apply Entrust at 7 to 10-day intervals if traps catch adults, or …
- Use 3 to 5 traps per semi-dwarf tree to "trap-out" egg-laying flies
  - ("Trapping out" is effective against this insect; usually not so)
- Pick up and destroy June-July drops as soon as they fall

Stink bugs

http://www.gov.on.ca/OMAFRA/english/crops/facts/tarbug.htm

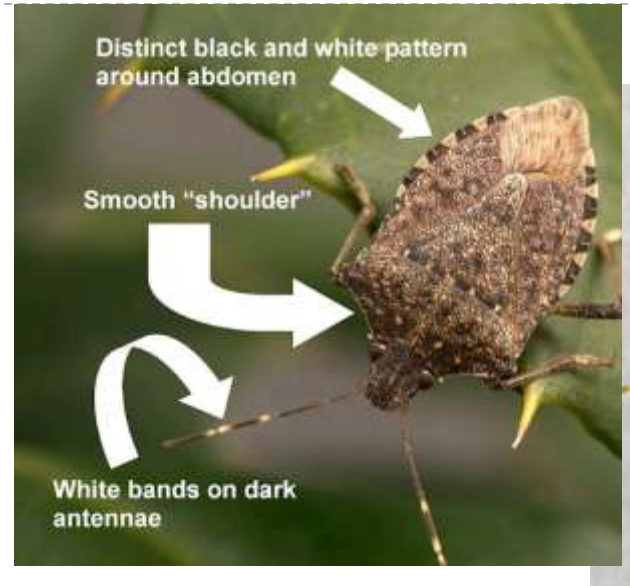
- Stink bugs and tarnished plant bugs cause dimpling or discolored corky areas at feeding sites
- Difficult to control with existing OMRI-listed insecticides
- Worse in areas with weedy or legume ground covers
- Use grasses for ground cover; time mowing to avoid triggering movement to fruit

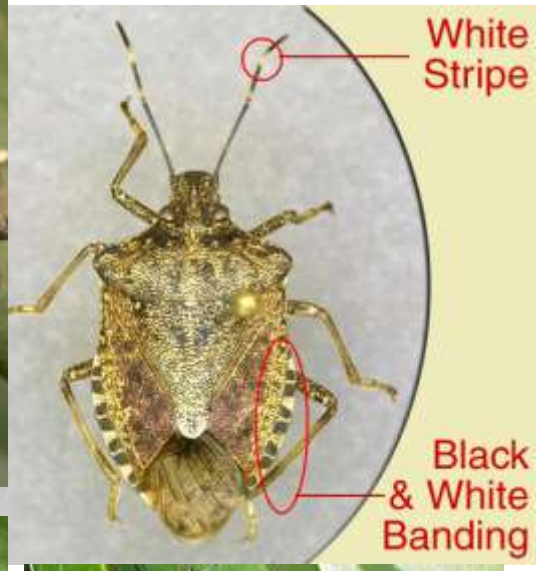
In peaches

- Plum curculio, oriental fruit moth, Japanese beetle, and stink bugs / plant bugs are the primary pests of fruit …
  - Pyrethrins are the only available OMRI-approved insecticides for plum curculio (Kaolin is approved, but residues are problematic)
  - Pyrethrins and neem may be used against Japanese beetle
  - Mating disruption works well against OFM (Entrust is an alternative)
  - Stink bugs ??? – pyrethrins give some control but not much
- Peachtree borer and lesser peachtree borer
  - Mating disruption is effective – contact Great Lakes IPM

Brown marmorated stink bug

- *Halyomorpha halys*
- Introduced (NOT intentionally) from Asia, first detected in Allentown, PA, in 1998
- Now established as far west as OH, KY, and IN?
- Overwinters as an adult, aggregates in large numbers in homes and other shelters
- Expect one to two generations per year





Brown marmorated stink bug

- Severe damage to apples, peaches, tomatoes, sweet corn, many other crops
- Many noncrop hosts serve as reservoirs for population buildup
- Very difficult to control … pyrethroids kill nymphs and adults present at the time of application



http://ento.psu.edu/extension/factsheets/brown-marmorated-stink-bug

http://ohioline.osu.edu/hyg-fact/pdf/FS_3824_08.pdf

Spotted Wing Drosophila

A new invasive pest of fruit crops

Rufus Isaacs

Department of Entomology, Michigan State University

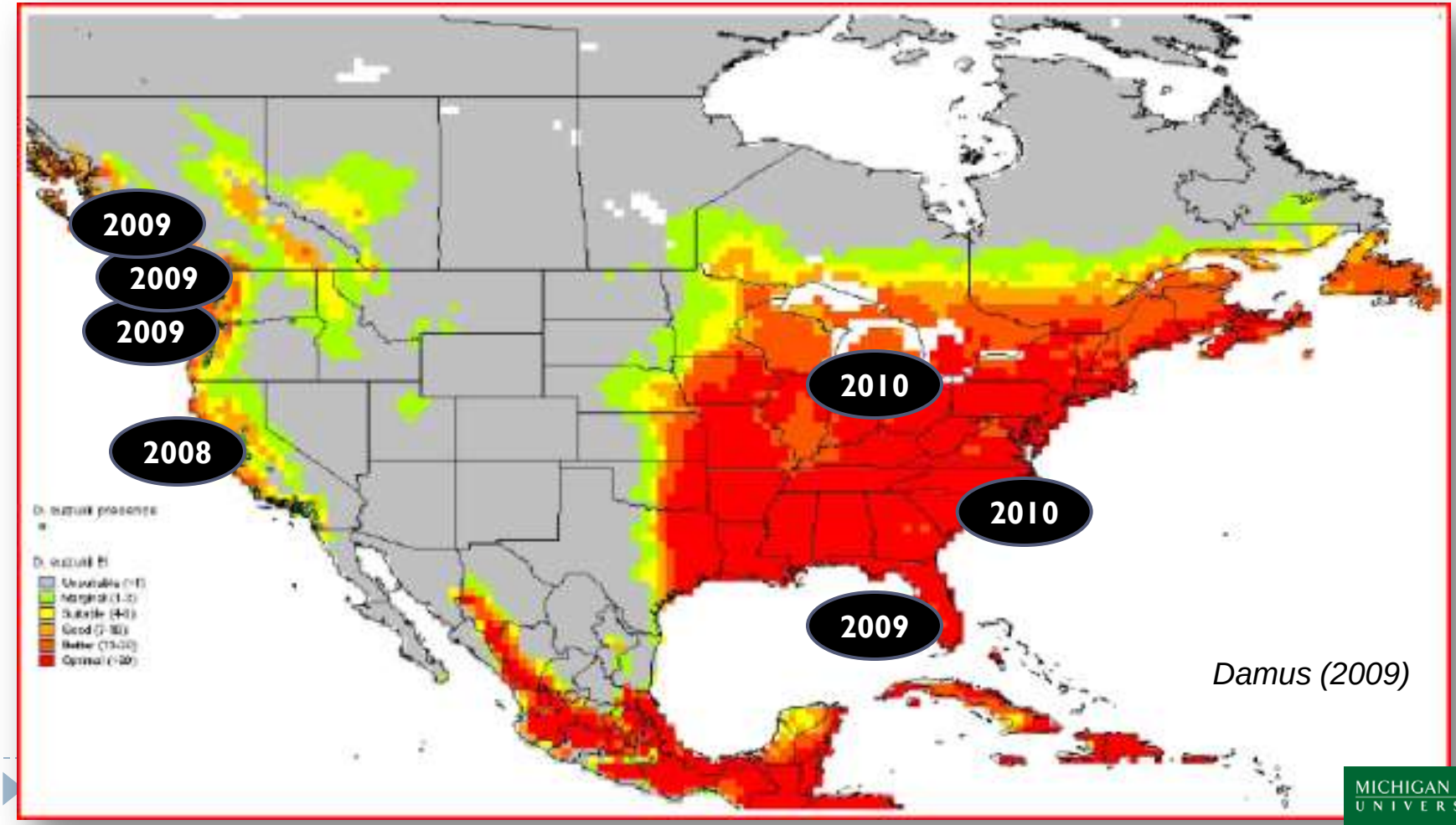
maes research | Project GREEEN | USDA | MICHIGAN STATE UNIVERSITY EXTENSION

Spotted wing Drosophila

- Native to East Asia, where it is a pest on fruit.
- Information on climate in Asia used to **predict** distribution in the Americas.
- Detected in CA in 2008, OR, WA, BC, FL in 2009, UT, SC, NC, MI, WI in 2010

Where has SWD been detected?

- Detected in CA in 2008, OR, WA, BC, FL in 2009, UT, SC, NC, MI, WI in 2010



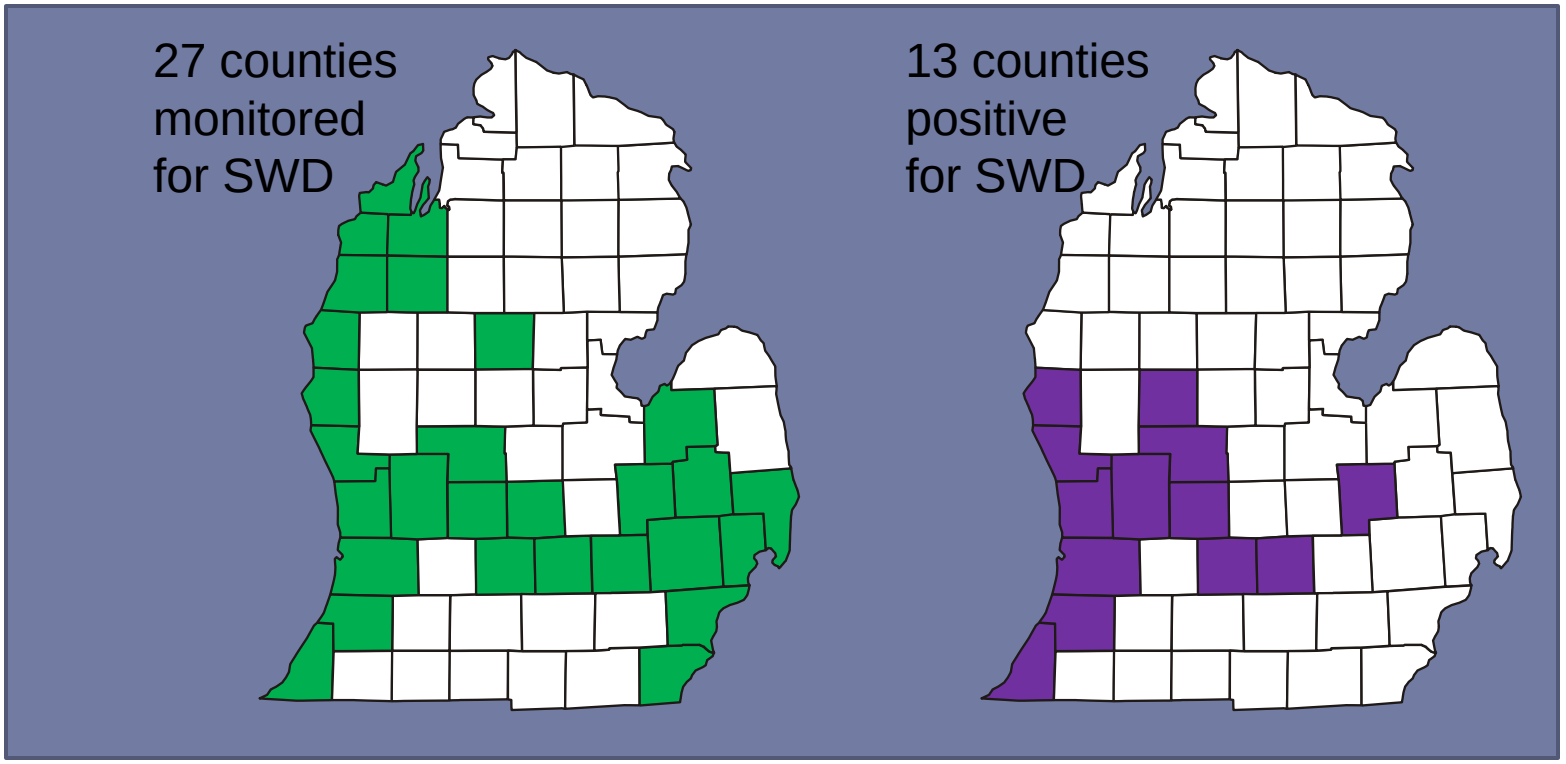
2010 Monitoring for SWD in Michigan

Over 300 traps deployed in spring, more in late September

Detections in blueberry, raspberry, grape, cherry, rest areas, backyards.

Highest activity of SWD was late-season, well into November.

13 counties positive for SWD as of Nov 20, 2010.



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Fruit affected by SWD

Highest risk

Strawberries

Raspberries

Cherries

Nectarines

Blueberries

Blackberries

Moderate risk

Peaches

Grapes

Pears

Apples

Tomato

Alternate hosts

Wild plants with berries, such as…

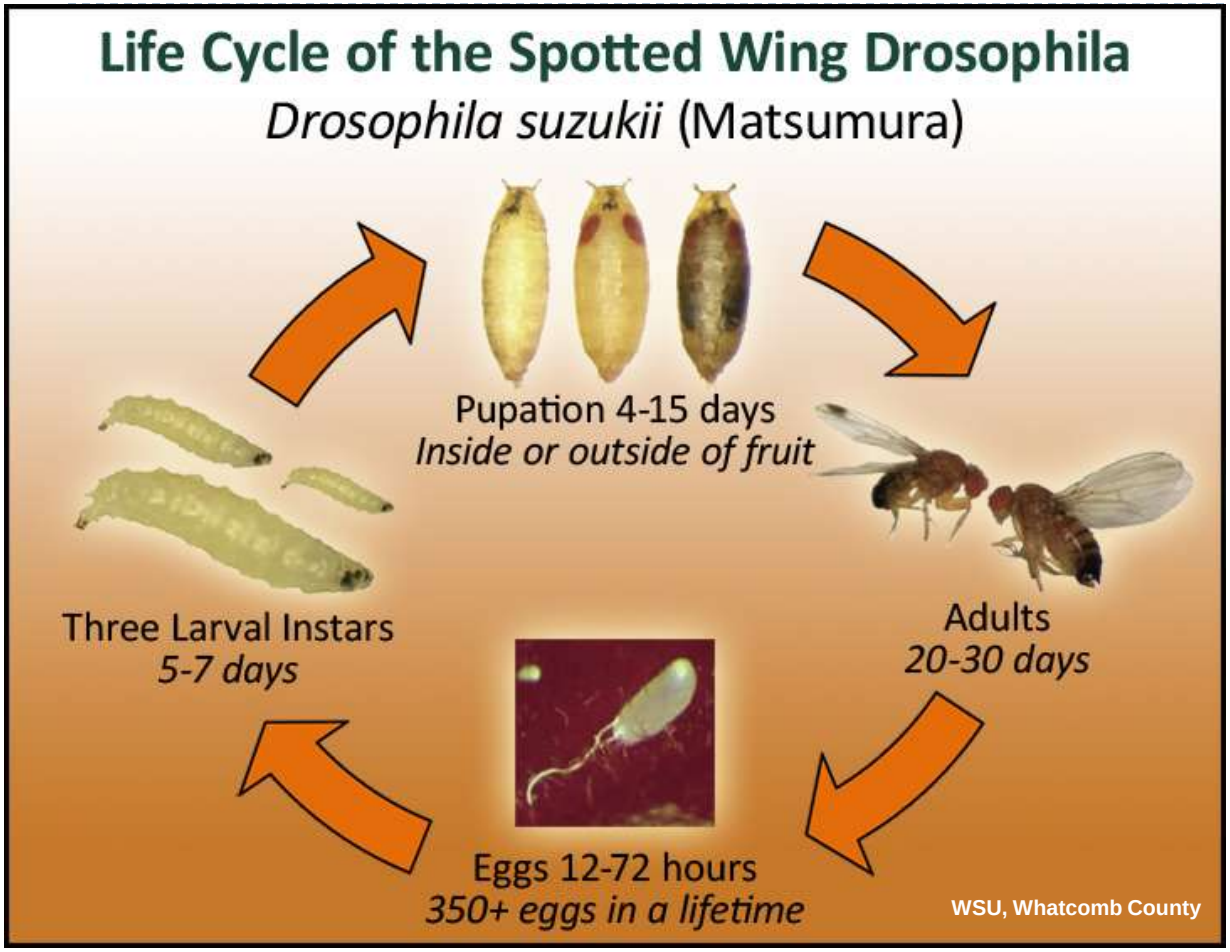
Snowberry

Elderberry

Pokeweed

Dogwood

Biology of SWD



- Optimal development is at 65-70°F, **~12 day** generation time.
- Adult flies live for 3-6 weeks, and females can lay over 300 eggs.
- Limited by high heat in summer and by winter cold. But, SWD populations are found in cold regions of Japan.

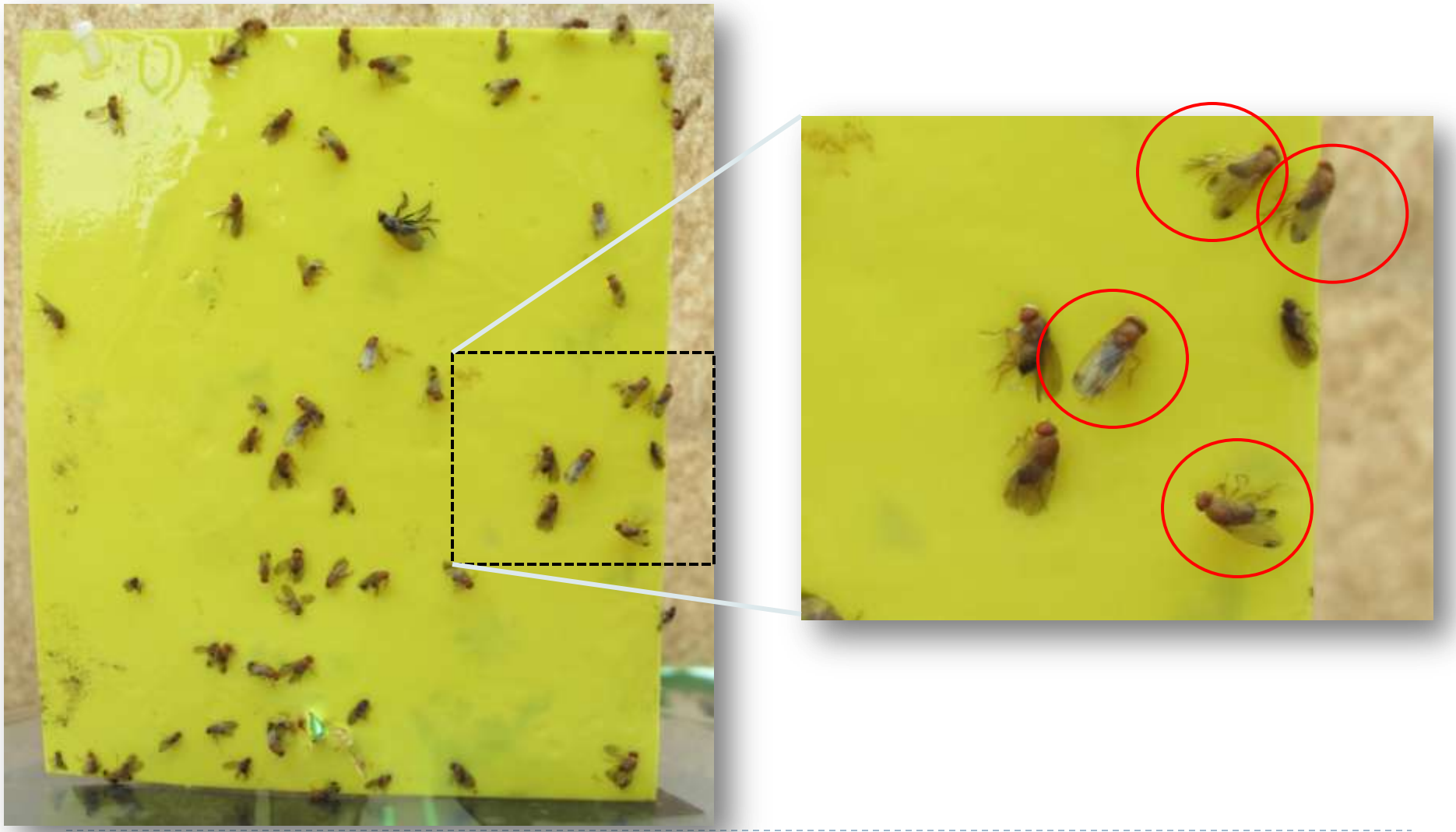
Strawberry, raspberry, and blackberry are hosts for SWD

Monitoring SWD

Approx. $1/trap for materials and construction.

- Plastic cup with side holes, apple cider vinegar bait.
- Use small yellow sticky trap to capture flies. Or, use only vinegar with a drop of unscented soap.
- Hang in fruit canopy near fruit and in the shade.
- Change vinegar weekly, and dispose away from trap.
- Best detection potential expected as fruit ripens.
- Check weekly, and record catches.

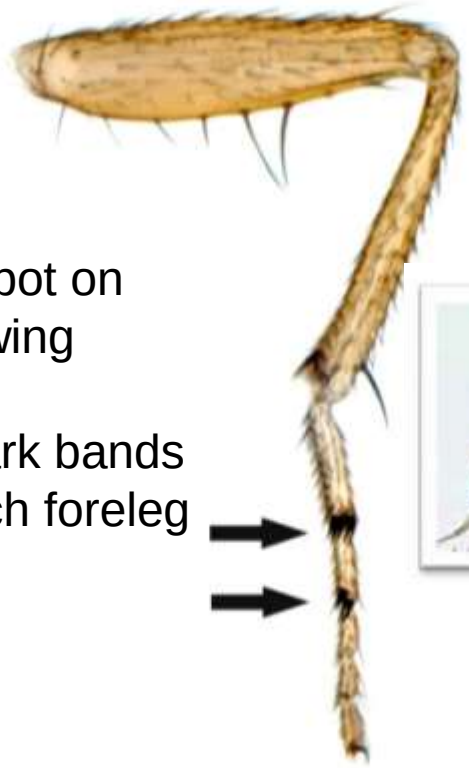
Spotting SWD males on traps



SWD identification

MALE

M. Hauser, UC



dark spot on each wing

two dark bands on each foreleg

FEMALE

two rows of serrations on ovipositor

no dark spots on wings

M. Hauser, UC

Click HERE for a detailed key for identifying SWD

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Checking fruit for SWD

To see eggs on berry surface

Look for pits in fruit surface or egg tubes

Use a 30x hand lens, also available with LED light for better viewing

To check berries for SWD larvae

Start as fruit begins coloring
Sample 1-2 lbs, ripest suspect fruit
Place in a shallow pan
Pour solution over: 1 Tbsp salt in 1 cup water

Look for mature larvae
Eggs and smallest larvae difficult to detect

IPM for SWD

- Midwest growers should be prepared to monitor and manage SWD in 2011.
- If SWD is present, protection is needed from fruit coloring to harvest.
- Remove over-ripe/infested fruit to minimize breeding sites.
- SWD is sensitive to OP (e.g. Malathion) and pyrethroid (e.g. Brigade) insecticides. Beware of PHIs, REIs, safety issues.
- Entrust and Pyganic are the most effective organic insecticides. Shorten interval (5 days) to maintain control.
- Stay informed through workshops, newsletters, websites.