

Spotted Wing Drosophila (SWD) Workshop



**Dr. Donn Johnson, Dr. Elena Garcia,
Barbara Lewis, and Soo-Hoon Sam Kim
Departments of Entomology and Horticulture**



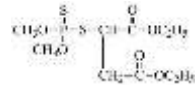
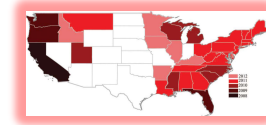
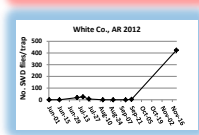
Acknowledgements

- SWD Workshops and 1st SWD studies in Arkansas are funded by the UA Cooperative Extension Service, Arkansas Department of Agriculture and USDA-NIFA-Specialty Crops Research Initiative IPM Project
- Special thanks for Workshop facilities provided by:
 - SWREC in Hope (March 13)
 - Faulkner County Office in Conway (April 3)
 - UA Pauline Whitaker Animal Science Center in Fayetteville (April 10)

Participant Introductions

Agenda

- SWD Project Objectives
- Spotted Wing Drosophila (SWD)
 - ✓ Origin and Spread in US
 - ✓ Identification, Biology, Hosts, Economic Damage
 - ✓ Trap catch, Sampling (flies / larvae), Management
- Hands-on Sessions I-IV
 - I. Handouts, ID SWD using 20X hand lens & vial of SWD flies, set up traps, learn sampling, use laminated SWD sheet
 - II. Grower Collaboration in monitoring SWD
 - III. Discuss SWD research/extension priorities
 - IV. Discuss fall grower survey
- Spotted Wing Drosophila Workshop Evaluation
- Lunch discussion with Agents and Growers



Project:

SWD Workshops and Monitoring in Arkansas 2013

Investigators: Donn T. Johnson and Elena Garcia

Assistants: Barbara Lewis, David Dickey,
Soo-Hoon Sam Kim and Kevin Durden

Project Objectives:

1. Prepare and conduct 3 SWD Workshops
2. In Arkansas, promote SWD monitoring SWD-susceptible fruit plantings
3. Process fly and larval samples from county agents for confirmation as SWD
4. Update Arkansas county map showing confirmed SWD samples and upload map to Fruit / Nut Pest Management web page:
<http://comp.uark.edu/~dtjohnso/>
5. Describe seasonal biology, damage and management of SWD
6. Conduct anonymous survey of fruit growers
7. Report findings of project and survey at winter grower

Why a SWD Workshop?

Other states with SWD damage stress:

“You need to educate county agents and fruit growers about this pest as soon as possible.”

- During 2012, most of the major fruit producing states have experienced multi-million dollar losses in blueberries and caneberries due to SWD infestation and the associated costs of controlling this insect.
- States that first detected SWD in 2009 - 2011 reported economic fruit damage by SWD the following year
- These states reported 100% fruit crop loss from SWD in untreated fruit plantings
- SWD was confirmed as present in Arkansas in 2012

Are other states Managing SWD?

✓ The positives to date:

- Most infestation occur after July
- Insecticides effective against SWD include: Entrust®, Delegate®, Brigade®, Mustang Max®, and/or malathion insecticides
- After a rain during high SWD fly counts, growers sprayed twice weekly
- With monitoring to time insecticide sprays, Oregon growers had < 10% loss to berries, < 3 % loss of peach, 0% loss to grape

Spotted Wing Drosophila

Origin

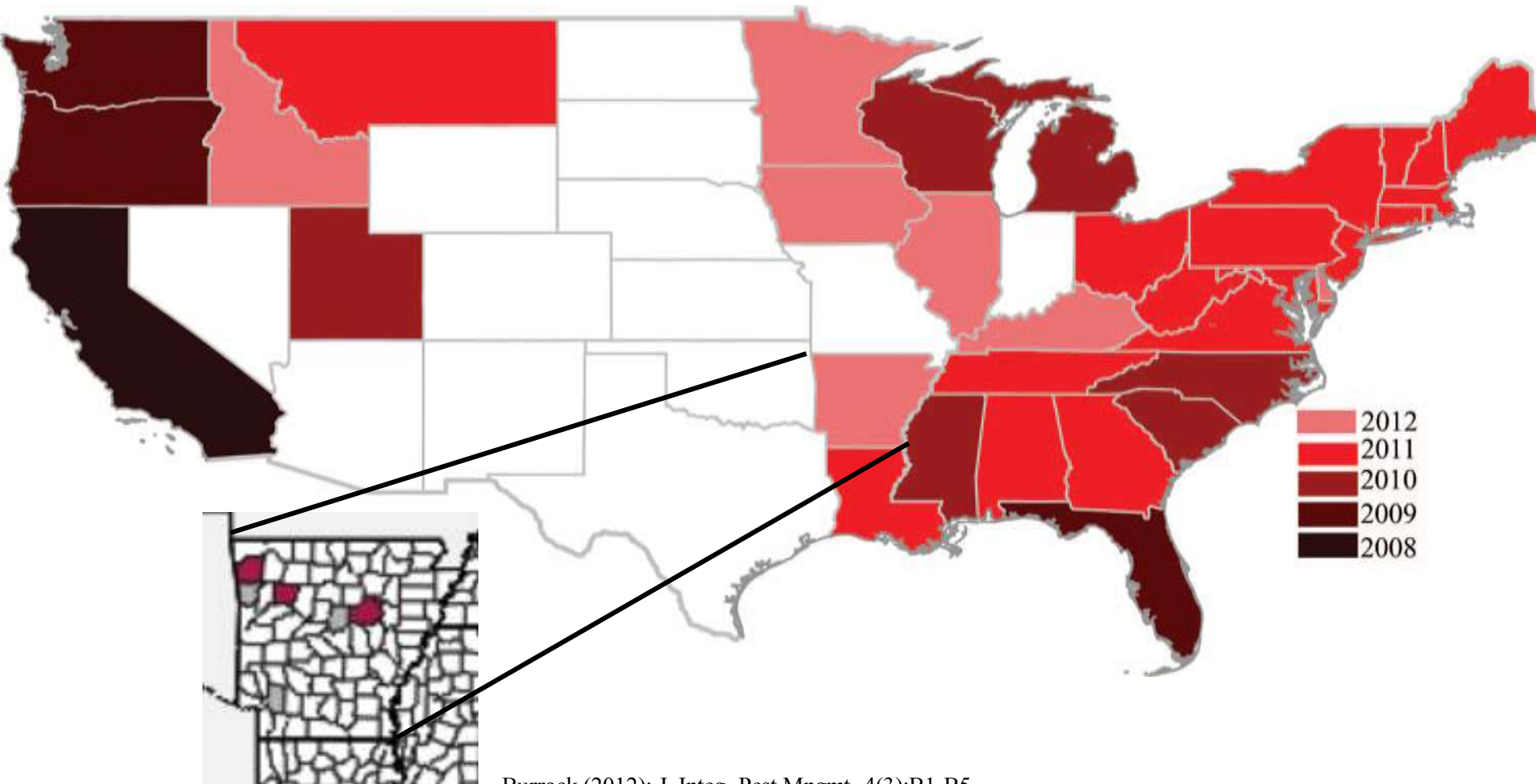
- *Drosophila suzukii* (Matsumura)
 - ✓ Invasive species from Asia



	January mean temperature	<i>D. suzukii</i>
Sapporo	- 3.6 C	1.77 %
Tokyo	4.2 C	20.54 %
Kume-jima	16.9 C	0.63 %
Iriomote-jima	18.3 C	0.001%

40° F; same as AR

SWD Spreads Across N. America



Burrack (2012): J. Integ. Pest Mngmt. 4(3):B1-B5

SWD Identification

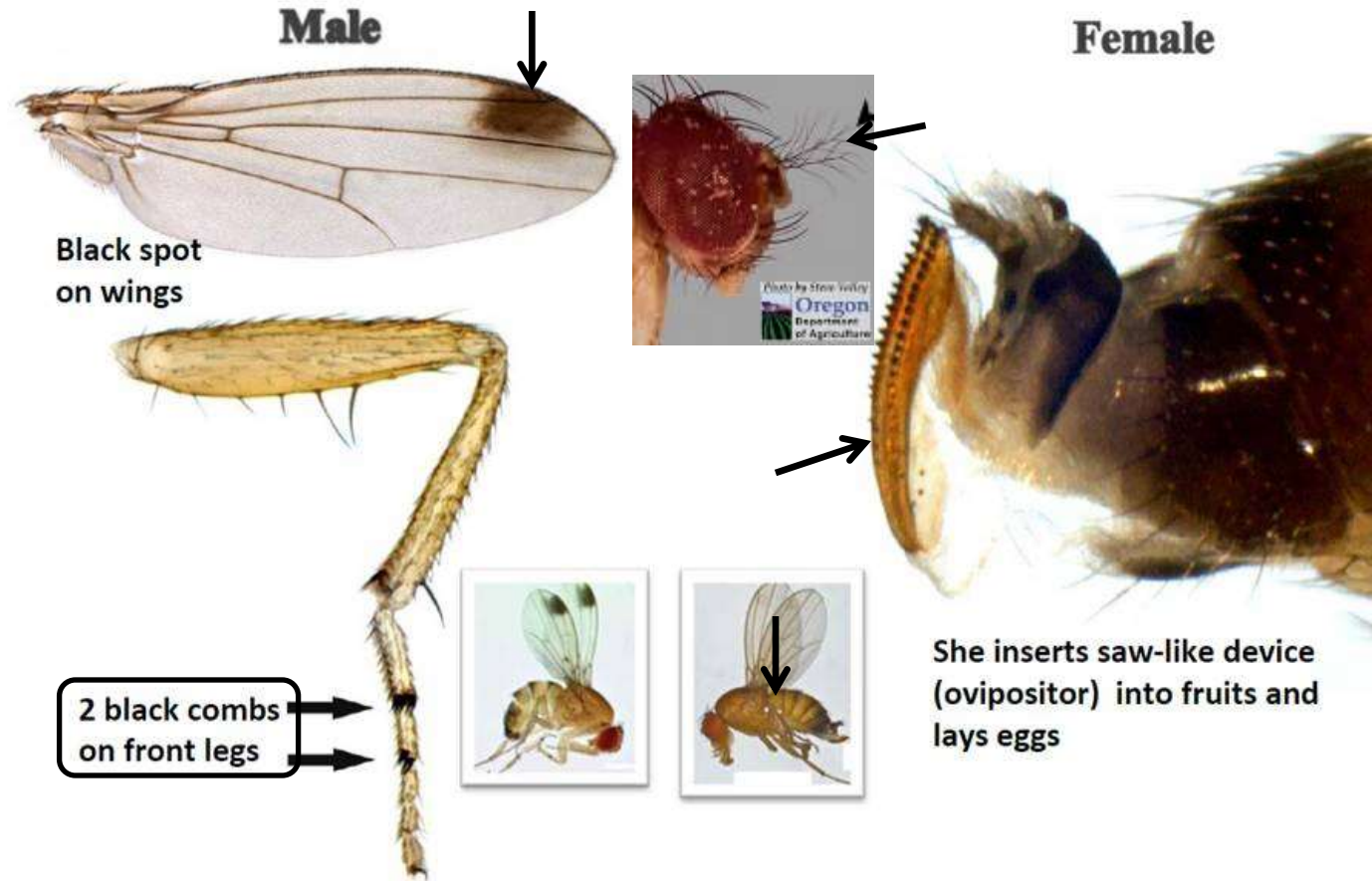
SWD Identification – key characters

❖ Males

- ❖ Black spot on the end of the first vein
- ❖ Two sets of combs on the front tarsi
- ❖ Antenna arista
- ❖ Red eyes

❖ Females

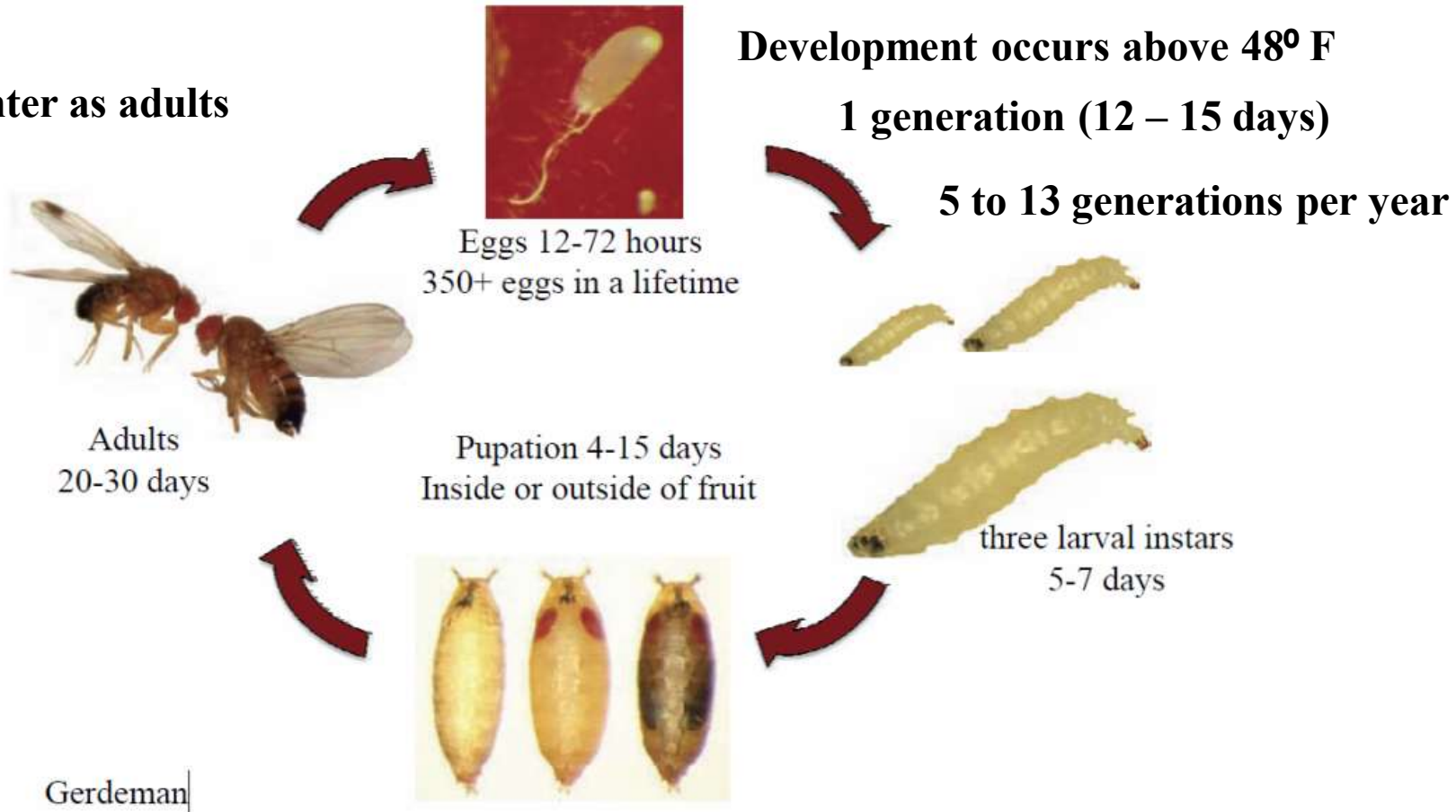
- ❖ No black spot on wing
- ❖ Sclerotized, double serrated ovipositor
- ❖ Antenna arista
- ❖ Red eyes



SWD Biology

Life Cycle of the Spotted Wing Drosophila *Drosophila suzukii* (Matsumura)

Overwinter as adults



Develop best at 68° F – may explain why SWD numbers increase after hot summer in September and October

Life stages

Eggs (1 – 3 days)



Larvae (5 – 7 days)



Pupae (3 – 15 days)

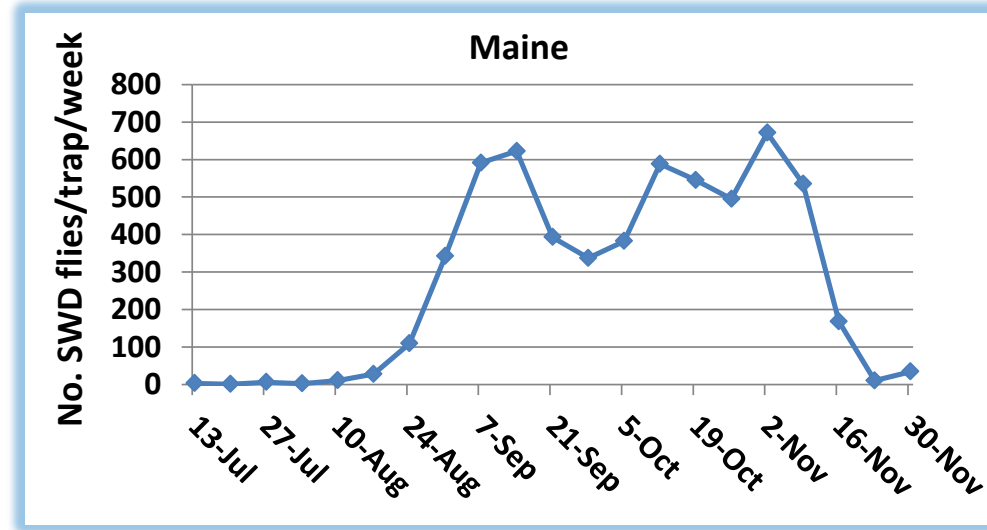
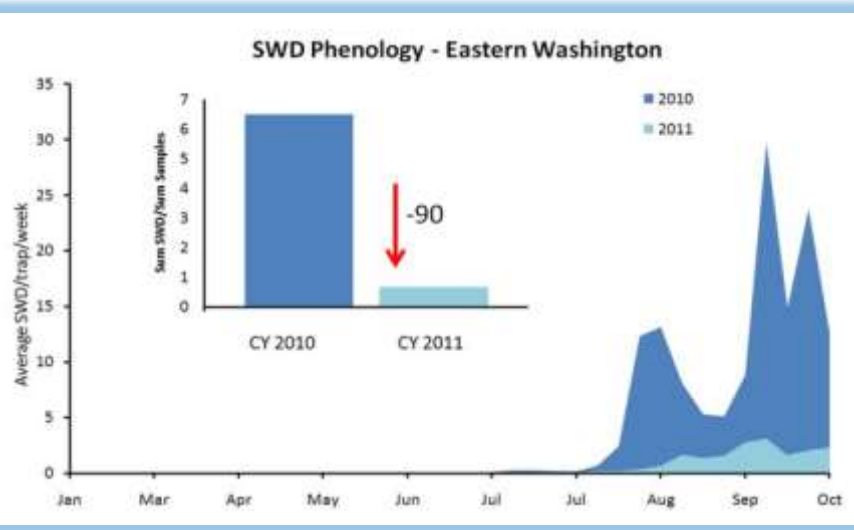


SWD Seasonal Activity in U.S.

- Corvallis OR: 1st egg laying in fruits on May 17, 2011
- 1st detection of SWD in Michigan changed over 3 years:
 - Sept 23 in 2010
 - July 3 in 2011
 - May 29 in 2012 (survived mild winter)
 - *Now more of the harvest period overlaps with this pest's activity*
- In White Co. Arkansas, vinegar-baited traps sampled on 25 July 2012 had 3 confirmed SWD flies with no further trap catch until October when we captured 424 SWD flies in trap

SWD Fly Counts Increase After July

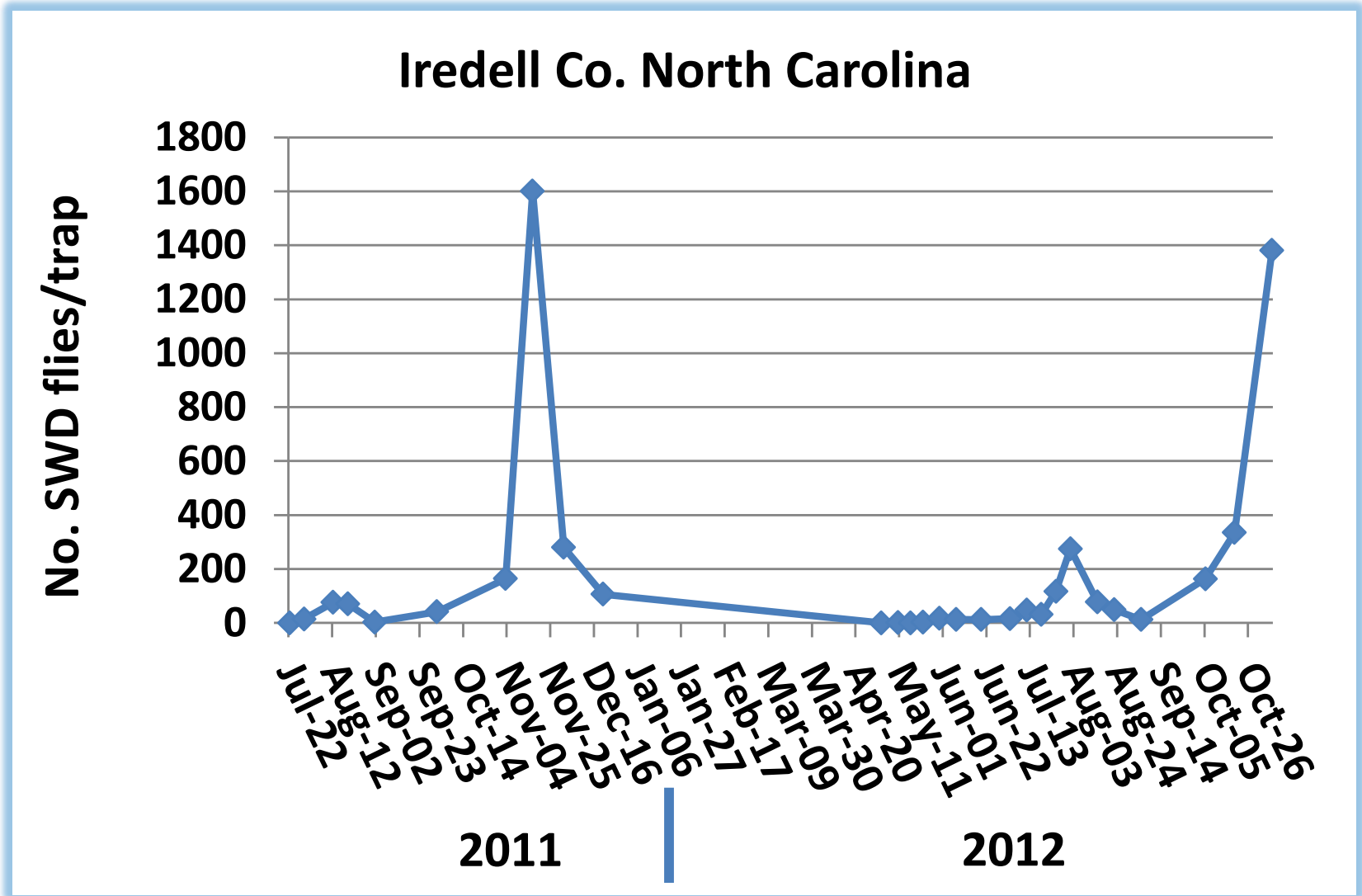
- Late season fruits are more vulnerable to SWD
- Arkansas, Maine, New York, North Carolina, Washington:
 - SWD fly counts in traps begin increasing in late July and peak from September to November
 - WA had freeze (24^o F) in October 2010 causing drop in SWD numbers in 2011



USDA/UCA-OSU-WSU SWD Project Report 2012:
http://horticulture.oregonstate.edu/system/files/SWD_ResearchReviewYear%202_7.16.12.pdf

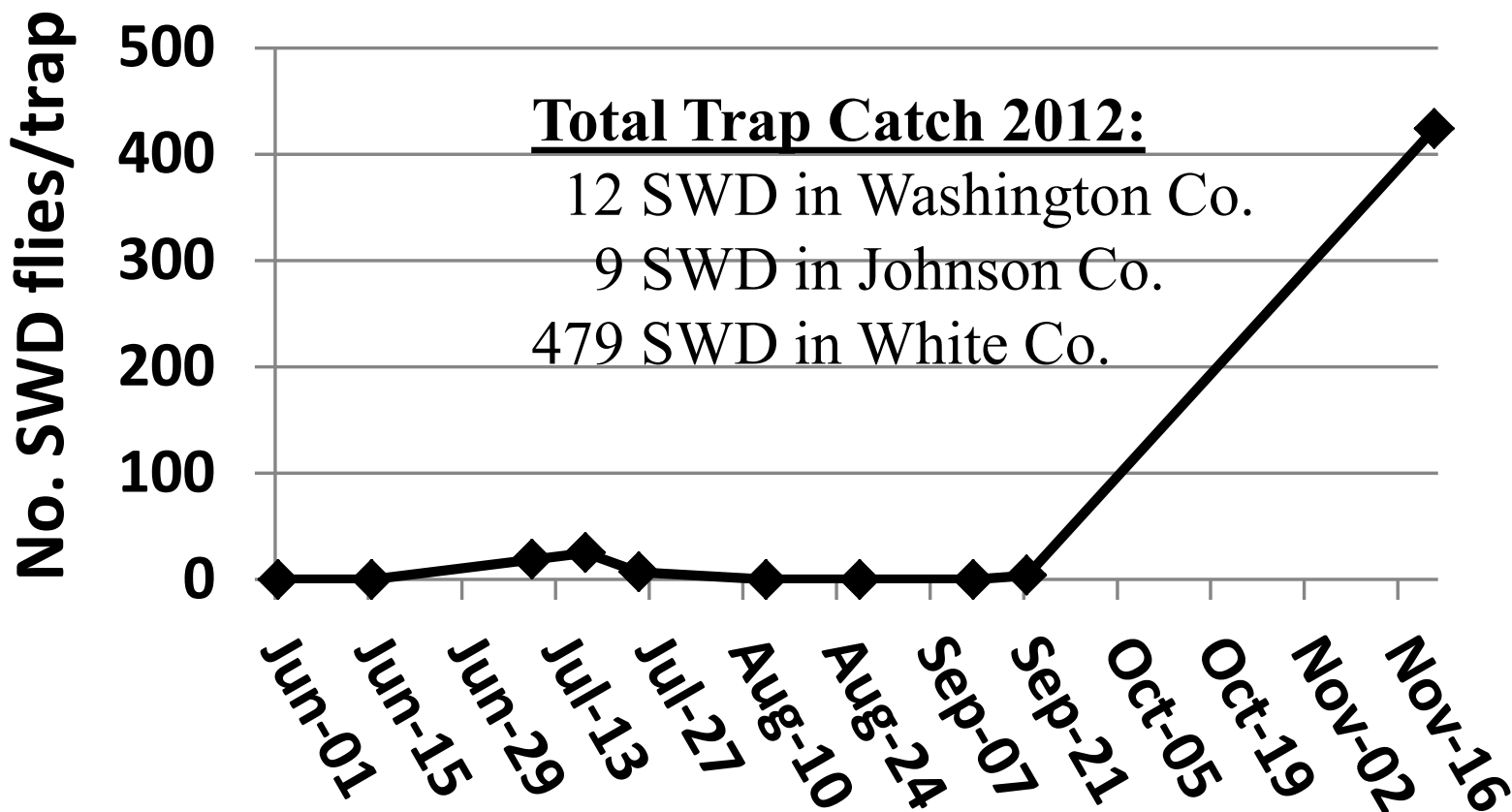
<http://umaine.edu/highmoor/blog/2012/12/03/spotted-wing-drosophila-update-for-maine-fruit-growers-july-23-2012/>

North Carolina Trap Catch 2011-2012



Arkansas 1st Seasonal Trap Catch 2012

White Co., AR 2012



SWD Hosts

How SWD Damages Fruit

- Adults and larvae can cause damage
 - ✓ Flies cut fruit skin that leads to fungal infections
 - ✓ Larvae – feed in ripening fruit flesh
- Can cause up to 100% yield loss



E. Beers



Photo: H. Burrack

H. Burrack

<http://www.omafra.gov.on.ca/>



<http://www.al.gov.bc.ca>



agdev.anr.udel.edu



<http://jenny.tfrec.wsu.edu/opm/pmimages>



H. Burrack

Susceptible Hosts for SWD

- **Attacks pre-harvest ripening fruits above 7.5 brix**
- SWD has caused significant economic damage in cherries, blueberries, raspberries, and blackberries strawberries and some grapes
- SWD has also been recorded feeding on apples, pears, nectarines, persimmons, peaches, plums, and their wild relatives.
- SWD larvae have also been found feeding on pokeweed and dogwood berries.
- Wine grapes from Oregon and Washington appear to be unsuitable hosts for SWD reproduction



Susceptible Hosts for SWD

- New York (May 2013): Greg Loeb and Faruque Zaman sampled four major grape cultivars grown during August to October:
 - ✓ No SWD eggs in ‘Pinot Noir’ and ‘Chardonnay’
 - ✓ SWD attack and complete development in grapes of ‘Merlot’ and ‘Cabernet Sauvignon’
 - ✓ 5% of ‘Merlot’ berries had SWD eggs by mid-October
 - ✓ No evidence of extensive damage, deterioration or loss of grape quality related to SWD



Oviposition of *D. suzukii* on wild cherry fruits in Tokyo



Wild cherry fruits change color and hardness with ripeness.



Light red



Red



Black

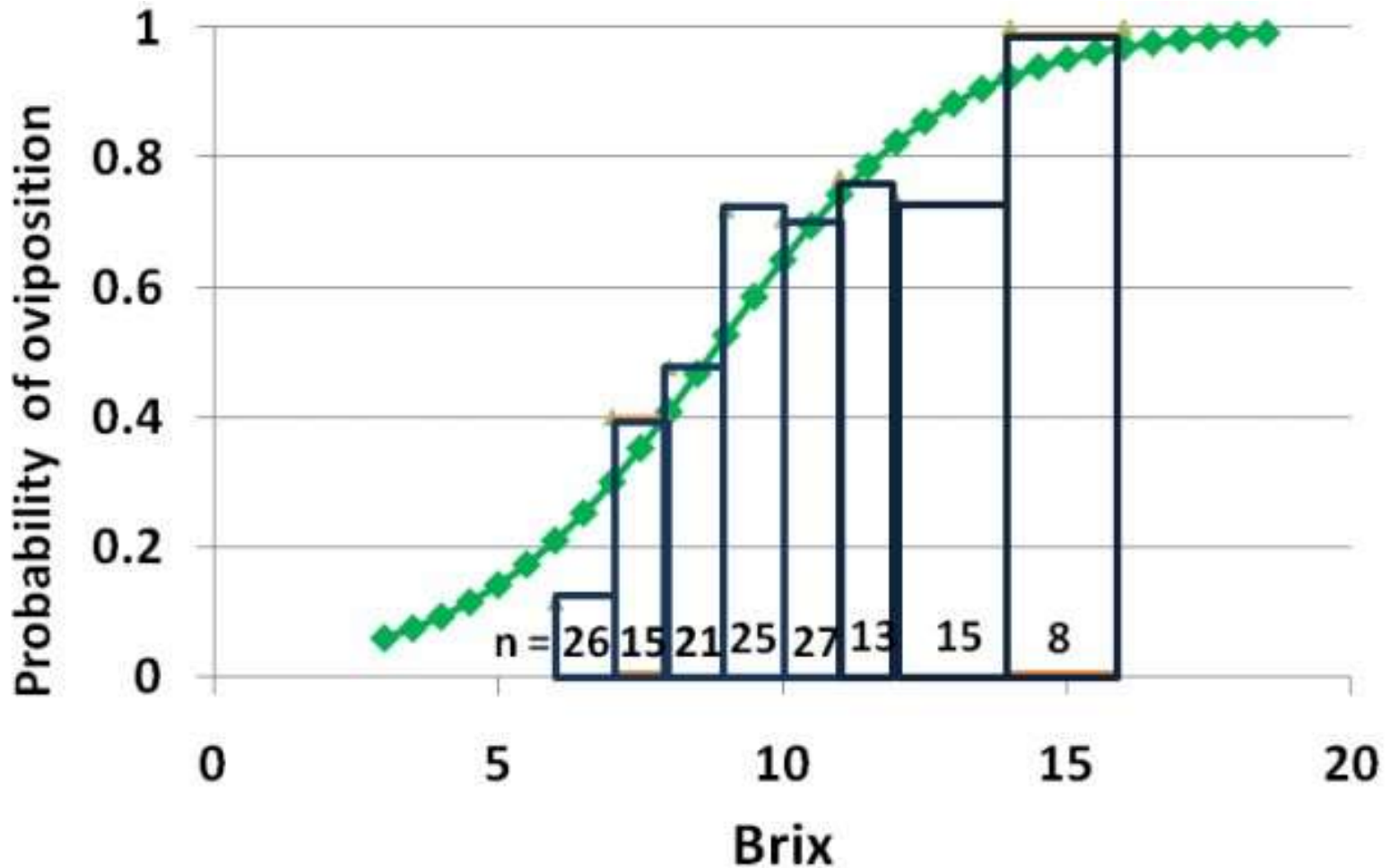
Number of *D. suzukii* eggs (per fruit) at different stages

	Light red	Red	Black
Tree A	0	1.15	1.75
Tree B	0	1.49	2.38

***D. suzukii* oviposits on ripe fruits**

(Ref.: Mitsui et al. 2006)

SWD Lay Eggs in Ripening Blueberry (> 7.5 Brix)



50% chance of SWD oviposition in blueberry at > 7.5% brix

Damage Increases After June

- NE and Midwest states:
 - Risk from SWD increases through the season
 - **June-bearing** strawberries may escape infestation
 - **Mid-season** ripening cultivars of blueberries are at risk
 - **Late summer and fall** harvested crops such as day-neutral strawberries and caneberries may be at higher risk
 - **Caneberries grown in high tunnels** need control of SWD over many months
 - Some SWD infestation reported in **vineyards**

Protect Late Maturing Crops in Arkansas

- **Goal:** assist fruit growers to produce SWD-free fruit
- 25% of 2.9 M Arkansans consume fruit
- 1,300 acres of AR fruits need protection from SWD
 - ❖ 200 acres of blackberries and raspberries (\$779,000)
 - ❖ 150 acres of blueberries (\$875,000)
 - ❖ 200 acres of strawberries (\$2,680,000)
 - 750 acres **table** grapes (\$1,600,000)
 - **Wine grapes less likely to be damaged**
- Total value > \$5,934,000 (without considering value added products)

Trapping Flies

SWD Trap Baits

- Preharvest to Harvest:
 - ✓ **Cowles SWD bait:** 12 oz. water + 4 Tbsp. sugar + 1 Tbsp. yeast + 2 Tbsp. whole wheat flour + 1 Tbsp. apple cider vinegar + 3 drops of liquid dishwashing detergent (breaks bait surface tension to catch flies)
 - ✓ Replace bait weekly
 - Post Harvest:
 - ✓ Mix 1 qt apple cider vinegar
 - ✓ Add ¼ tsp unscented dish soap
 - ✓ Pour 5 oz into each of 6 traps (replace bait weekly)
- DO NOT POUR BAIT ON GROUND NEAR TRAPS**

Best SWD Trap Bait

- In Michigan, Rufus Isaacs said,
“We have trapped 390 SWD in the yeast-baited traps this season so far, but only seven in the apple cider vinegar baited traps. Most of these SWD have been trapped in the liquid, so this is drained across a mesh surface before sorting to look for SWD flies. At least 80 percent of the SWD found in these traps have been females, which do not have the distinctive wing spots that males possess.”

http://msue.anr.msu.edu/news/managing_spotted_wing_drosophila_update

How to Use Trapping Results

- A good trap system (yeast bait) detects the SWD fly before damage occurs
- If SWD fly is present, then apply control measures when the fruit begins ripening = susceptible
- At 1st fly, begin collecting 30 to 100 fruit in bag (pin holes for air), hold in bag up to a week so larvae exit fruit, pupate on side of bag and emerge as flies - confirm they are SWD

Trapping Supplies Include:

- 1 qt sized plastic containers with 10 to 12 holes ¼” diam. near top of cup or glue 1/8-1/4” mesh screen on cup lid + red rain guard
- **Cowles SWD bait:** 12 oz. water + 4 Tbsp. sugar + 1 Tbsp. yeast + 2 Tbsp. whole wheat flour + 1 Tbsp. apple cider vinegar + 3 drops of liquid dishwashing detergent (breaks bait surface tension to catch flies)

Drill hole in lid of bait container or else it explodes

- Kitchen sieve (8 to 10 gage mesh)
- No. 1 craft brush to lift flies off sieve
- Bottle with lid to carry bait & flies back to office
- Sort flies on white or black styrofoam meat tray
- Sample vials with alcohol (can use 70% rubbing alcohol)
- Hand lens 20X magnification



Monitoring (fly)

Trap = clear or red cup with holes in side (3/16 inch dia.) and/or lid with, white or red rain cover, with or without yellow sticky card

Video of making yeast bait and placement of trap:

<http://horticulture.oregonstate.edu/content/spotted-wing-drosophila-sugar-and-yeast-trap>



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



Photo by D. Johnson

Monitoring Frequency

- In Michigan, Rufus Isaacs said,
“We have found declining activity of both apple cider vinegar and the yeast mix baits after one week. The attractive radius of a trap for SWD is also expected to be quite small, so different fields that might be ripening at different times should each be monitored if growers want to know when SWD activity starts in each field.”

http://msue.anr.msu.edu/news/managing_spotted_wing_drosophila_update

Sieve SWD Flies From Trap

- **Weekly:**
 - ✓ Use 8 to 10 gage mesh kitchen sieve or cloth to filter SWD flies from bait
 - ✓ Pour filtered apple cider vinegar back into trap **or**
 - ✓ Pour new yeast bait into trap and discard old yeast bait in garbage can

Drill hole in lid of bait container or else it explodes

Use hand lens to compare trapped flies to your voucher flies to confirm as SWD.

• **DO NOT POUR BAIT ON GROUND NEAR TRAPS***

- **Transfer suspected SWD flies into vial of alcohol.**
- **Give vial to county Extension agent who can mail it to:**
Ms. Barbara Lewis, AGRI 319 Department of Entomology, Univ. of Arkansas, Fayetteville, AR 72701 email: balewis@uark.edu



Detecting Larvae in Fruit

Float SWD Larvae From Ripe Fruit

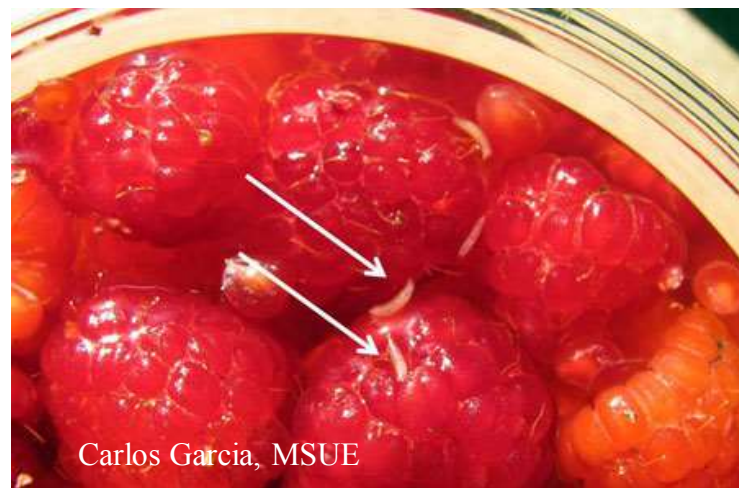
Collect 30 strawberries or 70 caneberries (ripe fruit you would eat) and place in bag:

1. Put pin holes in bag of fruit for air, let fruit sit in house for a week until flies emerge, then confirm flies as SWD and count/record number of SWD flies

Or

2. Make sugar or salt water solution:

- 1 qt water + 1 cup sugar or
- 1 qt water + $\frac{1}{4}$ cup salt
- Add solution to fruit in bag
- Count/record number of larvae floating to surface after 30 min



Video: Floating SWD larvae from Fruit

Testing for SWD larvae using a salt mixture. Video created by Julie Pond, Peerbolt Crop Management Scout Supervisor. Scout in the film is Caitlin Henden (2 min.):

<http://www.berriesnw.com/videos/baggieTest/SaltBagTest.html>

SWD Management

Effective Management of SWD

1. *Monitor fields with traps and check them regularly*
2. Record weekly number of male and female SWD per trap
3. **Spray:** If SWD is detected in traps *and* fruit are ripening, apply effective insecticides registered for fruit crop to protect the fruit
4. Continue monitoring to evaluate your management program, and respond quickly if needed.
5. **Sanitation**, remove leftover fruit to reduce SWD breeding and food resources.
6. Stay informed. These recommendations are subject to change based upon new information. There may be supplemental labels available that have been developed specifically for spotted wing drosophila.

Management Practices

- **Chemical:** *Spray weekly if SWD flies are captured in trap and fruit is ripening*
 - ✓ Organophosphates, pyrethroids, spinosyns, carbamate are effective
 - ✓ Short post harvest intervals (PHI) – less than 7 days
 - ✓ Reapply insecticide after a rain
 - ✓ No research-based information has measured whether post-harvest spraying reduces pest pressure next year
 - ✓ *Rotate IRAC code to delay resistance to sprays*
- **Cultural:**
 - ✓ Keep fields clean of overripe and rotten fruit
 - ✓ Mass trapping
 - ✓ Fine-mesh floating row covers can help protect some crops with lower growing heights

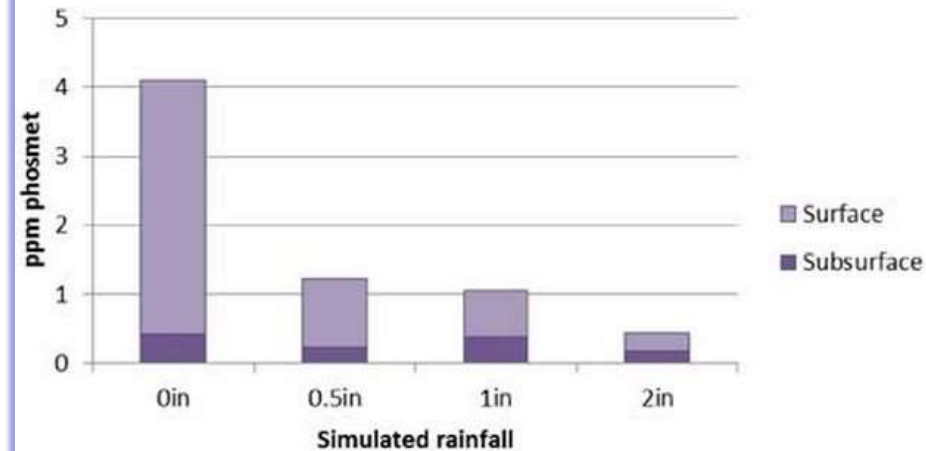
Bee Awareness

- When applying pesticides, limit the impact on bees by applying compounds during decreased bee activity such as late dusk.
- Minimize bee attraction into crop fields by minimizing pollen and nectar producing weeds.

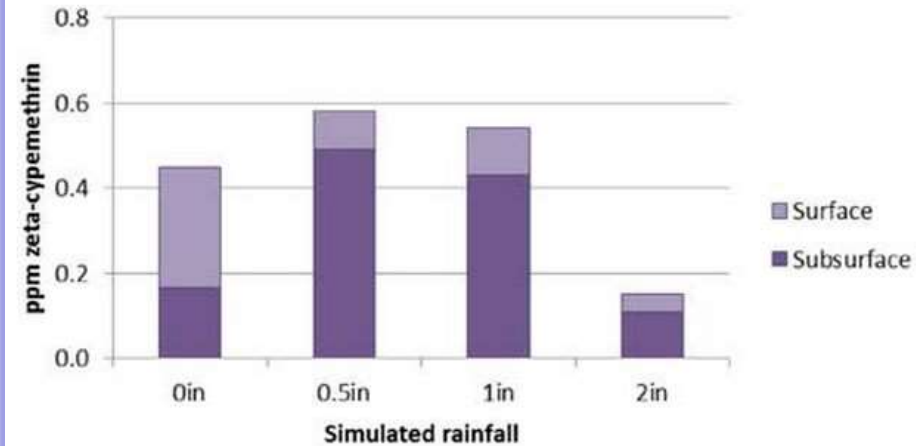


Rain Wash Off Potential on Blueberries

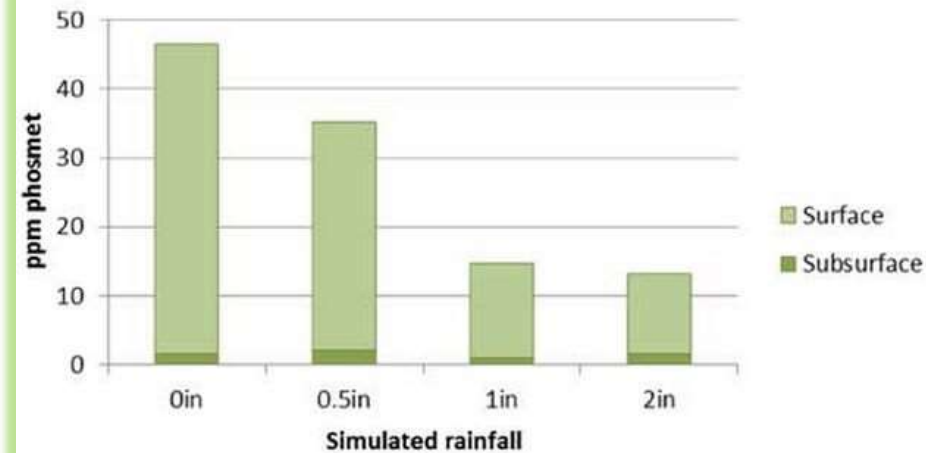
Imidan - Fruit Residues



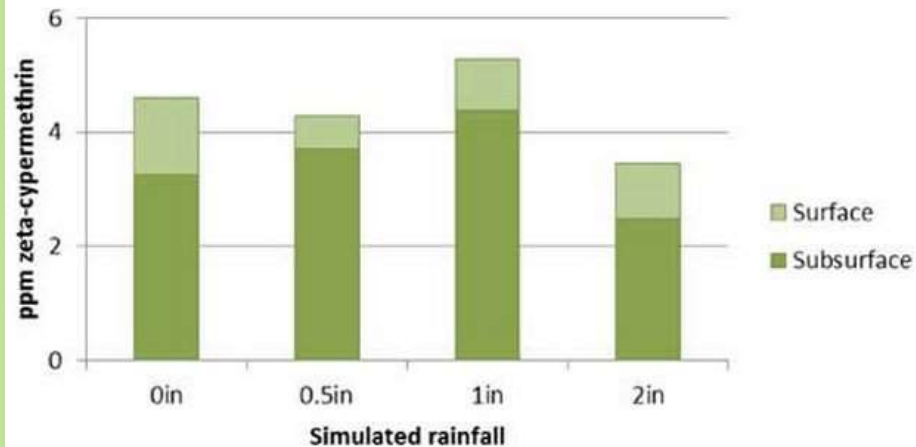
Mustang Max - Fruit Residues



Imidan - Leaf Residues



Mustang Max - Leaf residues



Insecticides for SWD in blueberries, caneberries, strawberries, grapes and stone fruits

Class (IRAC code)	Trade name	Active ingredient	PHI (days)	REI (h = hrs or d=days)	Efficacy against SWD ^h	Expected residual control (days)
Carbamate (1A)	Sevin	carbaryl	7	12 h	G	10-14
	Lannate	methomyl	3 ^a	48 h	E	7-10
Organophosphate (1B)	Imidan	phosmet	3 or 7 ^a	24 h or 3 d ^a	G	7
	Diazinon	diazinon	7	3 d to 5 d	E	7-10
	Malathion	malathion	1 or 3 ^b	12 h	E	7-10
Pyrethroid (3A)	Brigade	bifenthrin	0 or 3 ^c	12 h	E	10-14
	Asana	esfenvalerate	7 or 14 ^d	12 h	E	10-14
	Danitol	fenpropathrin	2 or 3 ^e	24 h	E	10-14
	Mustang Max	zeta-cypermethrin	1 or 14 ^f	12 h	E	10-14
Spinosyn (5)	Delegate	spinetoram	1,3, or 7 ^g	4 h	E	5-7
	Success	spinosad	1,3, or 7 ^g	4 h	G-E	5-7
Organic Options						
Pyrethrin (3A)	Pyganic	pyrethrin	0	12 h	G	0
Spinosyn (5)	Entrust	spinosad	1,3, or 7 ^g	4 h	E	5-7
UN	Aza-Direct	Azadirachtin	0	4 h	F	

* Where brand names or company names are used it is for the reader's information. No endorsement is implied nor is any discrimination intended against other products with similar ingredients. Always consult product labels for rates, application instructions and safety precautions.

Preharvest Interval (PHI) & Restricted Entry Interval (REI) for Table of Insecticides on previous slide:

- ^a PHI = 3 days for blueberry, 7 days for stone fruit
- ^b PHI = 1 day for blueberry or caneberry, 3 days for grape, stone fruit (REI = 3 days) or strawberry
- ^c PHI = 0 day for strawberry, 1 for blueberry, 3 for caneberry
- ^d PHI = 7 days for caneberry, 14 days for blueberry or stone fruit
- ^e PHI = 2 days for strawberry, 3 days for blueberry, caneberry or stone fruit, 21 days grapes
- ^f PHI = 1 day for blueberry, caneberry or grape, 14 days stone fruit
- ^g PHI = 1 day for caneberry, 3 days for blueberry, 7 days for grape or stone fruit

Allowed Residues on Exported Fruit

- When selecting an insecticide for SWD control in berries to be exported, consider the REI, PHI, and especially the Maximum Residue Level (MRL) restrictions in ppm in the destination country for exported fruit.
- Search the International Maximum Residue Level Database **by selecting: crop, pesticide, country you export to:**
<http://mrldatabase.com/>

Blueberry Maximum Residue Limits

TABLE 2. Blueberry maximum residue limits (parts per million) for insecticides with activity against SWD in the major export markets for blueberries. Values that are bolded are lower than the residue limit in the United States.

Active ingredient	Trade name	United States	Canada	Japan	EU	Taiwan	Korea
Malathion	Malathion	8.0	8.0	0.5	0.02	0.01	10
Phosmet	Imidan	10	5.0	10	10.0	0.02	10
zeta-cypermethrin	Mustang Max	0.8	-	0.5	0.05	-	-
Bifenthrin	Brigade/Bifenture	1.8	-	-	0.05	1.0	0.5
Esfenvalerate	Asana	1.0	-	1.0	0.1	1.0	0.02
fenpropathrin	Danitol	3.0	3.0	5.0	0.01	3.0	0.5
Methomyl	Lannate	6.0	6.0	1.0	0.02	2.0	1.0
Spinetoram	Delegate	0.25	0.5	0.01	0.05	-	0.1
Spinosad	Entrust	0.25	0.5	0.3	0.3	-	0.4
Acetamiprid	Assail	1.6	1.6	2.0	1.5	0.01	1.0

Maximum Residue Level (MRL) Allowed on Exported Small Fruits

- MRL of effective SWD insecticides in OR and WA blueberries:

<http://horticulture.oregonstate.edu/content/blueberry-swd-pesticides-or-and-wa>

- MRL of effective SWD insecticides in OR and WA caneberries:

<http://horticulture.oregonstate.edu/content/caneberry-swd-pesticides-or-and-wa>

- MRL of effective SWD insecticides in OR and WA strawberries:

<http://horticulture.oregonstate.edu/content/strawberry-swd-pesticides-or-and-wa>

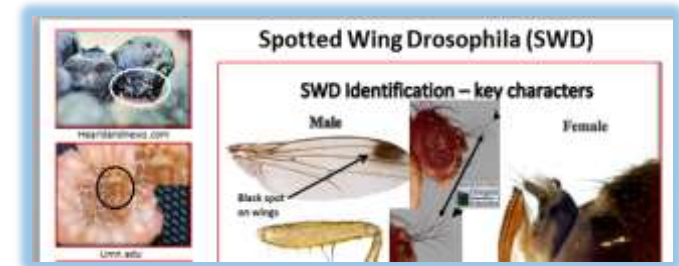
Hands-on Sessions

Hands-on Session I

- Get handout materials (vial, lens, trap, laminated sheet, fact sheet, host damage photos)
- Get into equal groups by each of 5 microscope stations and view male / female SWD flies
- Video: SWD trap and yeast bait:
<http://horticulture.oregonstate.edu/content/spotted-wing-drosophila-sugar-and-yeast-trap>
- Video: floatation of SWD larvae from fruit:
<http://www.berriesnw.com/videos/baggieTest/SaltBagTest.html>

Handouts

- SWD Folder:
 - Laminated sheet:
 - SWD ID, Crop Damage photos
 - Sampling, Management (back page)
 - Recommended insecticides
 - SWD damage photo sheet
 - SWD fact sheet online http://www.uaex.edu/Other_Areas/publications/PDF/FSA-7079.pdf
 - SWD trap data recording sheet
 - Vial of SWD fly specimens
 - Grower Survey (draft)
 - Research/Extension Priorities (draft)
 - Evaluation sheet
- Jewelers hand lens (20X)
- Trap prototype



Hands-on Session II

Need Help Monitoring SWD in Arkansas

Grower: SWD monitoring in Arkansas in 2013

- Hand out: Grower SWD trap/floatation record sheet
- **We need collaborators to report to us:**
 - Send in samples of suspected flies
 - Keep records (example of data sheet):
 - Dates of SWD catch
 - Numbers of SWD flies per trap
 - Number of SWD larvae per floated fruit sample
 - What fruit crop was infested?
 - Did you see SWD damage on ripening fruit?
 - What insecticide did you use against SWD?
 - Did you try another control tactic?
 - If yes, what?

Research: SWD monitoring in 2013

- Weekly from early-May to mid-November, we will be sampling at SWREC, Fruit Station and Fayetteville:
 - will trap by small fruit plantings in high tunnels
 - will trap by small fruit plantings in open fields
 - we will collect and float samples of 30 ripening fruit to detect SWD larvae
 - If we capture some SWD flies, we will start a colony and test efficacy of several insecticides inside and outside of high tunnels to compare days of residual activity

Hands-on Session III

Discuss Priorities for Research and Extension

eFly SWD Priorities

Regulatory:

- Expand insecticide labels within current residue levels, etc.

Organizational:

- Mechanism to coordinate research, extension, and outreach efforts
- Agent involvement

eFly SWD Priorities

Extension:

- Agent training and incorporation into projects
- Educate growers on what is currently in the toolbox
- A comprehensive spray program (incorporating PHI, REI, MRL)
- Outreach to small growers, cottage industries, hobbyists
- ASAP, disseminate best management practices to growers / packers / shippers
- Communicating practices in context of sustainability (e.g. Sustainability Initiative) – how do growers not get docked for staying viable

eFly SWD Priorities

Research:

- Predict risk - effect of summer heat on fruit infestations
- When does egg laying start in spring and stop in fall?
- A lure/trap that can detect flies earlier and be used to develop an adult trapping threshold
- Management:
 - adjuvant or bait - ways to improve pesticides like GF-120 Fruit Fly Bait (spinosad) and develop bait sprays for other modes of action (MoA) compounds
 - How to apply after a rain when drive rows are flooded
 - Organic management tools
 - Effects and minimization of spray residue
 - Pesticide resistance management
 - How do you remove larvae from berries before fresh market
 - Host susceptibility screening/relating

Hands-on session IV

Grower Survey About SWD

Anonymous Grower Survey on SWD (2013)

(copy in folder)

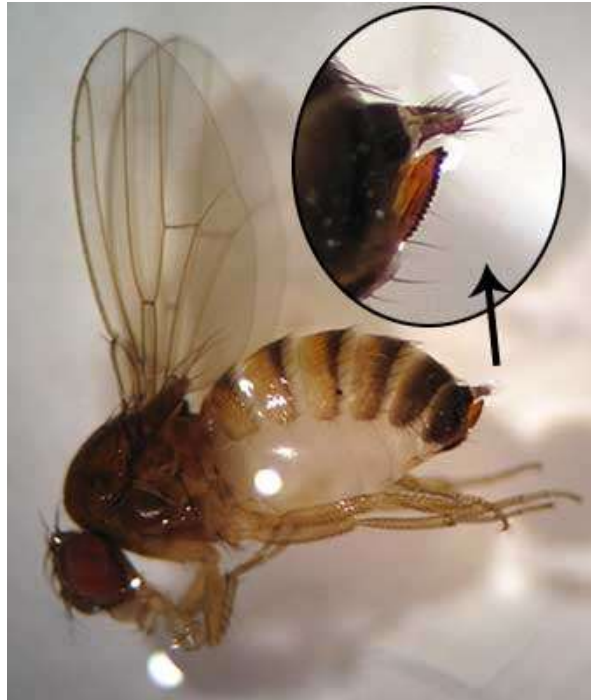
1. County? _____
2. Have you heard about the spotted wing drosophila? Yes ___ No ___
3. How did you hear about this new fruit pest? Circle one or more: SWD workshop, county extension agent, radio, newspaper, TV, another grower
4. Insert the number of acres of each SWD-susceptible crop that you produce: Blackberry ___ Blueberry ___ Cherry ___ Grapes ___ Peaches ___ Raspberry ___ Spring Strawberry ___ Summer Strawberries ___ Fall brambles ___ Strawberries in high tunnel ___ Other crop or harvest period _____
5. Did you detect SWD in your fruit planting this year using a baited trap? Yes ___ No ___
6. When did you detect SWD flies in traps? _____
7. When did you find SWD larvae in ripening fruit? _____
8. Did you float SWD larvae from ripening fruit sample? Yes ___ No ___
9. What fruit crops had SWD larval damage? Blackberry ___ Blueberry ___ Cherry ___ Grapes ___ Peaches ___ Raspberry ___ Spring Strawberry ___ Summer/fall berries ___
10. Did you send samples to your county Extension agent to confirm flies or larvae were SWD? Yes ___ No ___
11. What was the relative percent loss of fruit to SWD larvae? % loss ___ or None ___ Low ___ moderate ___ high ___
12. List and rank importance of future research and extension priorities concerning SWD management?
13. What is the best manner to get new SWD information to you?
Email ___ Fruit Pest Management web site ___ Mail ___ Phone ___

Fill Out Workshop Evaluation

Lunch Discussion Priorities Grower Monitoring Grower Survey on SWD

- Are there other questions that we should ask?
- What are some research and extension priorities on SWD to be addressed this year?

Questions?



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