Monitoring and Control of Rednecked Cane Borer and Flatheaded Apple Tree Borer and Update on Spotted Wing Drosophila.

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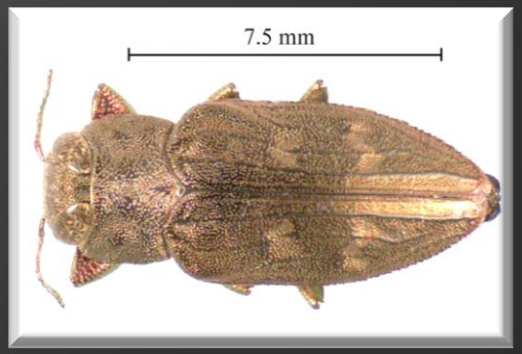


http://insects.tamu.edu/extension/publications/epubs/eee_00027.cfm

Sheila Fitzpatrick - http://www.agf.gov.bc.ca/cropprot/swd.htm

Outline

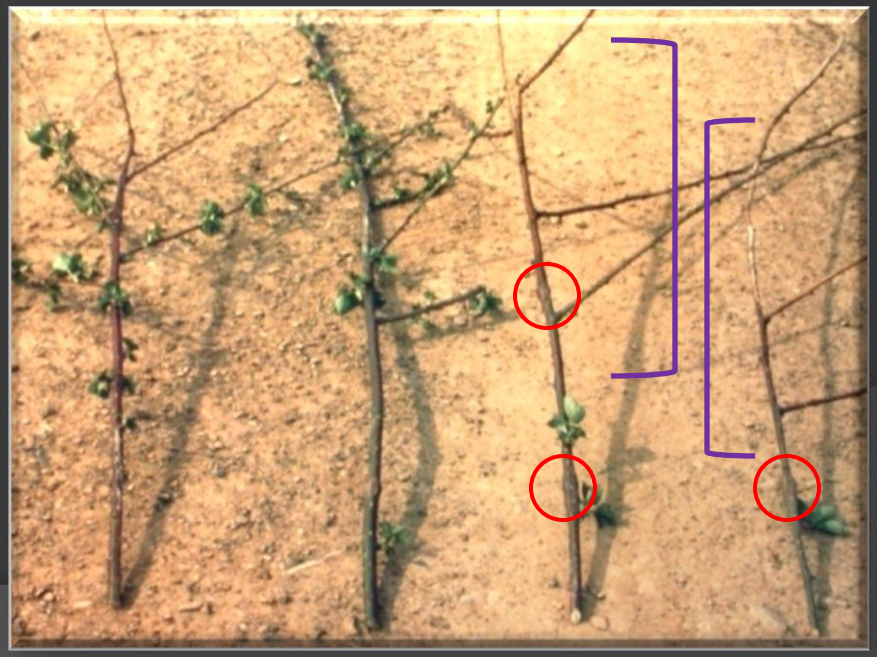
- Rednecked cane borer
- Flatheaded apple borer
- Spotted wing drosophila

Rednecked cane borer *Agrilus ruficollis* (F.) (Coleoptera: Buprestidae)

- Found from Midwest to East coast of the United States
- Adults are all black with red pronotum
- Adults emerge late April to early June
- Feed and oviposit only on primocane leaves and canes
- Larvae develop within the cane
- Larvae girdle cane causing galling of cane

Damage to blackberry

- Rednecked cane borer
  - Development of galls weakens developing canes, predisposes canes to winter injury or death
  - Lowers yield



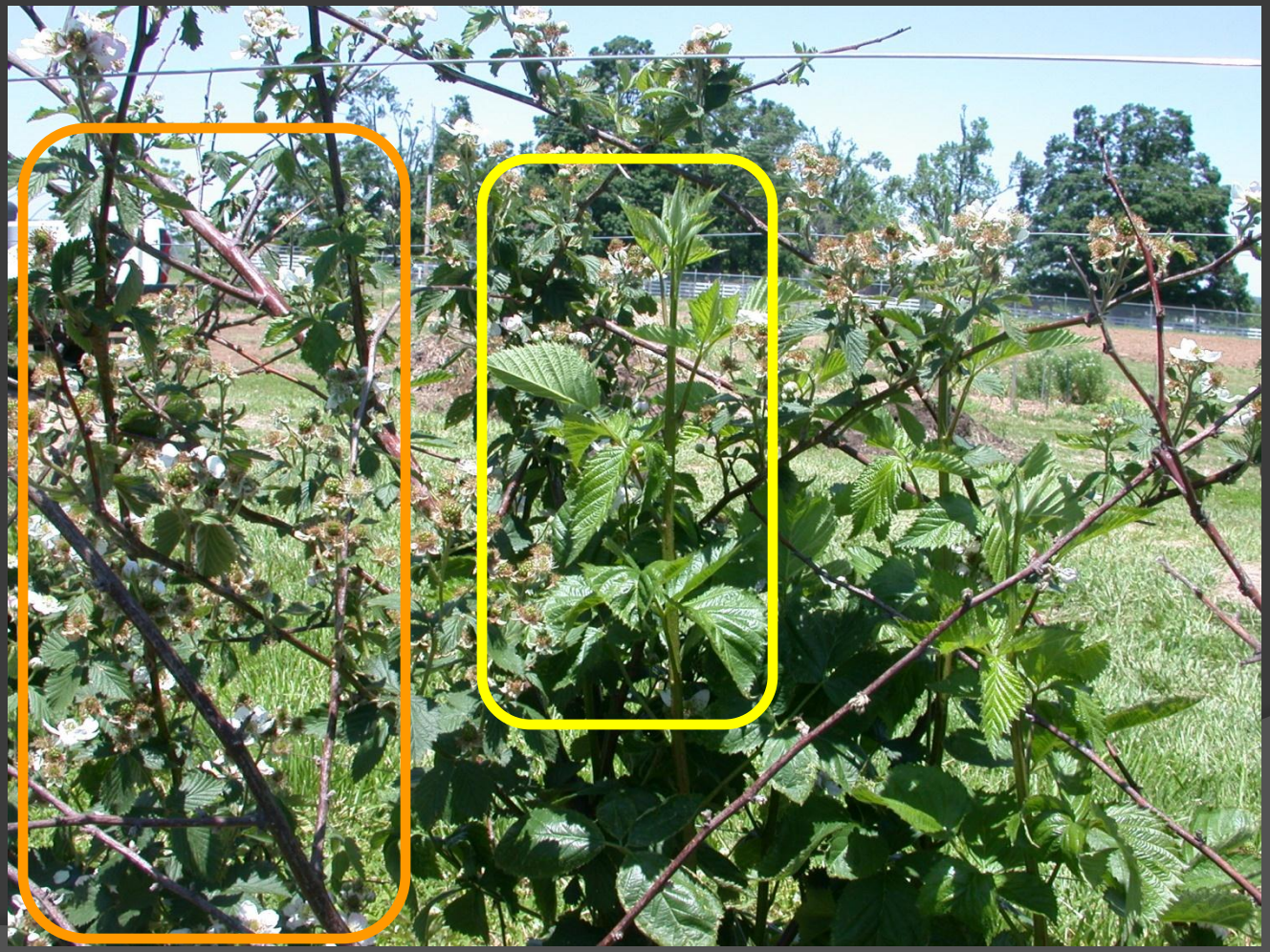
Control measures

- Rednecked cane borer
  - Cultural – if infestation <10% galled
    - remove galled canes
  - Chemical – if infestation >10% galled
- Problem:
  - Imidacloprid (ex. Admire Pro) is the only registered compound

Monitoring?

- Currently:
  - No traps available for monitoring
  - Use visual inspection of plants for presence of RNCB adults
  - Labor and time intensive

Do RNCB adults differentiate primocanes from floricanes using color, shape or odor?



Color and Odor?

- Emerald ash borer purple traps (Crook et al. 2008)
  - Addition of plant odor to traps = increased trap capture
- Emerald ash borer electroretinogram (Crook et al. 2009)
  - most sensitive to the visual spectrum in:
    - UV (340 nm), violet/purple (420-430 nm), blue (460 nm), green (540-560 nm)
    - Only female emerald ash borer to red (640-670 nm)
- Does same concept apply to RNCB?

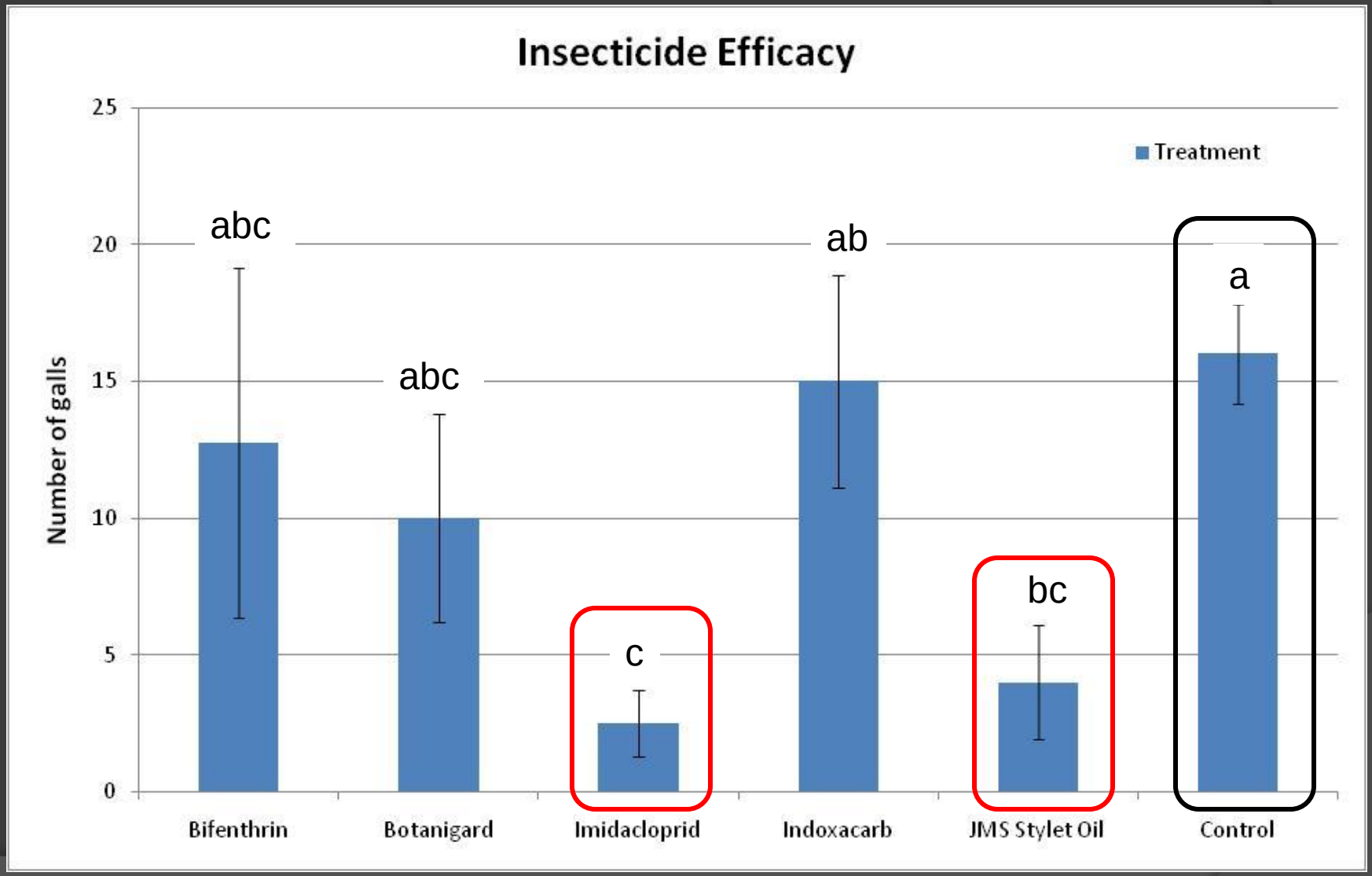
Objectives

- Insecticide efficacy testing
- Identification and attractiveness of primocane and floricane colors

Insecticide Efficacy

- Treatments (x number sprays):
  - Synthetic - Admire Pro (1x), Avaunt (2x), Fanfare (2x)
  - Organic - JMS oil, Botanigard – sprayed weekly (4x)
  - Untreated check
- Early Oct. counted galls per plant per treatment plot

Results: Insecticide Efficacy



Trap attractiveness

- Color attractiveness of traps
  - Obtain paint from hardware store that does paint matching
  - 8 different colors - primocane, floricane, yellow, EAB green, EAB light and dark purple, control

Results: Color differences

- Color Differences
  - Primocane leaf and cane similar to EAB Green trap

Color	Wavelength (nm)	Reflectance (%)
Primocane (leaf-plant)	554	10
Primocane (cane-plant)	546	13
Floricane (leaf-plant)	550	10
Floricane (cane-plant)	630	15
Primocane (leaf-paint)	546	19
Primocane (cane-paint)	555	25
Floricane (leaf-paint)	560	12
Floricane (cane-paint)	617	17
Yellow	579	80
EAB Dark Purple	440	18
EAB Light Purple	424	21
EAB Green	544	50

Color Trap Results

- Color Trap Data 2012
  - Cane mimic caught significantly higher than leaf mimic
  - EAB Green (cane and leaf) significantly higher captures than any other color
  - Primocane leaf significantly higher capture than all colors except EAB Green

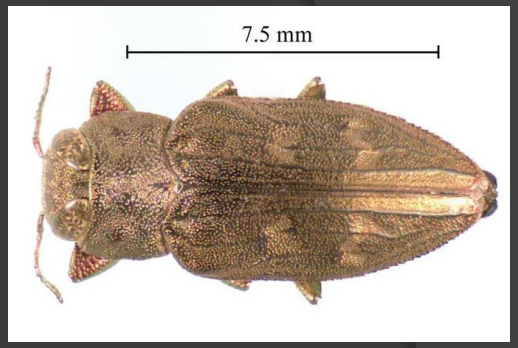
	Mean number of beetles captured (Plant Mimic)	
Trap Color	Cane	Leaf
Primocane	2.1b	1.3b
Floricane	1.7bc	0.6c
EAB Dark Purple	0.7c	0.3c
EAB Light Purple	1.1bc	0.0c
EAB Green	7.4a	4.1a
Yellow	2.0bc	0.0c
Control	0.6c	0.1c

Conclusion

- Insecticide efficacy
  - Imidacloprid and JMS stylet oil provided significantly less galling
  - Trials with other chemistries necessary
- Trap color attractiveness
  - EAB green similar in color (wavelength) to actual plant coloration
  - Green colored traps (EAB green and primocane) captured significantly higher than other colors
  - Traps with higher percent reflectance tend to have higher trap capture

Flatheaded apple borer

- Flatheaded appletree borer, *Chrysobothris femorata* (Olivier)
- Found throughout the United States
- Wood boring beetle, that can attack apple trees and blueberries
- Most active from May – June
- Adults are “bullet” shaped and dark green to brown in color



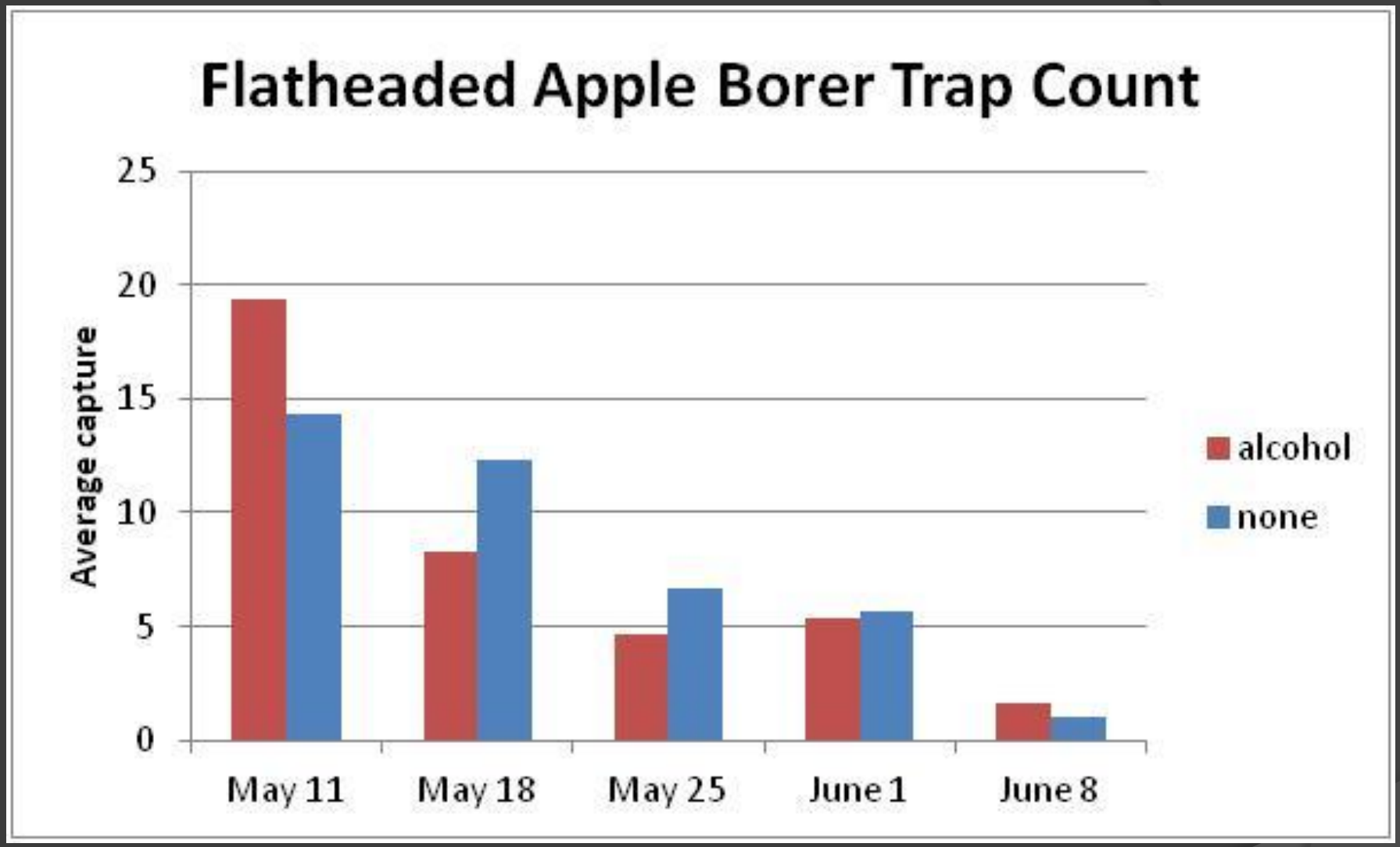
http://insects.tamu.edu/extension/publications/epubs/eee_00027.cfm

Monitoring

- Adults monitoring done with purple traps
- Same color to emerald ash borer traps
- Place traps out from April to June
- We tested if addition of an alcohol lure would increase capture

Photo by Nadeer Youssef, TSU Otis Floyd Nursery Research Station, McMinnville, TN

http://www.agbio-inc.com/flathead-borer-trap.html



- Addition of alcohol lure did not increase capture

Damage

- Majority of damage caused by larval feeding
- Adults are foliage feeders
- Newly transplanted and stressed trees are more susceptible to attack
- Larvae feed on the phloem and sapwood
- Can become an entry point for bacteria infections

http://ipm.illinois.edu/hyg/insects/flat_headed_apple_tree_borer/index.html

Control

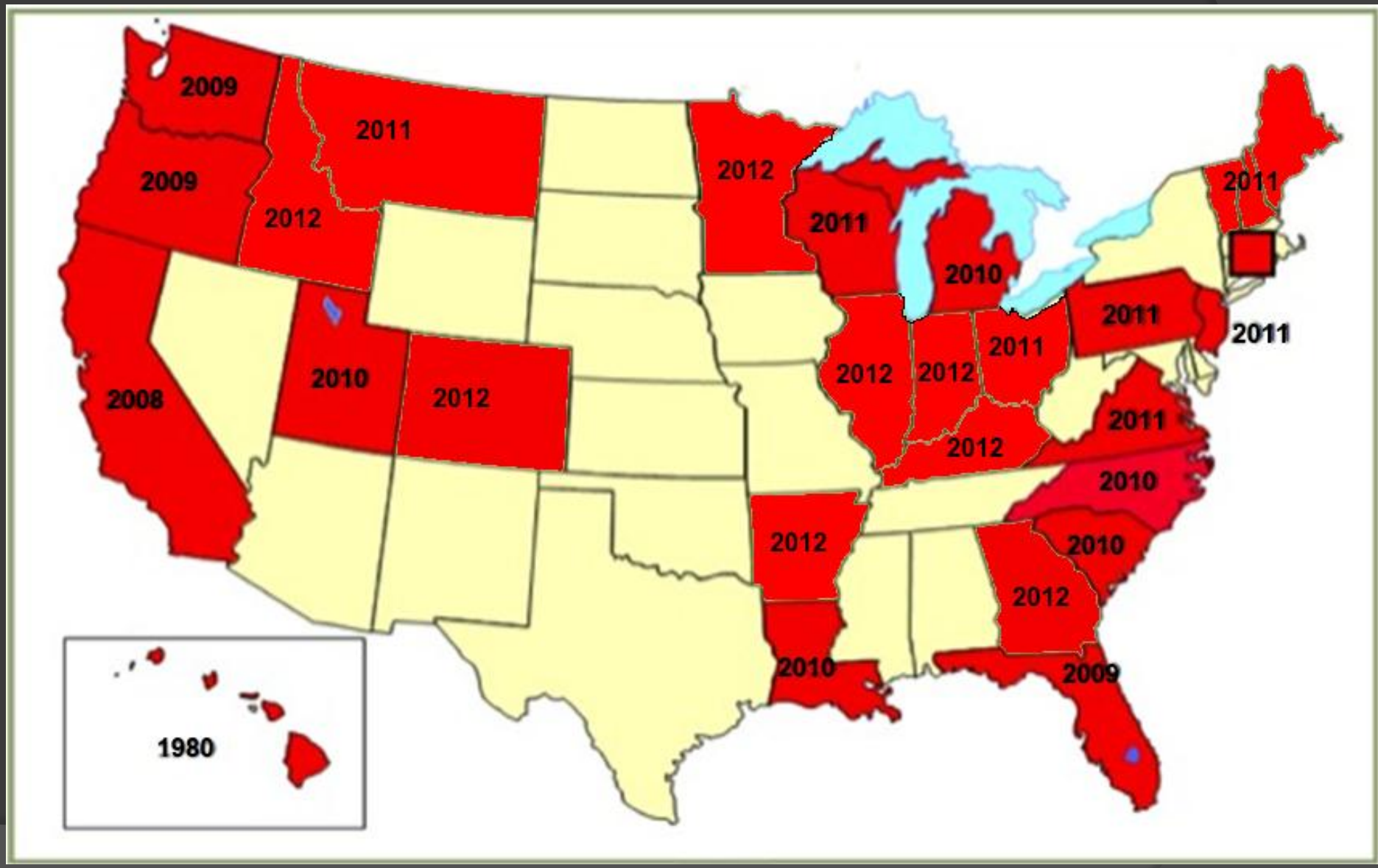
- Chemical
  - Foliar applications of Carbaryl
  - Trunk applications of bifenthrin
  - Soil drench with imidacloprid
- Cultural
  - Avoid transplanting plants near wooded areas
  - Remove vegetation around base of young trees
  - Remove fallen trees and pruned limbs

New Pest Alert!!!!

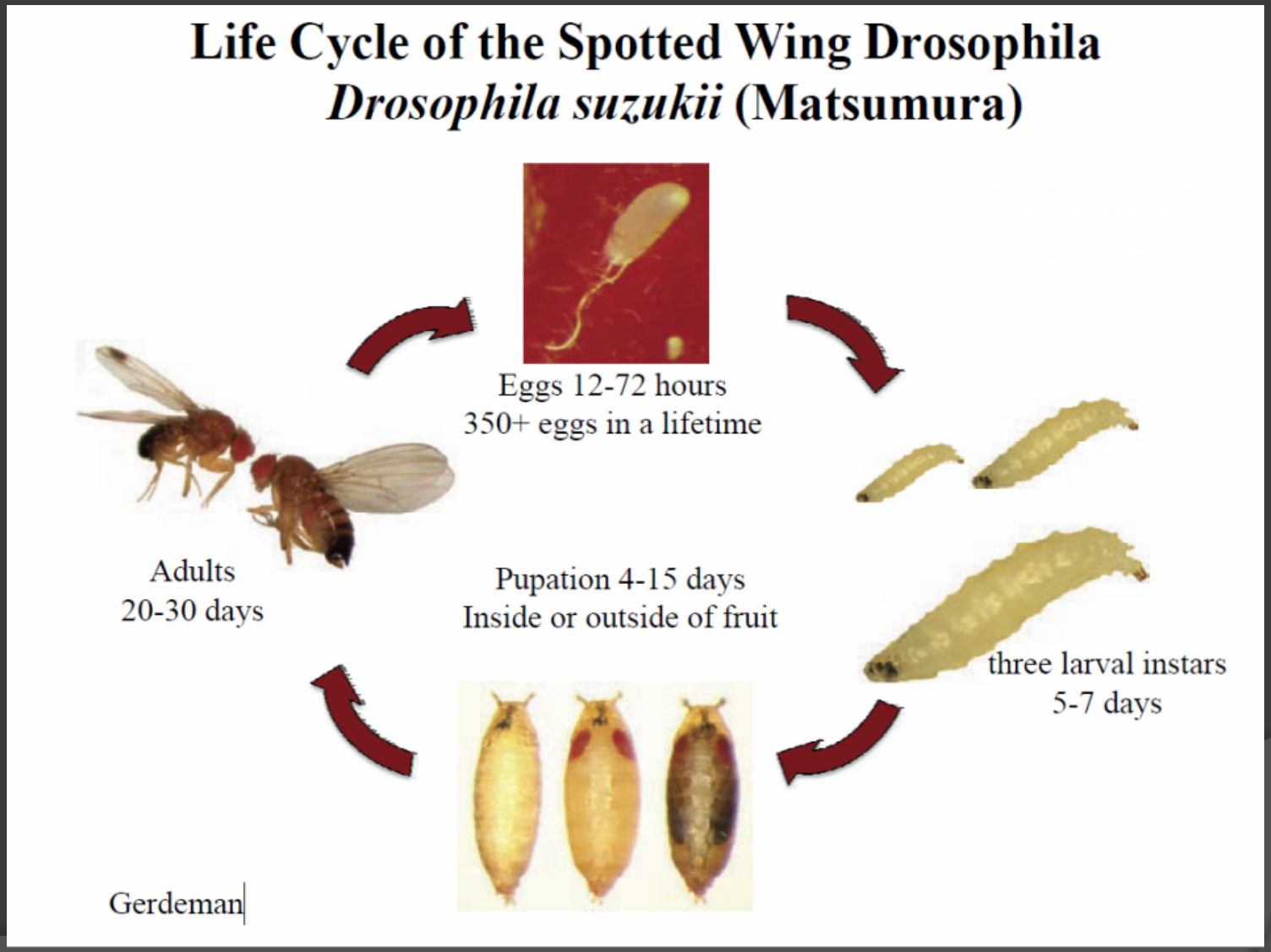
Spotted Wing Drosophila (SWD)

- *Drosophila suzukii* (Matsumura)
- Invasive species from Asia
- SWD attacks fruit pre-harvest
  - Larvae in fresh market fruit
- Serious pest in many fruit
  - Caneberry, blueberry, strawberry, cherry, various other tree and small fruits, and fruiting vegetables (tomato)
- Most active around 20ºC, males become sterile above 30ºC

Distribution



Life Cycle (Cowles 2012)



http://www.ct.gov/caes/lib/caes/documents/plant_science_day/plant_science_day_spring/2012/cowles_spring_open_house_2012.pdf

Damage

- Adults and larvae can cause damage
  - Adults – oviposition scars can lead to secondary fungal infections
  - Larvae – feeding on fruit flesh
- Can cause up to 100 percent yield loss

E. Beers - http://jenny.tfrec.wsu.edu/opm/gallery.php?pn=165

http://www.omafra.gov.on.ca/english/crops/facts/swd-damage.htm

Hannah Burrack - http://ncsmallfruitsipm.blogspot.com/2012/02/larvae-in-fruit-distinguishing-between.html

Monitoring (fly)

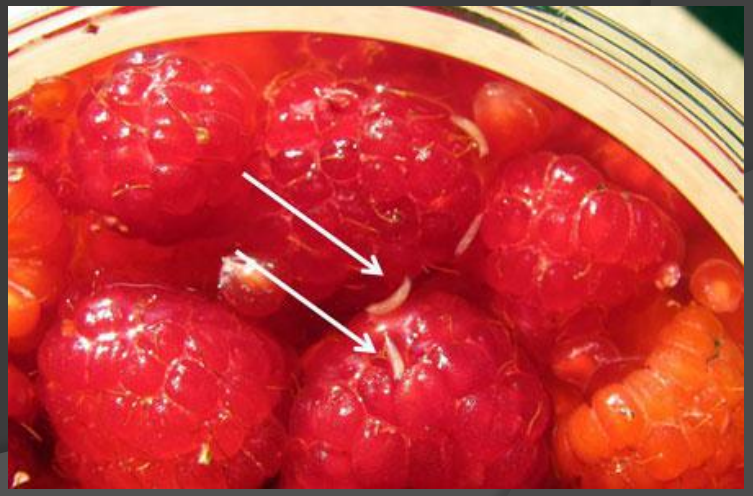
- Simplest trap:
  - Clear deli cups with yellow sticky trap
- Lures available
  - Apple cider vinegar
  - Vinegar + wine (best bait)

http://www.ipm.msu.edu/invasive_species/spotted_wing_drosophila/monitoring

Monitoring (larvae)

- Collect 30 ripe fruit and place in ziploc bag
- Slightly crush fruit
- Add 2-3 cups of sugar or salt water solution (1 qt water + ¼ cup sugar/salt)
- Allow 20-30 min for larvae to float to top

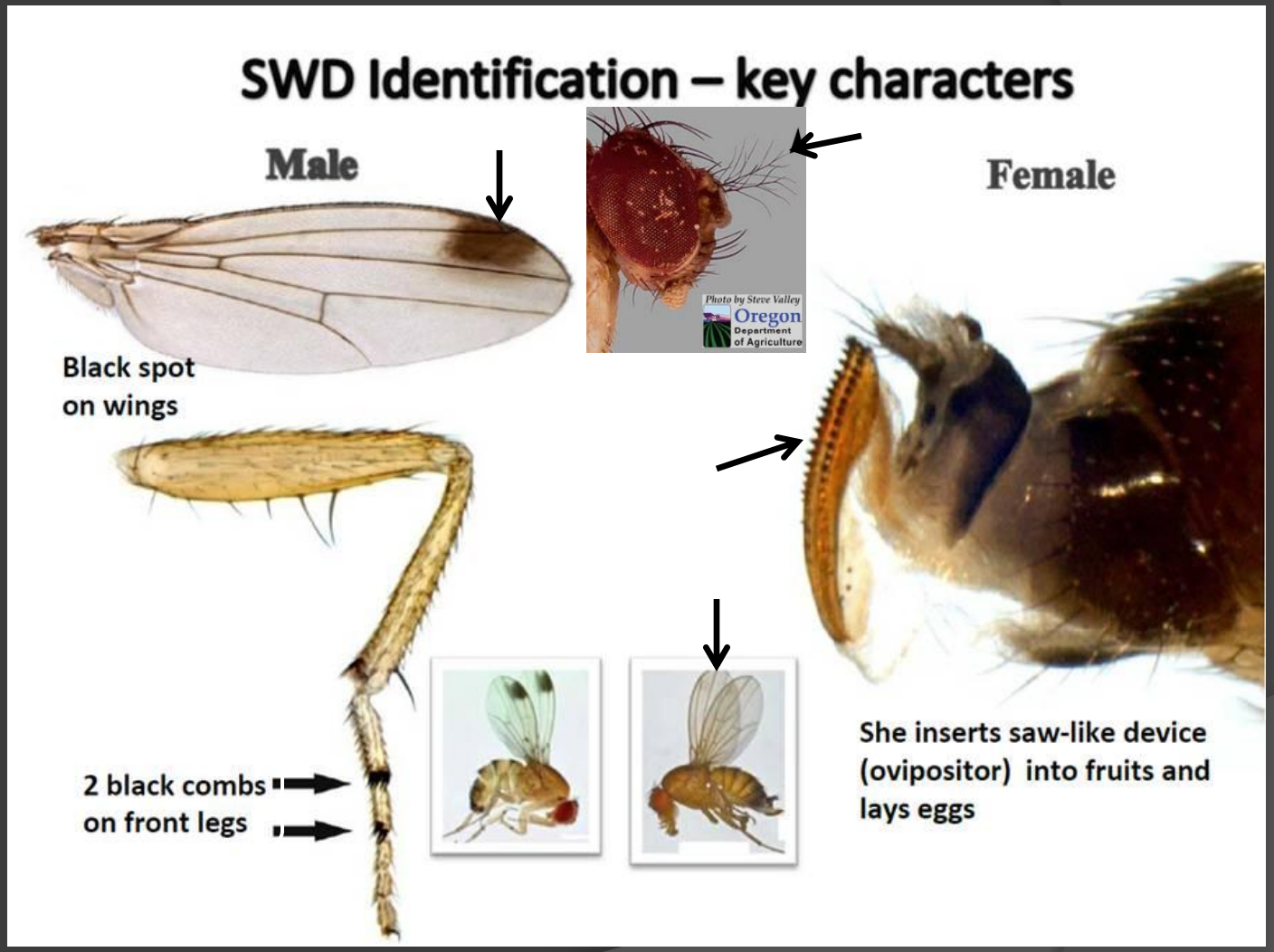
http://horticulture.oregonstate.edu/system/files/Spotted_Wing_booklet-11-2.pdf



Carlos Garcia, MSUE

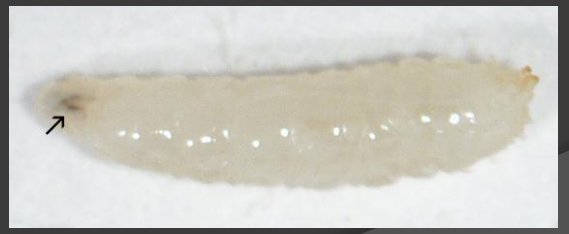
Identification

- Males
  - Black spot on the end of the first vein
  - Two sets of combs on the front tarsi
  - Antenna arista
  - Red eyes
- Females
  - No black spot on wing
  - Sclerotized, double serrated ovipositor
  - Antenna arista
  - Red eyes



Problem: Identifying Specimens to Species

- Difficult and time consuming to identify *Drosophila* specimens to species:
  - Old fly specimens are brittle
  - Larvae - hard to see discriminating morphological characteristics
- *Objective* was to develop a molecular diagnostic protocol to identify *Drosophila* specimens to species.



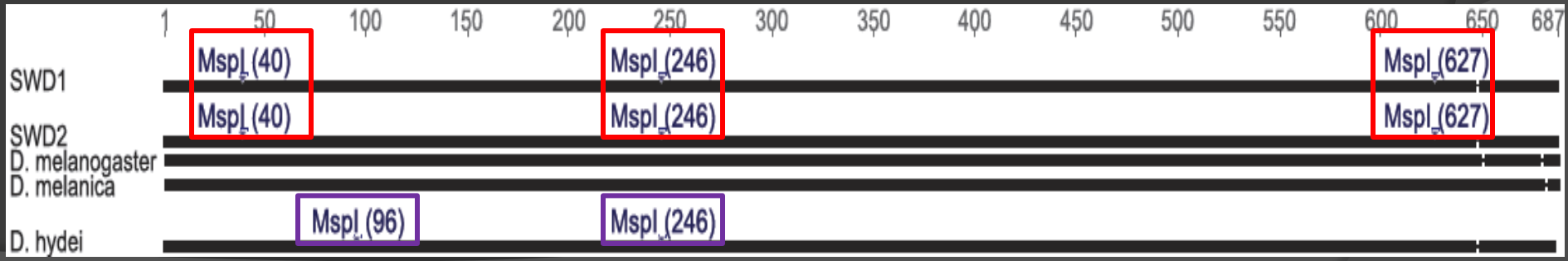
Not SWD

SWD

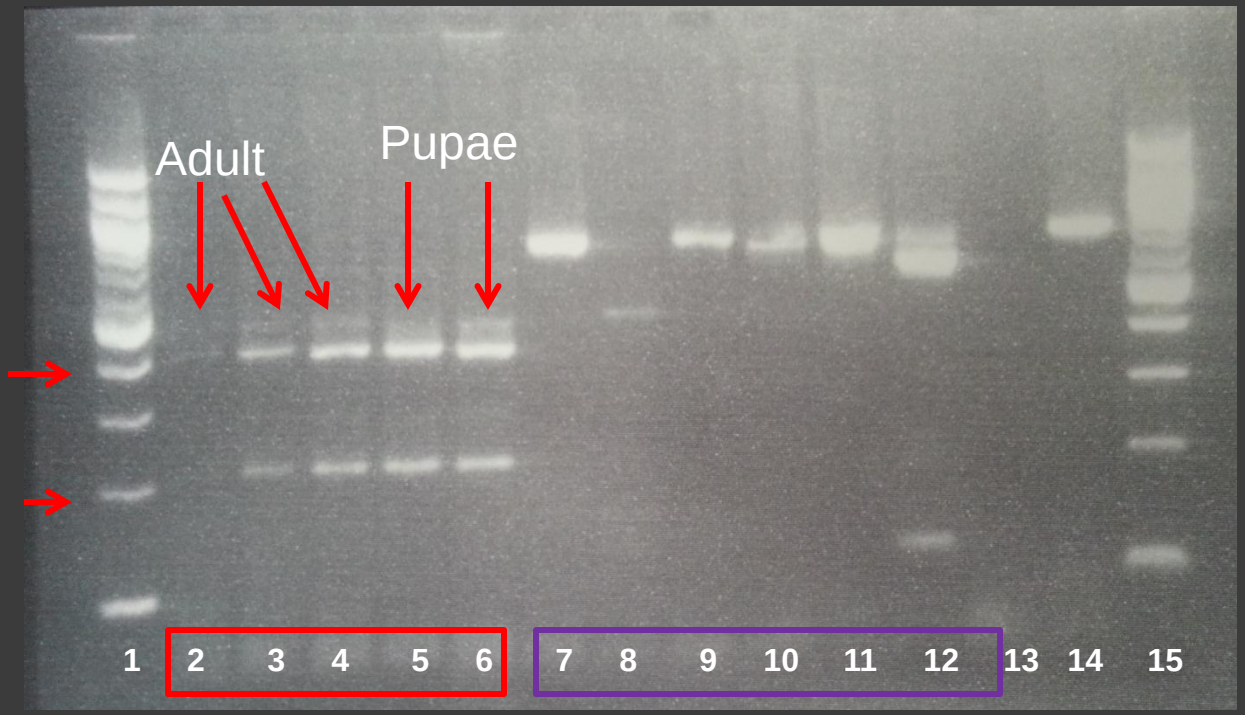
Methods

Used Restriction Fragment Length Polymorphism (RFLP) to ID to species

- Some DNA molecules in the population contains a particular restriction site whereas others lack it
- This change in the restriction site creates different sizes of a restriction fragment
- PCR-RFLP
  - DNA is amplified using PCR with primers specific for predetermined regions of the genome
  - Portion of the PCR product is digested using restriction enzymes



Results



1) 100 Bp ladder
2) Spotted wing drosophila
3) Spotted wing drosophila
4) Spotted wing drosophila
5) Spotted wing drosophila
6) Spotted wing drosophila
7) *Drosophila melanica*
8) *Drosophila hydei*
9) *Drosophila melanogaster*
10) *Muscidae sp.*
11) *Drosophila melanogaster*
12) *Carpophilus sp.*
13) Negative control
14) Enzyme control
15) 100 Bp ladder

- PCR – RFLP on spotted wing drosophila produces two fragments – 200 Bp & 400 Bp
- Other *Drosophila* species or other insects uncut or cut into different lengths by enzyme
- PCR – RFLP worked on adults and pupae of spotted wing drosophila

Pest Management Practices

- Chemical
  - Organophosphates, pyrethroids, spinosyns
  - Short post harvest intervals (PHI) – less than 7 days
  - Weekly to twice weekly sprays for control
- Cultural (being evaluated in 2013)
  - Mass trapping
  - Screen mesh

Active Ingredient	Trade name	IRAC code	Blueberry	Caneberry	Strawberry	Probable Efficacy
			PHI (days)	PHI (days)	PHI (days)	
Carbaryl	Sevin 80S	1A	7	7	7	Good
Diazinon	Diazinon	1B	7	7	5	Excellent
Malathion	Malathion 5EC	1B	1	1	3	Excellent
Methomyl	Lannate LV	1A	3	Not labeled	Not labeled	Excellent
Phosmet	Imidan 70W	1B	3	Not labeled	Not labeled	Good
Bifenthrin	Brigade WSB	3	1	3	0	Excellent
Esfenvalerate	Asana	3A	14	7	Not labeled	Excellent
Fenpropathrin	Danitol	3	3	3	2	Excellent
Pyrethrin	Pyganic*	3A	0	0	0	Good
Zeta-cypermethrin	Mustang Max	3	1	1	Not labeled	Excellent
Acetamiprid	Assail 30SG	4A	1	1	1	Fair
Imidacloprid	Provado	4A	3	3	7	Fair
Spinetoram	Delegate	5	3	1	Not labeled	Excellent
Spinetoram	Radiant	5	Not labeled	Not labeled	1	Excellent
Spinosad	Entrust*	5	3	1	1	Good/Exc
Pyriproxyfen	Esteem	7	7	Not labeled	2	Fair/Good

* OMRI approved

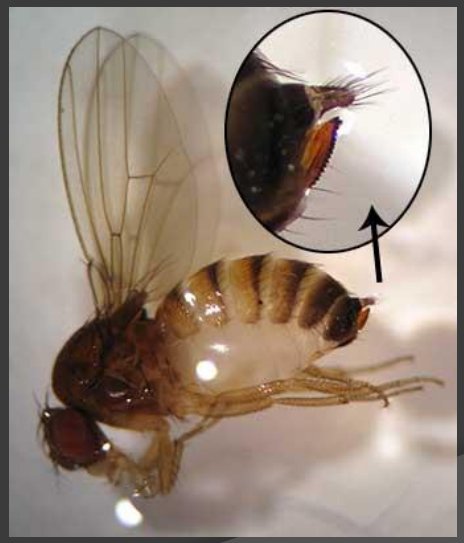
Discussion

- Spotted wing drosophila is a new invasive pest in Arkansas that has a very high potential to negatively impact fruit yields
- Need method to properly identify *Drosophila* fly or larval specimens to species so grower can decide on the best pest management practice
- Molecular techniques can be used to identify Drosophila, but
- Further testing is needed to develop species specific primers

Acknowledgments

- Fruit sub-station in Clarksville, AR and Lez Dozier for use of blackberry plots
- Funding provided by
  - North American Bramble Grower Research Foundation
  - Southern Region Small Fruit Consortium

Questions?



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