SWD Research Update: What We Have Learned so Far and Potential Management Strategies for 2018

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2017 SWD Research Projects

- Modifying orchard landscape to reduce SWD populations
- Influence of wild hosts on tart cherry orchards
- Choice and no-choice tests for SWD fruit preference
- On-farm insecticide spray program trial
- Grower spray programs in SW, WC, and NW MI
- Optimal insecticide programs: field efficacy trial

Modifying the Orchard Landscape to Help Reduce SWD Populations in Michigan Cherry Orchards

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Objective

- Establish reliable and cost effective ways to modify orchard landscapes to make tart cherry less suitable for SWD
  - Tart cherries grown on standard rootstocks
    - Large trees have dense canopies
    - Traditional sod row middles
      - Contribute to humidity in orchard?

Pruning Treatments

No Pruning:
No limb removal

25% Less Pruning:
Remove 6 limbs

25% More Pruning:
Remove 10 limbs

Under Tree Canopy Treatments

Wood chips

Weed fabric

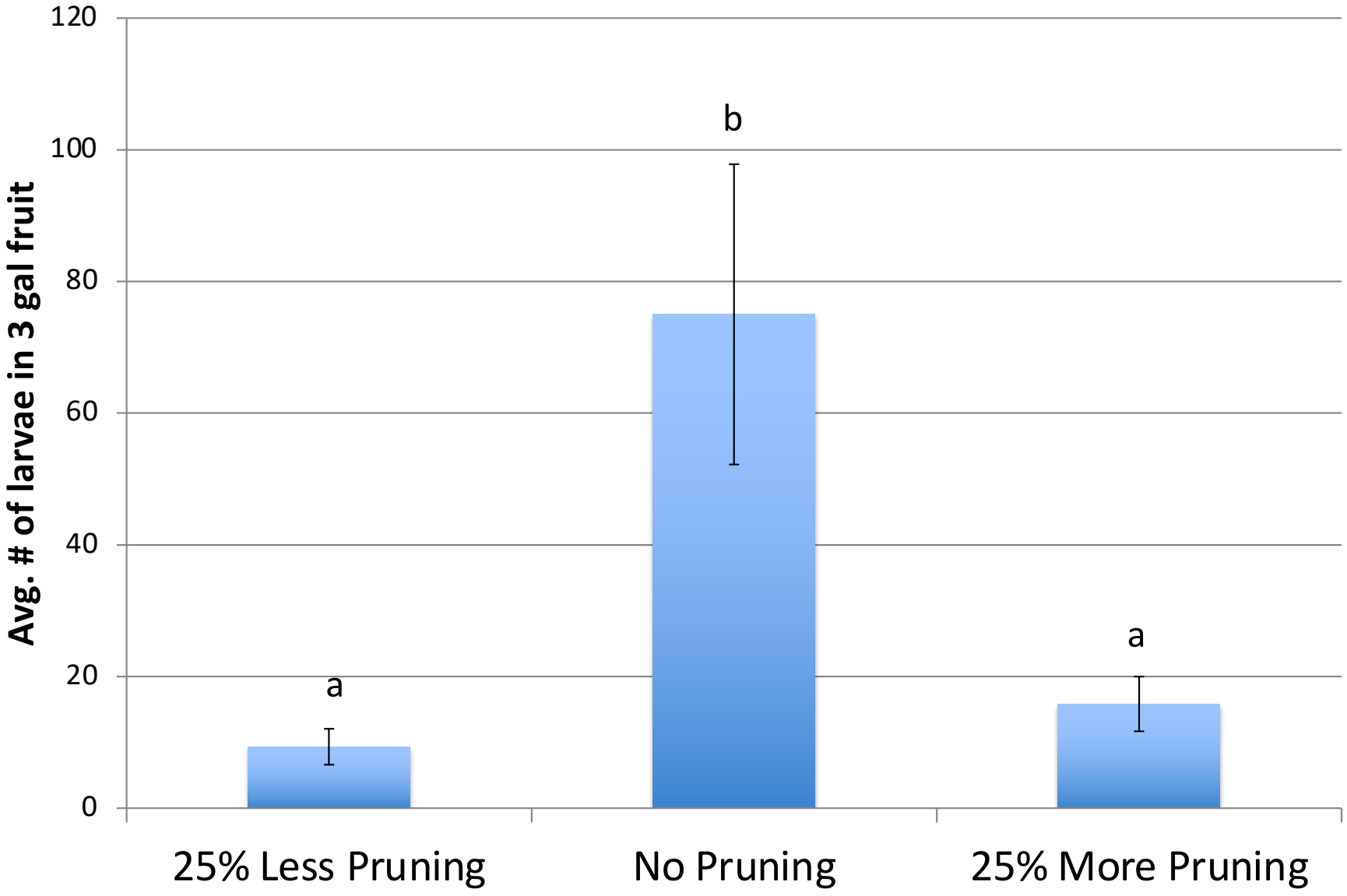
Grower standard: Herbicide

Orchard Row Middle Treatments

1. Sod row middles mowed every two weeks
2. Sod row middles *not* mowed
3. Herbicide on row middles to maintain bare ground
4. Clean cultivated row middles using herbicide followed by tilling every two weeks

Processing Fruit for SWD Larvae

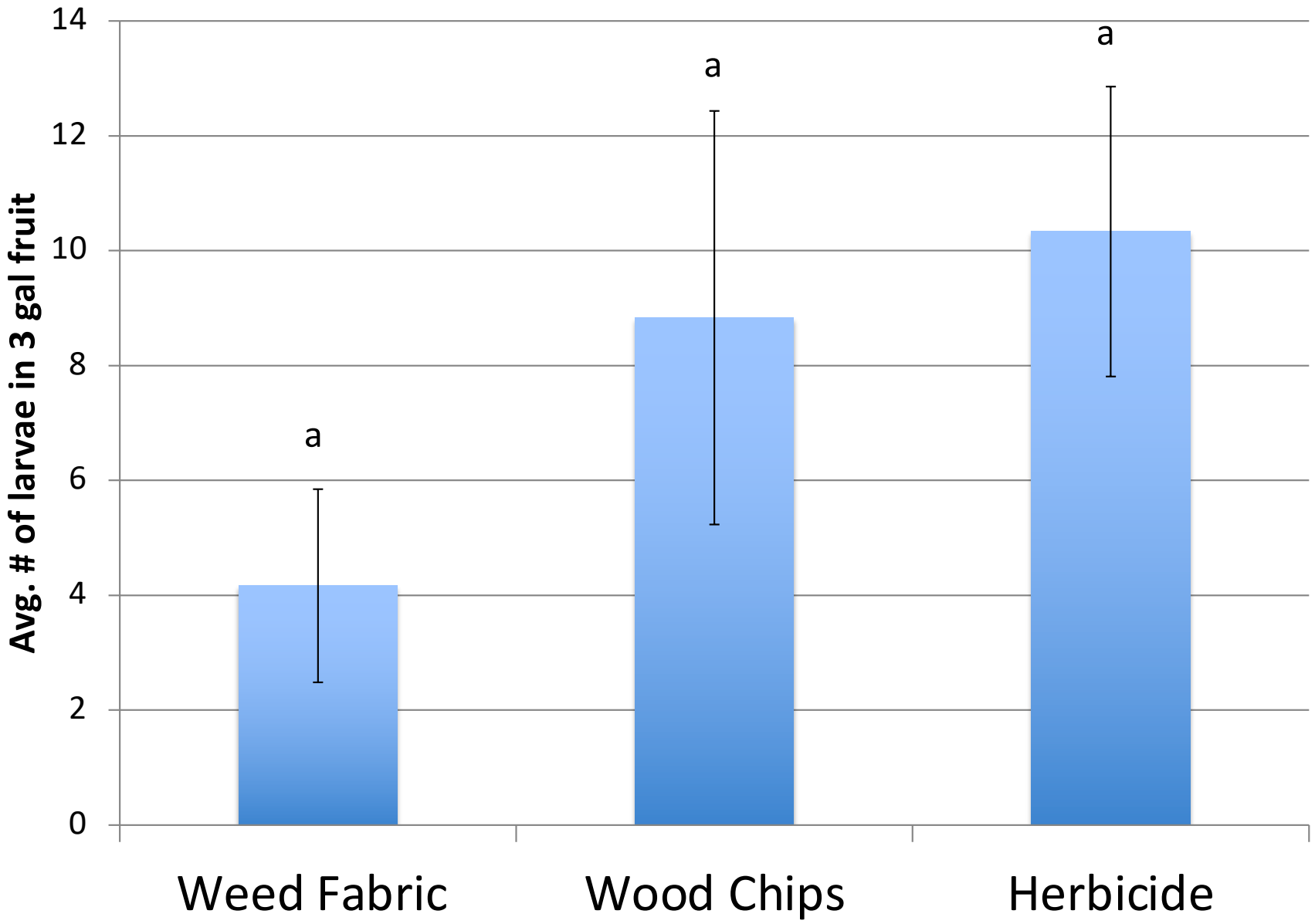
Pruning Treatments



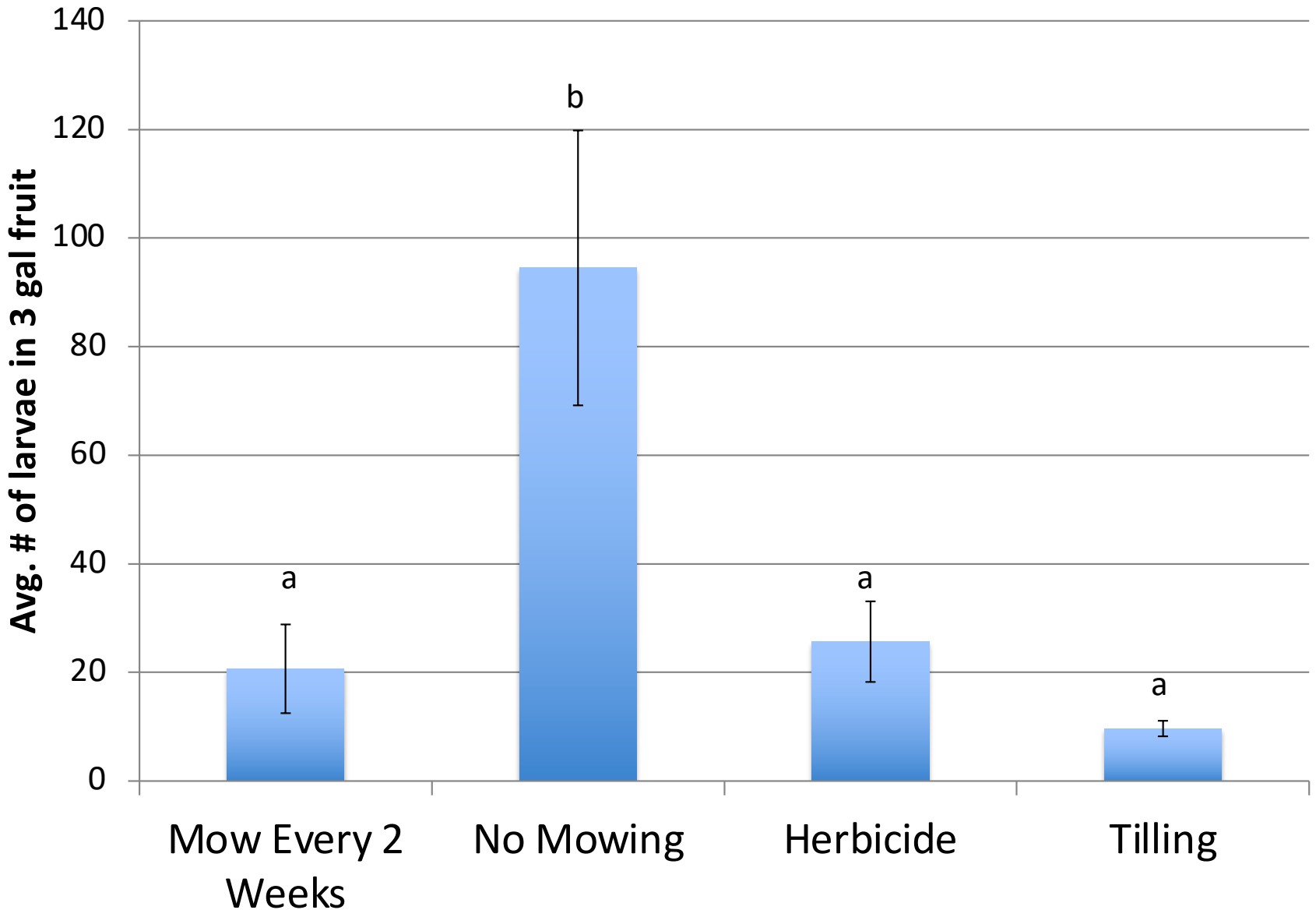
Impact of Pruning on Yield

	Avg. lbs/tree
25% More Pruning	73.6 a
25% Less Pruning	101.3 b
No Pruning	132.0 c

Under Canopy Treatments



Orchard Row Middle Treatments



Canopy Size Can Make a Difference

Treatment	Avg. # Larvae in 3 gal fruit	Tree Age	Harvest Date
UTC Efficacy Trial	0.9	7	24-Jul
25% Less Pruning	9.3	15	25-Jul
No Pruning	75.0	15	25-Jul
25% More Pruning	15.8	15	25-Jul
Weed Fabric	4.2	15	25-Jul
Wood Chips	8.8	15	25-Jul
Herbicide	10.3	15	25-Jul
Mow Every 2 Weeks	20.7	17	25-Jul
No Mowing	94.5	17	25-Jul
Herbicide	25.7	17	25-Jul
Tilling	9.7	17	25-Jul

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Conclusions

- Increasing pruning intensity may be an affordable and effective way to reduce SWD
  - Removing 6 to 10 limbs reduced SWD infestation by 40%
    - Data were collected in trees with no insecticide applications
- Removing 6-8 limbs reduced yields by almost half
- Need to develop annual pruning recommendations to minimize SWD *and* maintain yields
- *No* mowing of row middles had more SWD larvae
  - Mowing every two weeks was effective in reducing SWD #'s

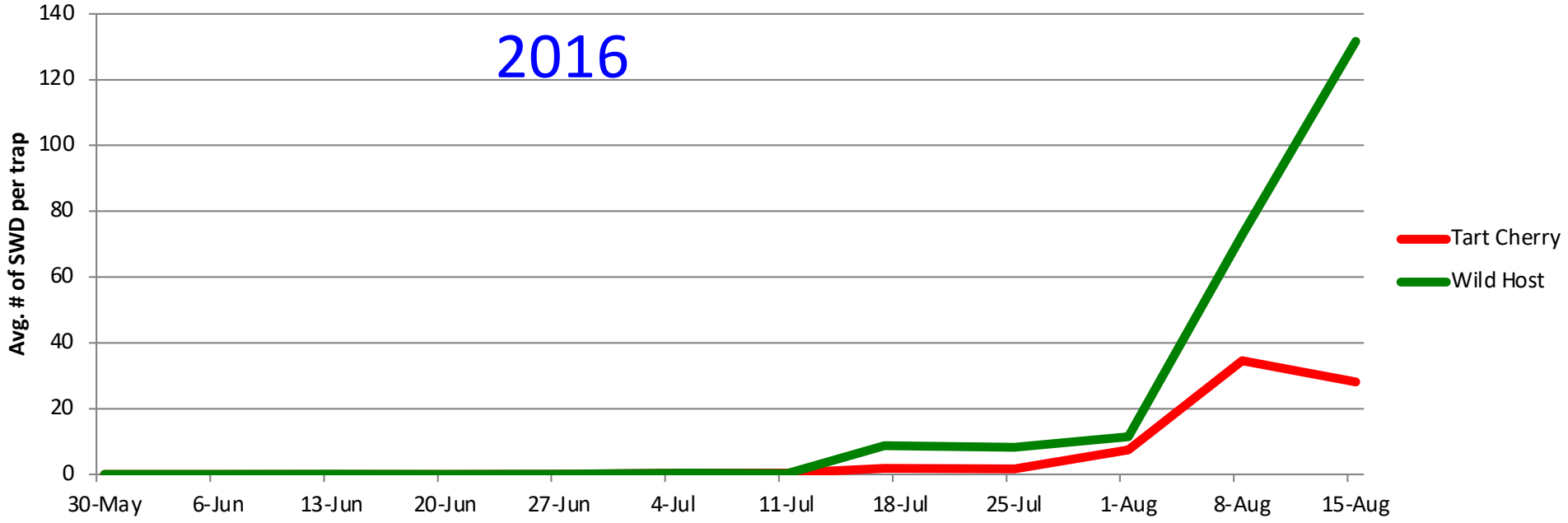
Influence of Adjacent Wild Host Plants on Commercial Tart Cherry Orchards

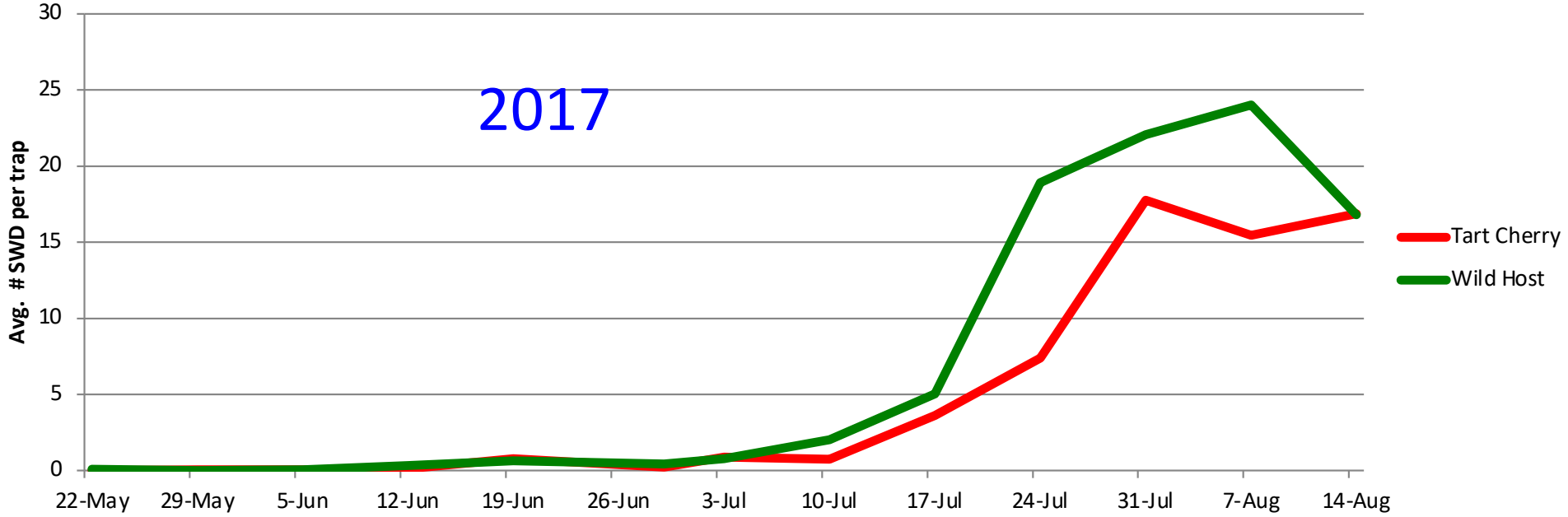
Methods

- Two-year project
- Five farms with healthy wild host plants near edge of orchard
- Two transects of 5 traps at 0m, 25m, 50m, 75m, and 100m into orchard
- Ten traps in wild host plants at orchard edge
- Check traps weekly
- Collect wild host fruit and tart cherries as they ripen for SWD larvae

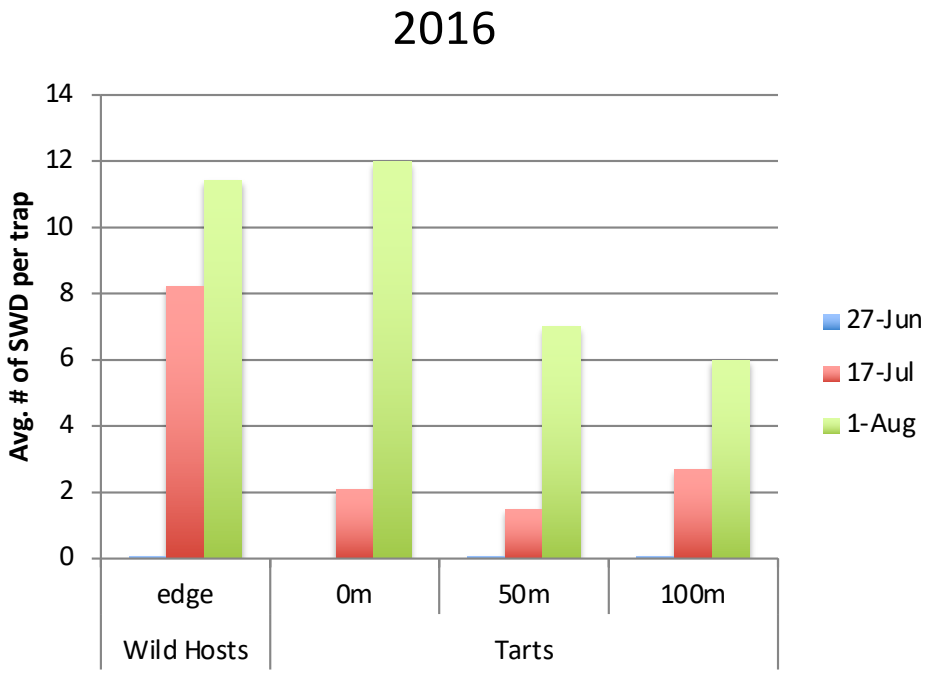
Raspberries along orchard edge

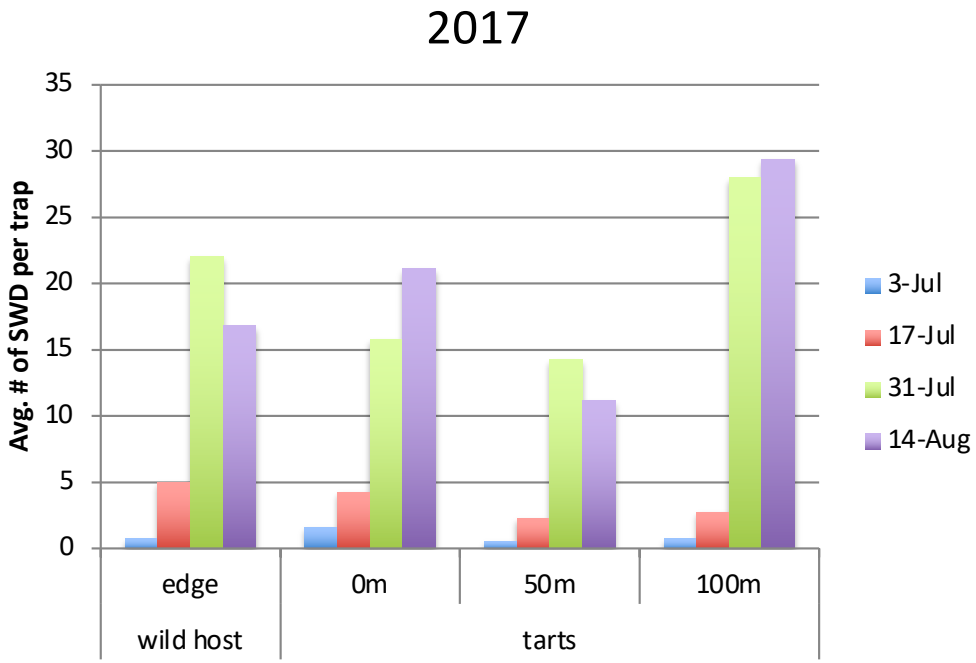
SWD Flight in Tart Cherry and Wild Hosts





Adult SWD Trap Catch in NW Wild Host and Orchard





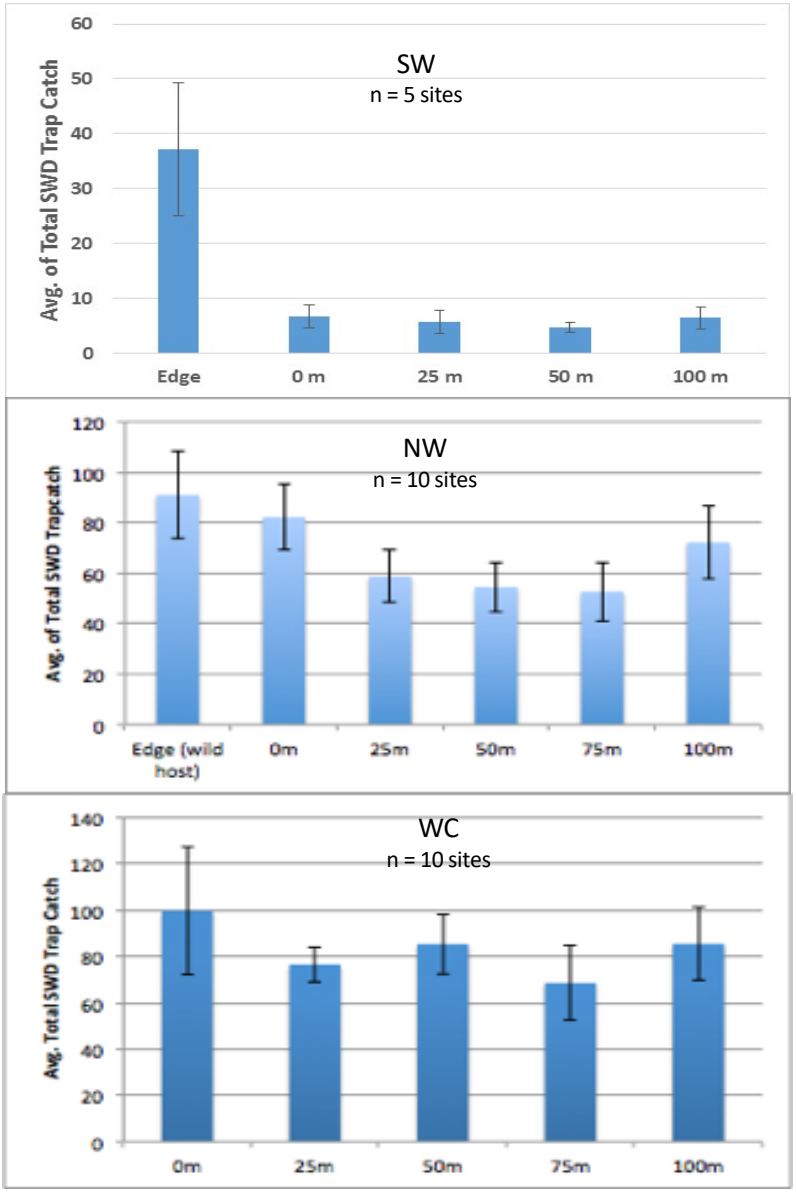
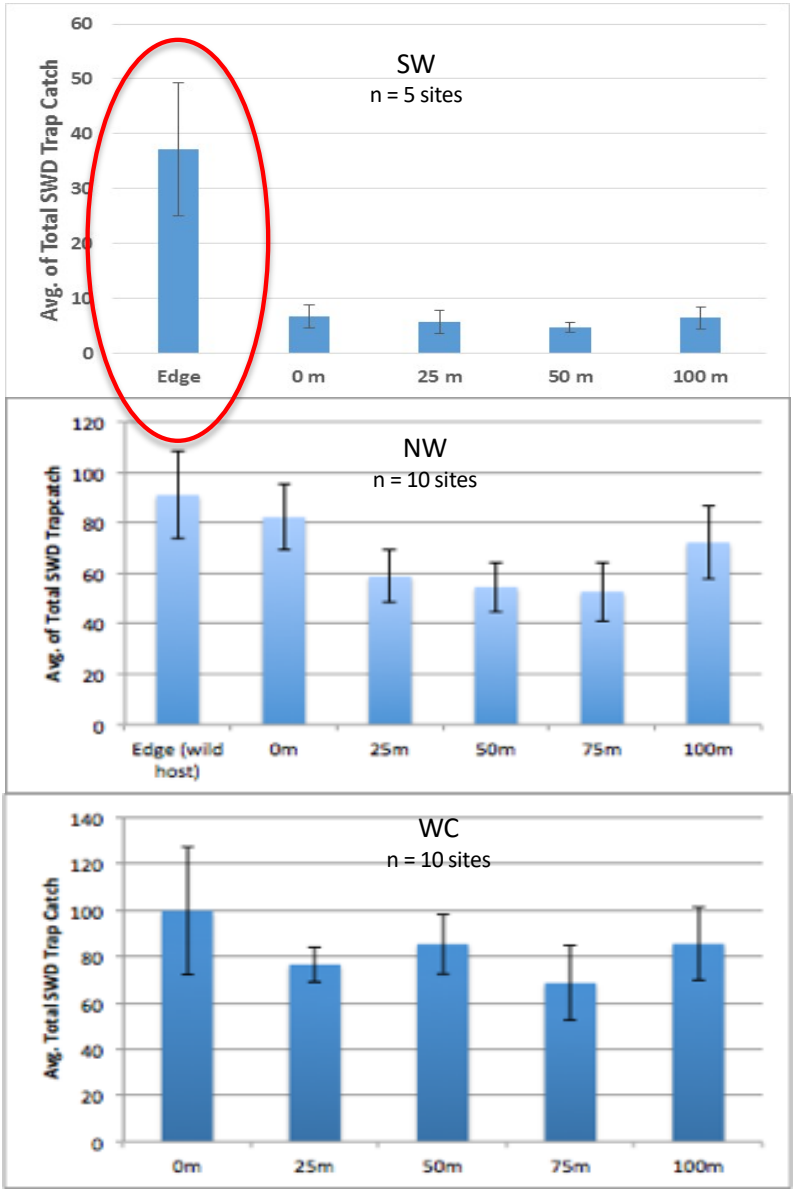


Figure 1. Average total number of SWD collected at five tart cherry orchards in SW (top), NW (middle), and WC (bottom) Michigan, 2017. No traps were put up in the wooded edge at the WC sites.



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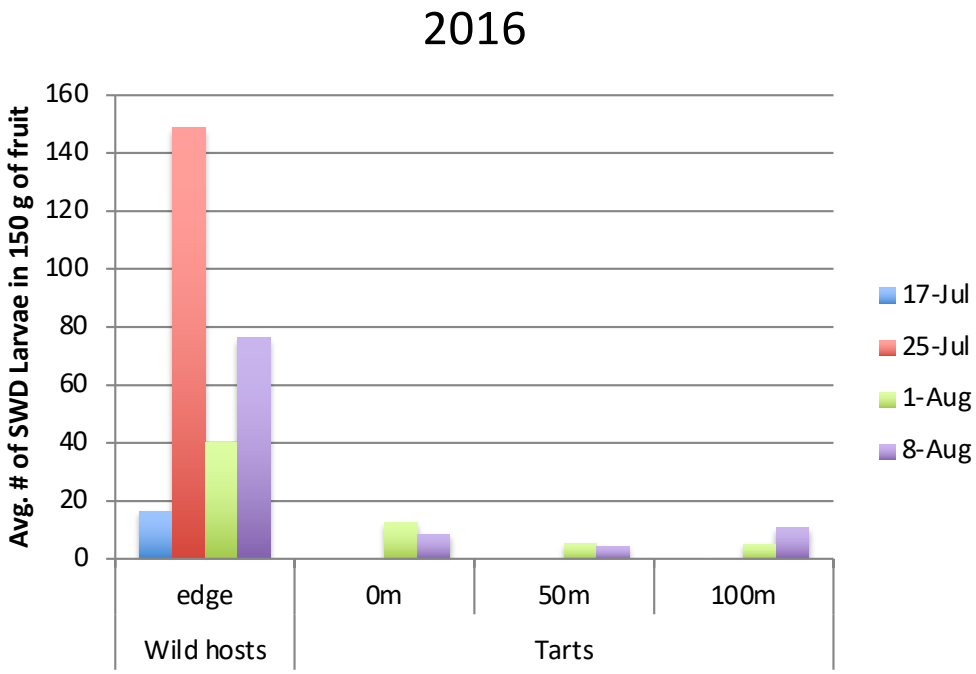
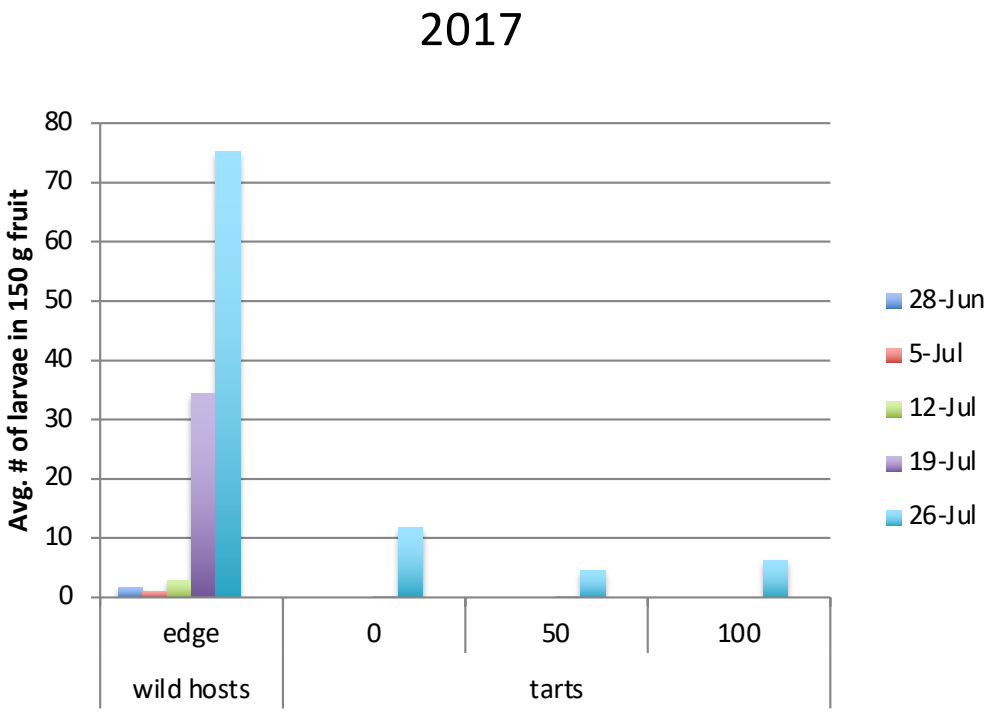
SWD Larvae in Wild Host Fruit and Tart Cherries



*150g is ~ 30 cherries



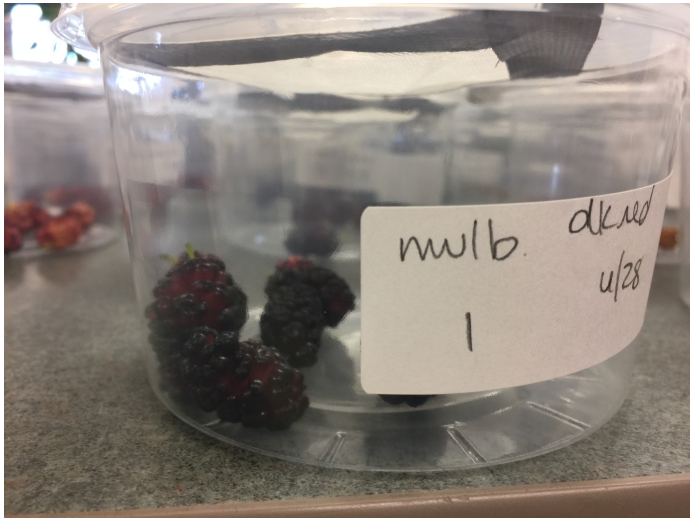
Conclusions

- Currently, in NW MI, no clear trend of wild host influence on commercial tart cherries
  - Higher adult trap counts do not always = higher larval counts at orchard edge
    - In many cases, just as likely to see larvae at 100m as 0m
- Does canopy size influence SWD behavior?
  - No need to move to and from additional resources when large trees have ample fruit and shade/humidity?
    - Different scenario in blueberry
    - Wild hosts influence SWD populations in commercial blueberry fields

Laboratory No-Choice and Choice Tests for SWD Fruit Preference

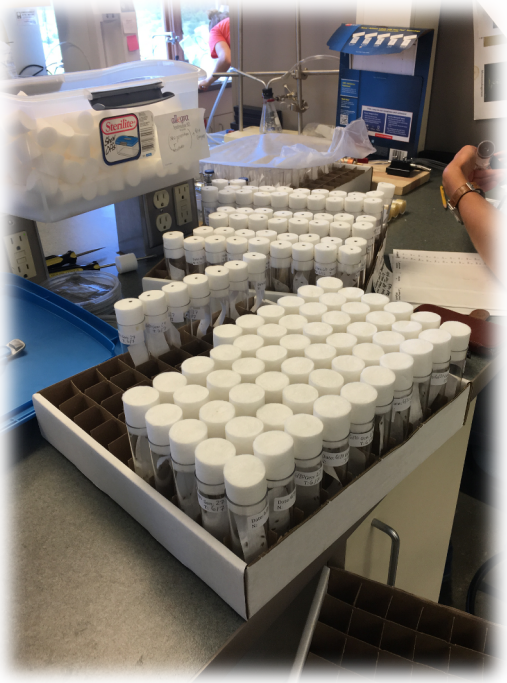
No-Choice Tests

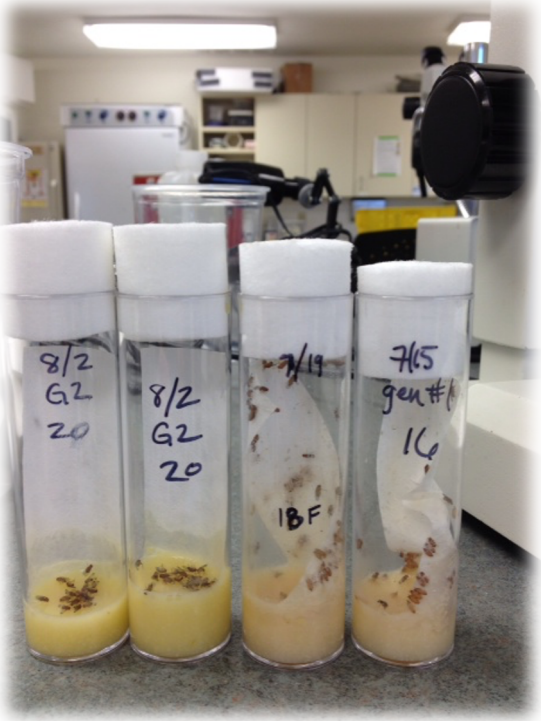
- Seven fruit in deli-cup
- Exposed fruit to 4 male and 5 female SWD for 48 hrs
- Check fruit for larvae after 5+ days



SWD Colony Management

- All choice and no-choice lab assays used laboratory-reared SWD





Fruit in No-Choice Tests

No-Choice Results

Variety	Ripeness	Date	Avg. Firmness	Avg. Weight (g) (7 fruit)	Brix	Avg. # larvae/pupae
Mont	green	21-Jun	629.4	7.8	no juice	0.0
Mont	straw	21-Jun	455.0	10.0	9.2	11.0
Mont	blush	26-Jun	366.3	19.0	10.0	2.0
Mont	red	3-Jul	229.4	24.1	10.2	1.1
Mont	red	10-Jul	115.0	30.0	11.2	1.5
Balaton	underripe	18-Jul	436.3	35.1	14.0	12.8
Emperor Francis	green	14-Jun	544.4	10.6		0.3
Emperor Francis	yellow/red	19-Jun	289.4	20.7	8.1	14.5
Emperor Francis	blush (50-75%)	28-Jun	528.8	38.2	12.2	1.0
Emperor Francis	blush (95%)	3-Jul	568.8	48.1	14.5	2.0
Emperor Francis	blush (100%)	10-Jul	202.5	65.3	16.5	10.8
Gold	green	14-Jun	548.8	8.3	no juice	0.0
Gold	yellow	19-Jun	482.5	24.8	10.0	0.0
Gold	yellow	28-Jun	701.3	20.5	10.6	0.3
Gold	yellow	3-Jul	642.5	28.4	13.2	1.0
Gold	yellow	10-Jul	255.0	38.2	14.6	2.3
Regina	green	14-Jun	568.8	11.4	no juice	0.0
Regina	green/yellow	19-Jun	525.0	18.2	9.3	0.0
Regina	red	28-Jun	562.9	41.7	13.1	1.0
Regina	red/purple (4)	5-Jul	363.8	50.8	16.8	26.0
Regina	dark red (5)	10-Jul	198.8	60.2	16.0	2.5
Ulster	green	12-Jun	392.5	10.7	no juice	0.0
Ulster	green/yellow	19-Jun	499.1	13.0	6.5	25.5
Ulster	dark red	26-Jun	267.5	52.4	14.7	11.0
Ulster	purple (5)	3-Jul	541.3	60.0	17.0	4.3
Mulberry	green	28-Jun		2.2	no juice	0.3
Mulberry	yellow/pink	28-Jun		3.2	5.0	1.3
Mulberry	pink/red	28-Jun		9.2	11.6	6.8
Mulberry	dark red	28-Jun		13.4	11.9	8.0
Black Raspberry	green	12-Jul	577.5	2.0	no juice	0.0
Black Raspberry	green/yellow	12-Jul	603.8	1.4	1.0	0.0
Black Raspberry	yellow/red	12-Jul	293.8	2.6	1.4	0.3
Black Raspberry	purple	12-Jul	25.0	5.1	5.0	10.5
Honeysuckle	green	5-Jul	452.5	1.4	no juice	0.0
Honeysuckle	orange	5-Jul	228.8	2.0	no juice	0.3
Honeysuckle	red	28-Jun		2.0	15.2	0.0
Raspberry	yellow/green	6-Jul	203.1	2.7	2.5	4.0
Raspberry	pink/yellow	6-Jul	152.1	3.5	4.0	5.3
Raspberry	red	6-Jul	0.0	3.8	5.5	37.0

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Gold	yellow	10-Jul	255.0	38.2	14.6	2.3
Regina	green	14-Jun	568.8	11.4	no juice	0.0
Regina	green/yellow	19-Jun	525.0	18.2	9.3	0.0
Regina	red	28-Jun	562.9	41.7	13.1	1.0
Regina	red/purple (4)	5-Jul	363.8	50.8	16.8	26.0
Regina	dark red (5)	10-Jul	198.8	60.2	16.0	2.5
Ulster	green	12-Jun	392.5	10.7	no juice	0.0
Ulster	green/yellow	19-Jun	499.1	13.0	6.5	25.5
Ulster	dark red	26-Jun	267.5	52.4	14.7	11.0
Ulster	purple (5)	3-Jul	541.3	60.0	17.0	4.3
Mulberry	green	28-Jun		2.2	no juice	0.3
Mulberry	yellow/pink	28-Jun		3.2	5.0	1.3
Mulberry	pink/red	28-Jun		9.2	11.6	6.8
Mulberry	dark red	28-Jun		13.4	11.9	8.0
Black Raspberry	green	12-Jul	577.5	2.0	no juice	0.0
Black Raspberry	green/yellow	12-Jul	603.8	1.4	1.0	0.0
Black Raspberry	yellow/red	12-Jul	293.8	2.6	1.4	0.3
Black Raspberry	purple	12-Jul	25.0	5.1	5.0	10.5
Honeysuckle	green	5-Jul	452.5	1.4	no juice	0.0
Honeysuckle	orange	5-Jul	228.8	2.0	no juice	0.3
Honeysuckle	red	28-Jun		2.0	15.2	0.0
Raspberry	yellow/green	6-Jul	203.1	2.7	2.5	4.0
Raspberry	pink/yellow	6-Jul	152.1	3.5	4.0	5.3
Raspberry	red	6-Jul	0.0	3.8	5.5	37.0

No Choice Results

Variety	Ripeness	Date	Avg. Firmness	Avg. Weight (g) (7 fruit)	Brix	Avg. # larvae/pupae
Mont	green	21-Jun	629.4	7.8	no juice	0.0
Mont	straw	21-Jun	455.0	10.0	9.2	11.0
Mont	blush	26-Jun	366.3	19.0	10.0	2.0
Mont	red	3-Jul	229.4	24.1	10.2	1.1
Mont	red	10-Jul	115.0	30.0	11.2	1.5
Balaton	underripe	18-Jul	436.3	35.1	14.0	12.8
Emperor Francis	green	14-Jun	544.4	10.6		0.3
Emperor Francis	yellow/red	19-Jun	289.4	20.7	8.1	14.5
Emperor Francis	blush (50-75%)	28-Jun	528.8	38.2	12.2	1.0
Emperor Francis	blush (95%)	3-Jul	568.8	48.1	14.5	2.0
Emperor Francis	blush (100%)	10-Jul	202.5	65.3	16.5	10.8
Gold	green	14-Jun	548.8	8.3	no juice	0.0
Gold	yellow	19-Jun	482.5	24.8	10.0	0.0
Gold	yellow	28-Jun	701.3	20.5	10.6	0.3
Gold	yellow	3-Jul	642.5	28.4	13.2	1.0
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Raspberry	red	6-Jul	0.0	3.8	5.5	37.0

No Choice Results

- More SWD larvae detected in under-ripe/just ripening cherries
  - Do SWD prefer to lay eggs in unripe fruit?
  - Do they use visual cues to detect fruit just starting to color?
    - No relationship between number of larvae and fruit firmness, weight, or brix
  - Serrated ovipositor: can outcompete other Drosophila to lay eggs into fruit that is under-ripe?
  - Even when SWD are given no other choice, very few larvae were detected in var. Gold

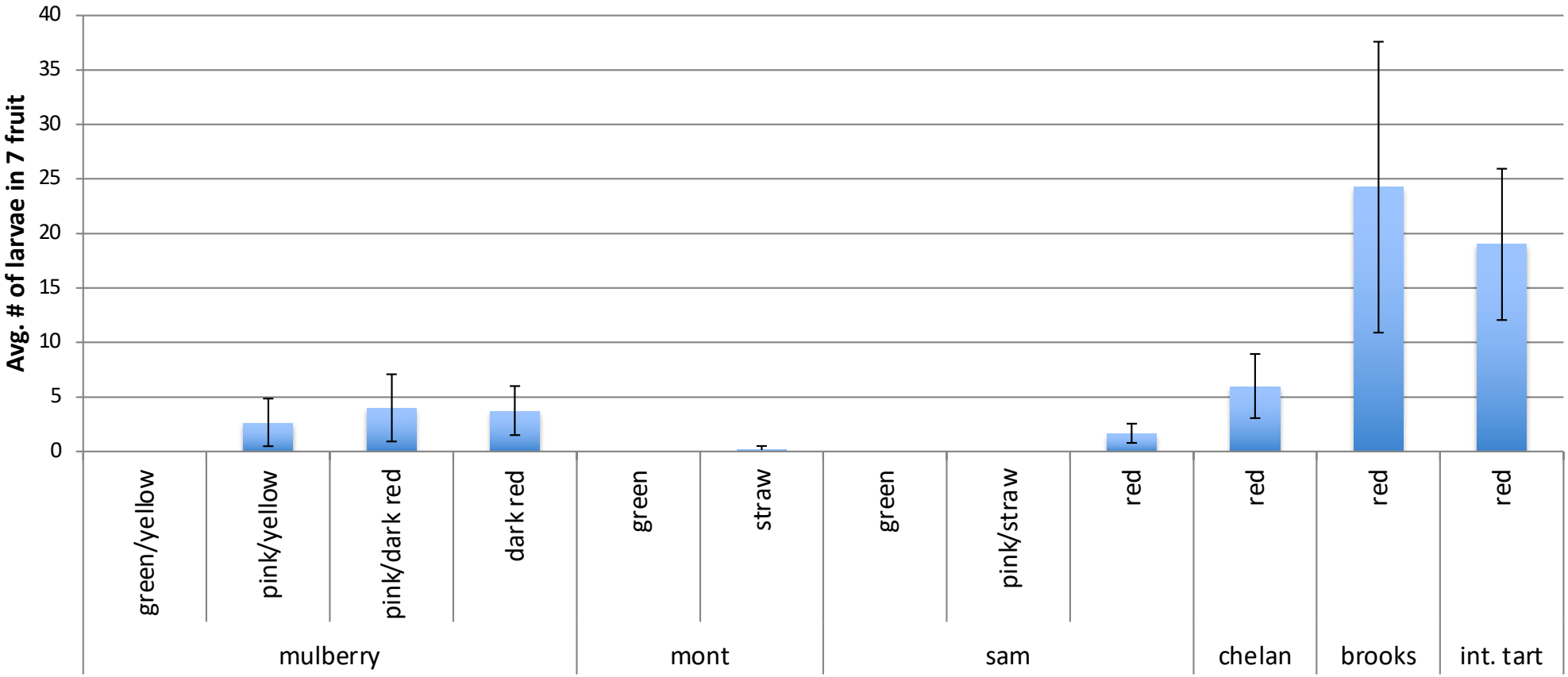
No Choice Results, cont.

- More SWD larvae in ripe berries
  - Mulberry, red and black raspberry
  - Little flesh on berries until fruit is ripe
    - Nowhere to lay eggs until fruit is close to ripe
- Even with no other choice, very few larvae detected in honeysuckle
  - We have observed honeysuckle infested with SWD in the field
  - Honeysuckle is an SWD-preferred host adjacent to blueberry fields in SW (Leach et al. unpublished)

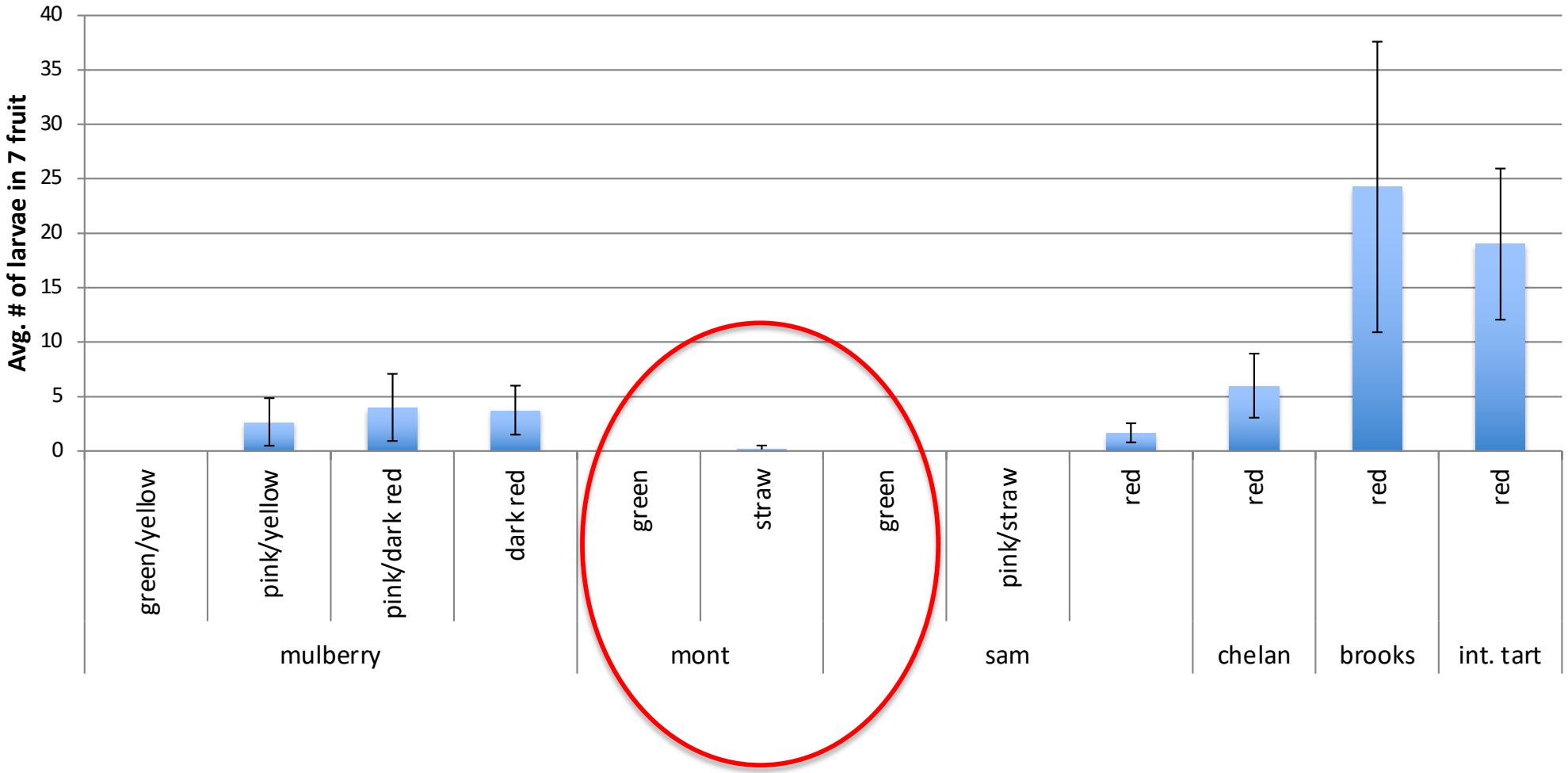
Choice Tests

- Multiple fruit varieties in bug tent
- Exposed fruit to 10 male and 10 female SWD for 48 hrs
- Check fruit for larvae after 5+ days

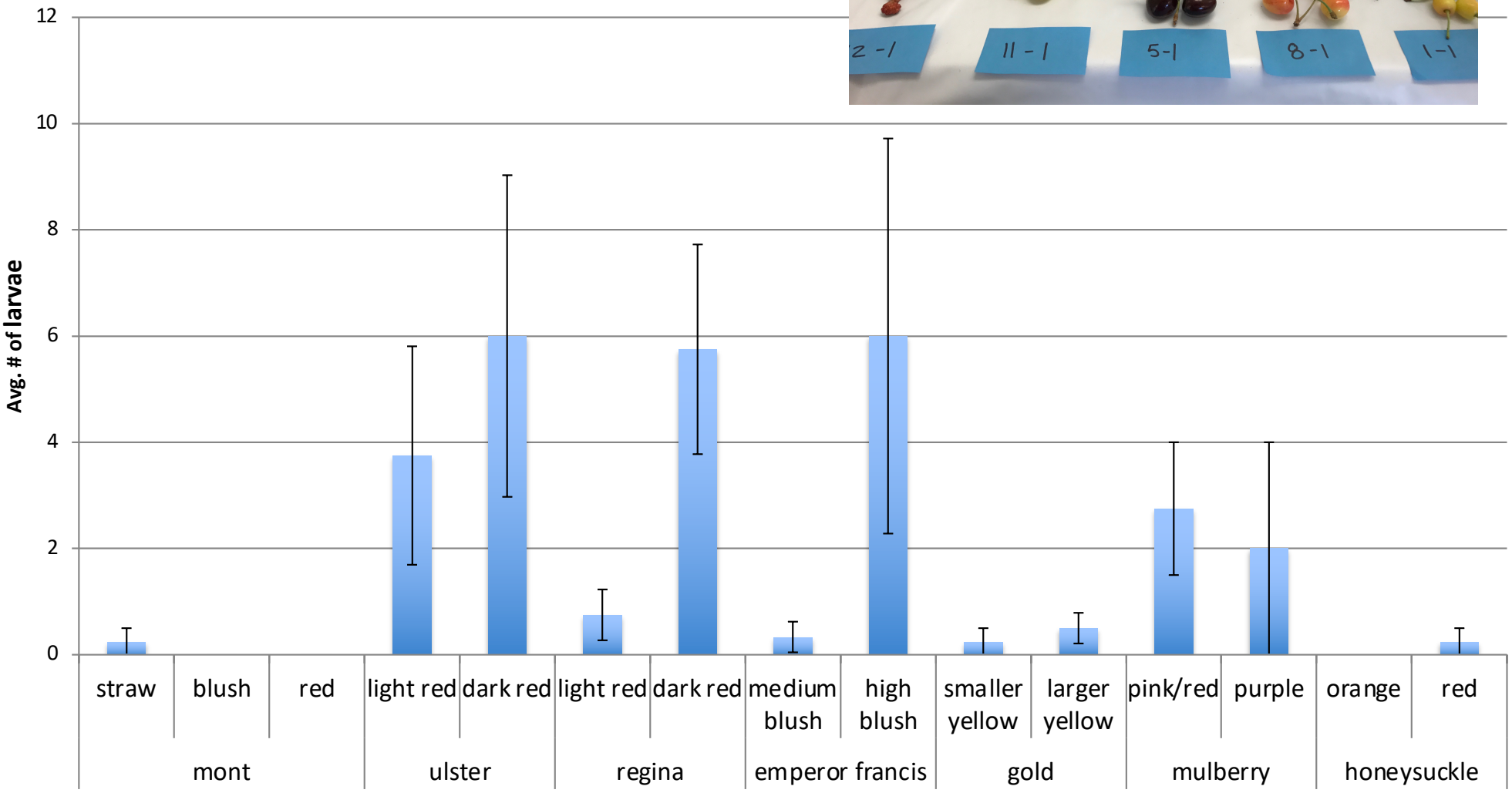
Choice Test 1 – 6/21/17



Choice Test 1 – 6/21/17



Choice Test 2 – 7/5/17



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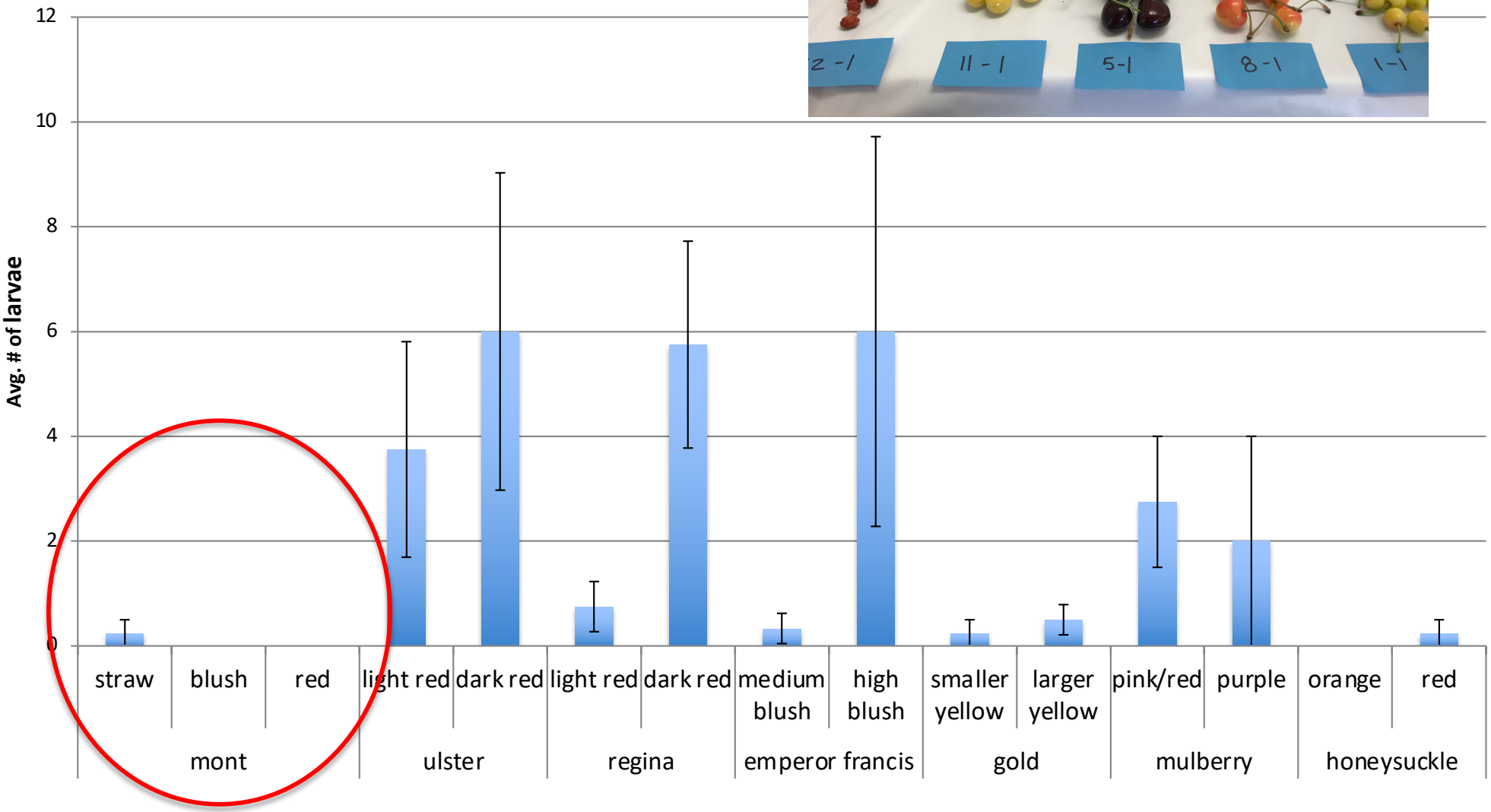
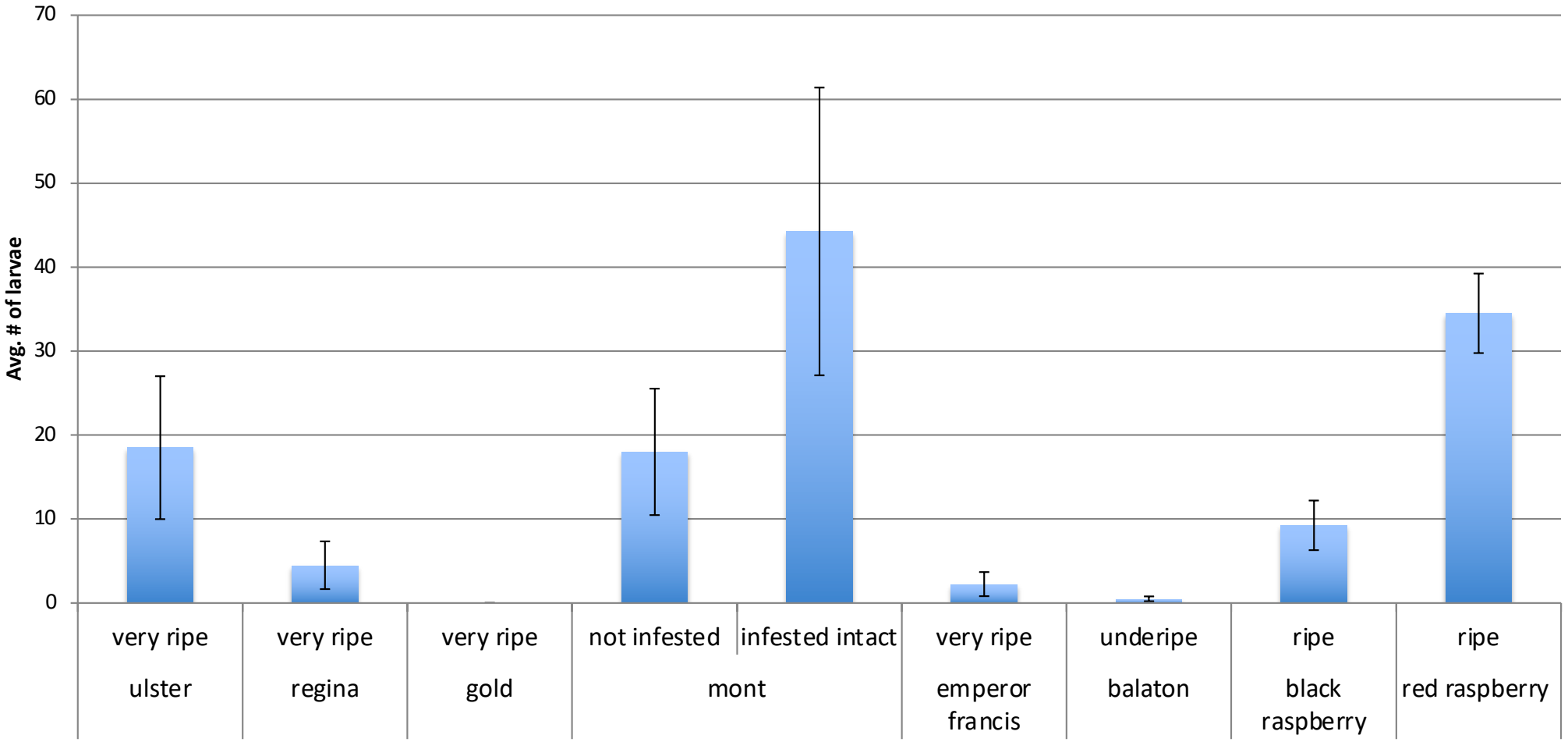


Choice Test 3 – 7/18/17



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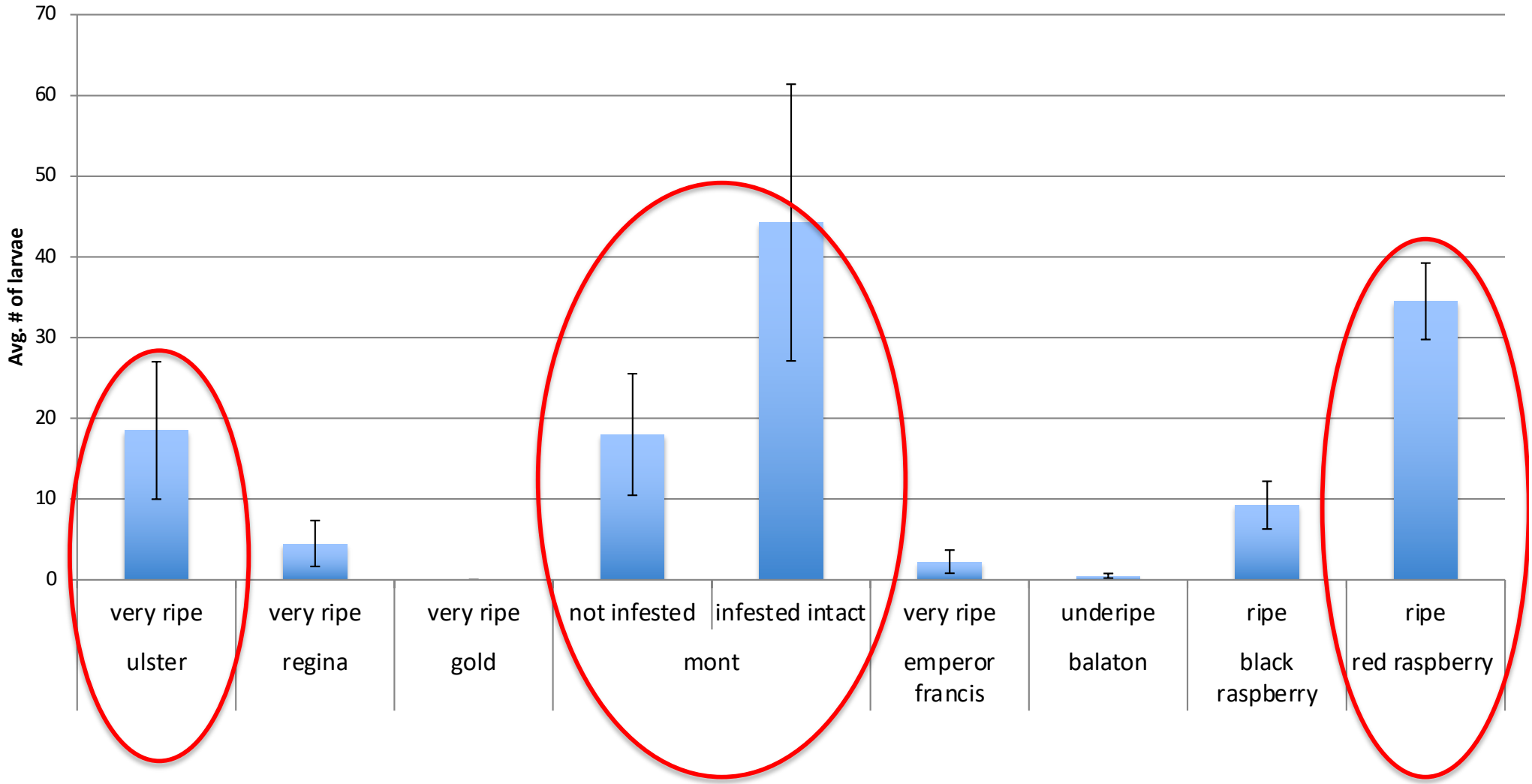
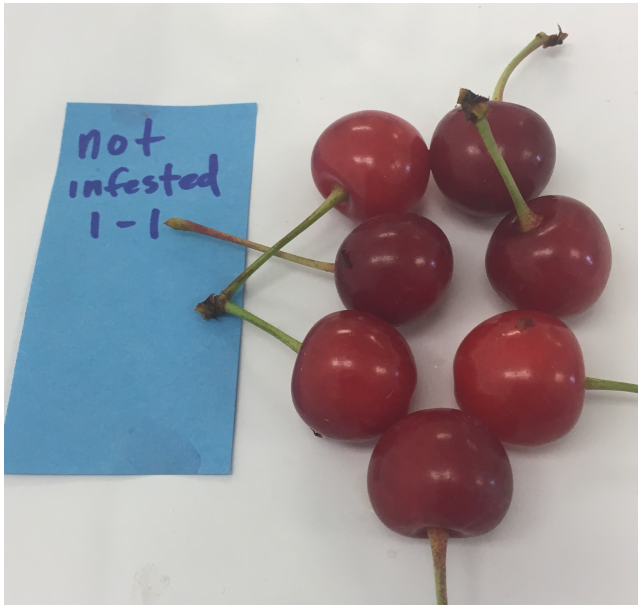
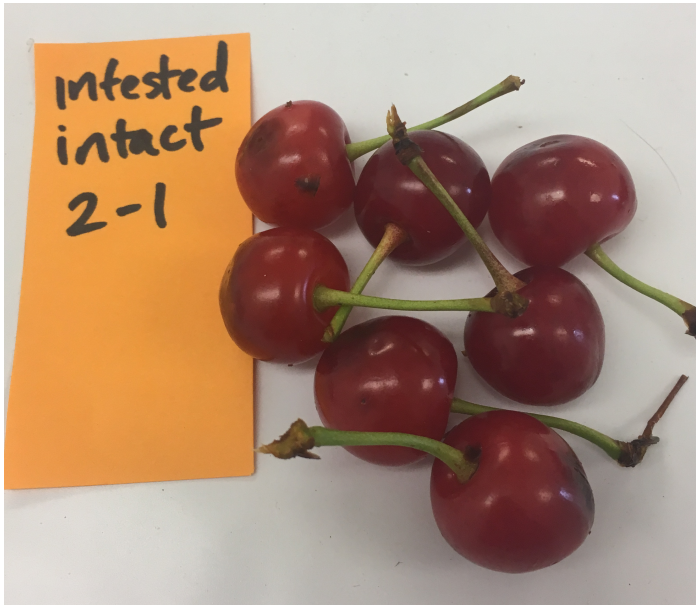
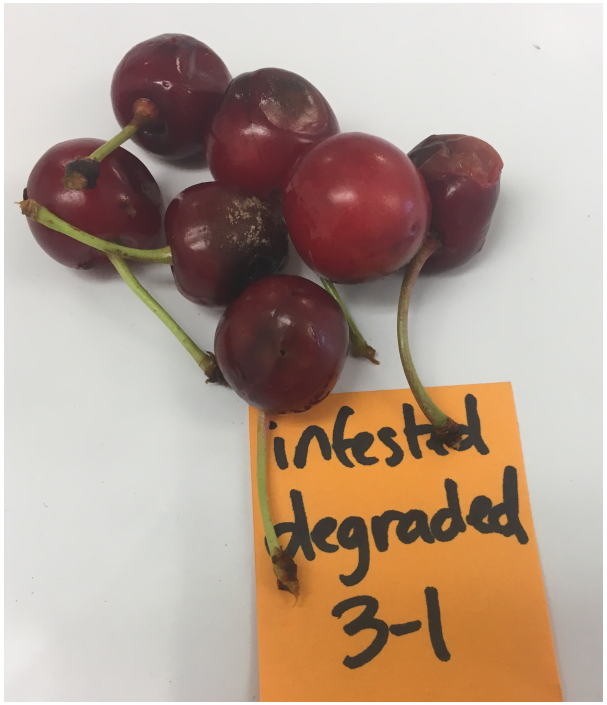


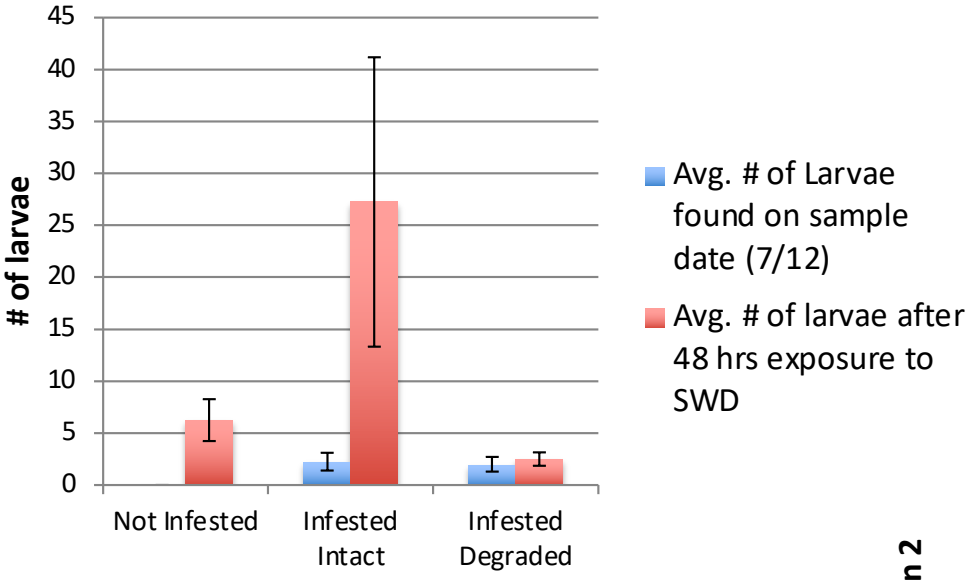
Infested vs. Non-Infested Montmorency

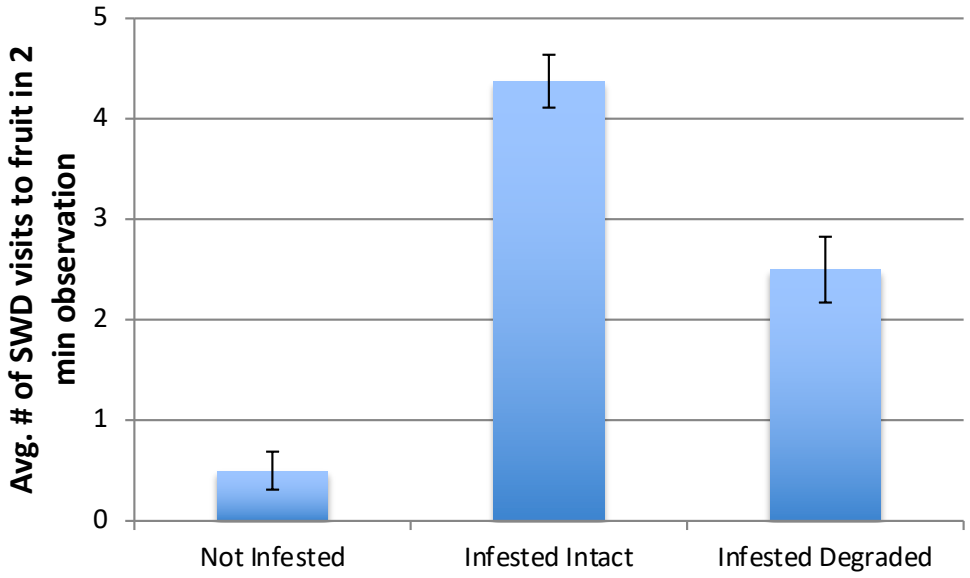






Infested vs. Non-infested Cherries





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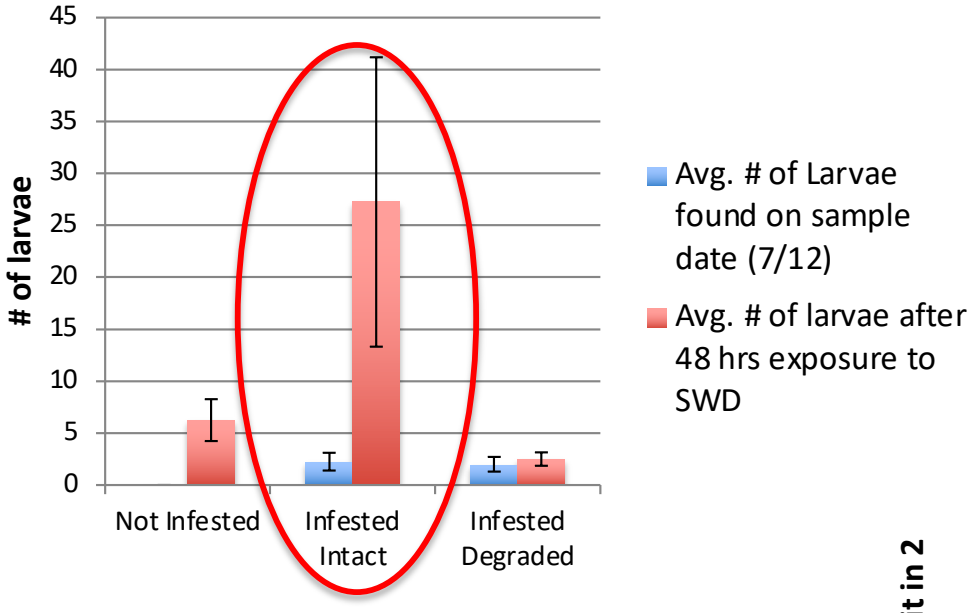

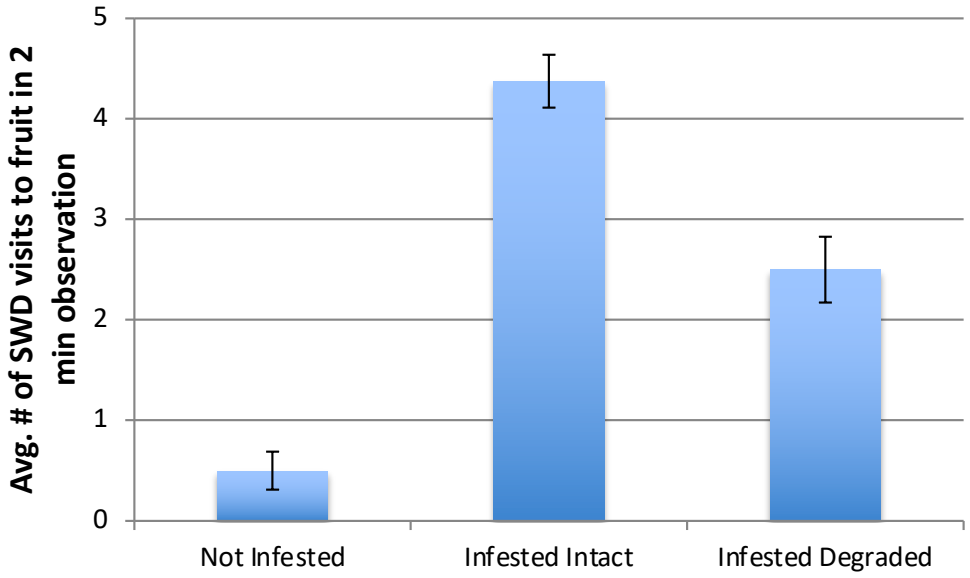

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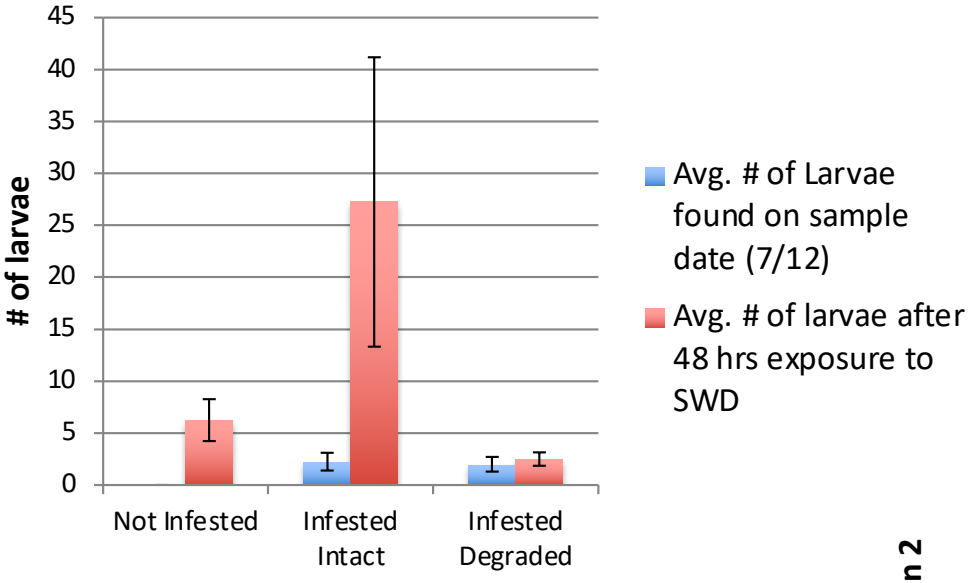

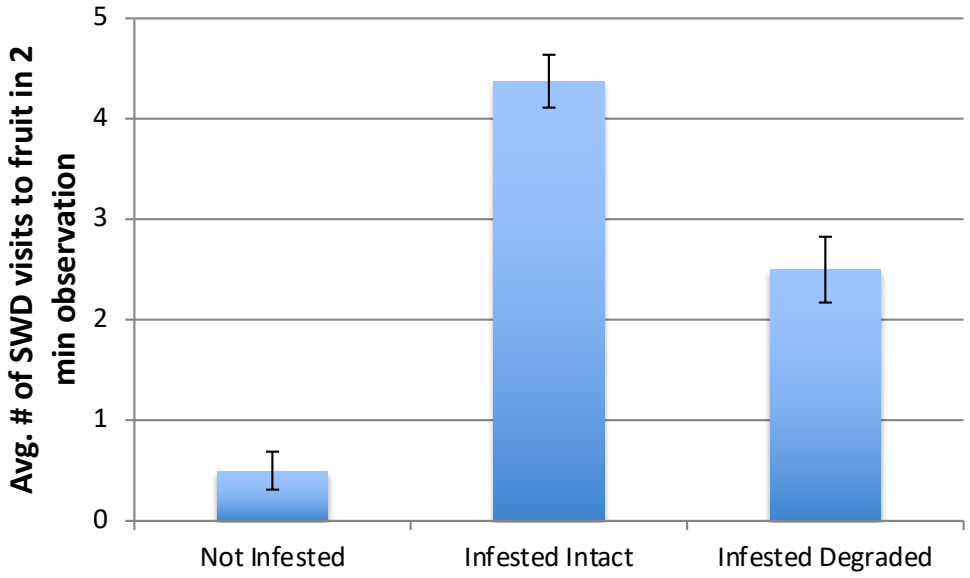

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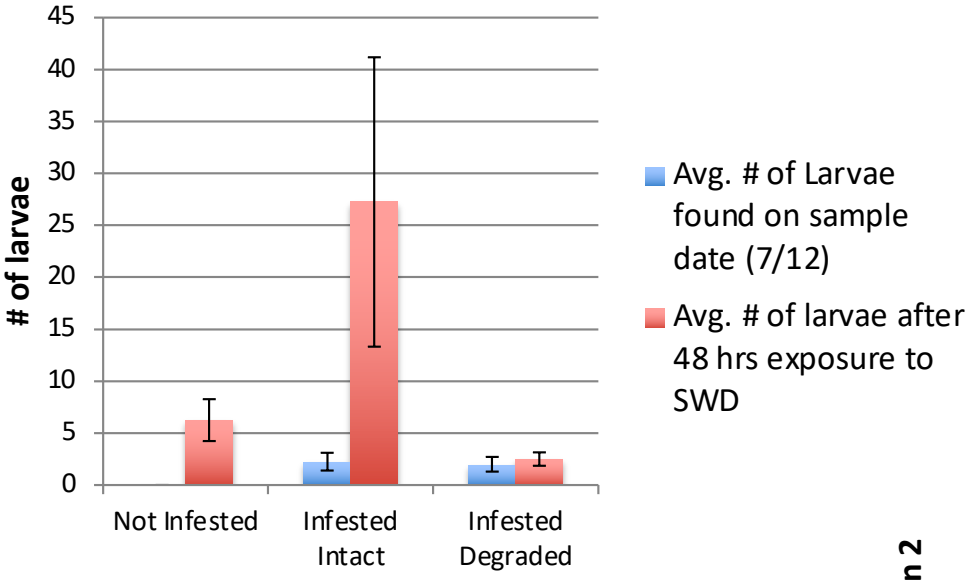

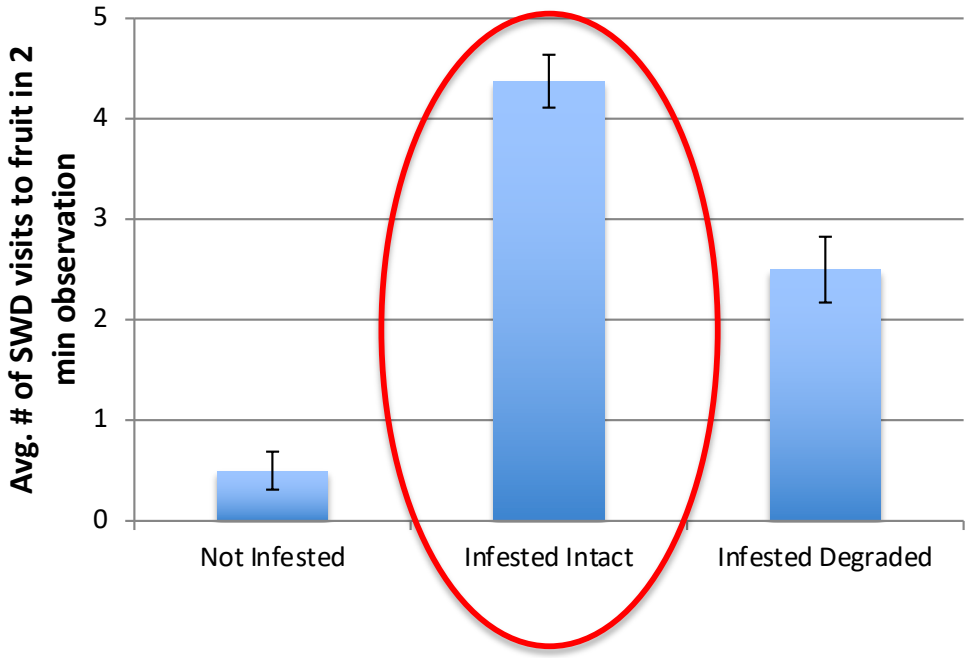

Choice Test Results

- Fewer SWD larvae in Montmorency than other fruits when given choice
  - Higher numbers of larvae in Montmorency cherries that were previously infested with SWD
    - Comparable with other fruits in arena
  - What are the cues SWD use to detect infested fruit in orchard?
    - Corresponds to our observations of many infested fruit on individual tree while other surrounding trees are not infested

Monitoring SWD in Three Michigan Tart Cherry Growing Regions

N.L. Rothwell, E.A. Pochubay, D.S. Jones, M. Haas, K.L. Powers, and L.J. Gut

Objective

- Determine SWD population dynamics and the potential for tart cherry fruit infestations in SW, WC, and NW MI growing regions
  - Does early first catch influence overall populations?
  - Implications of early vs. late harvest on:
    - Number/rotation of insecticides
    - Infested vs. clean fruit at harvest timing

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
WC 9	22-May	1	19-Jul	71	11-Jul	No
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
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SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

First catch:
5/29-6/19

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
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SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

First catch:
5/22-6/19

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
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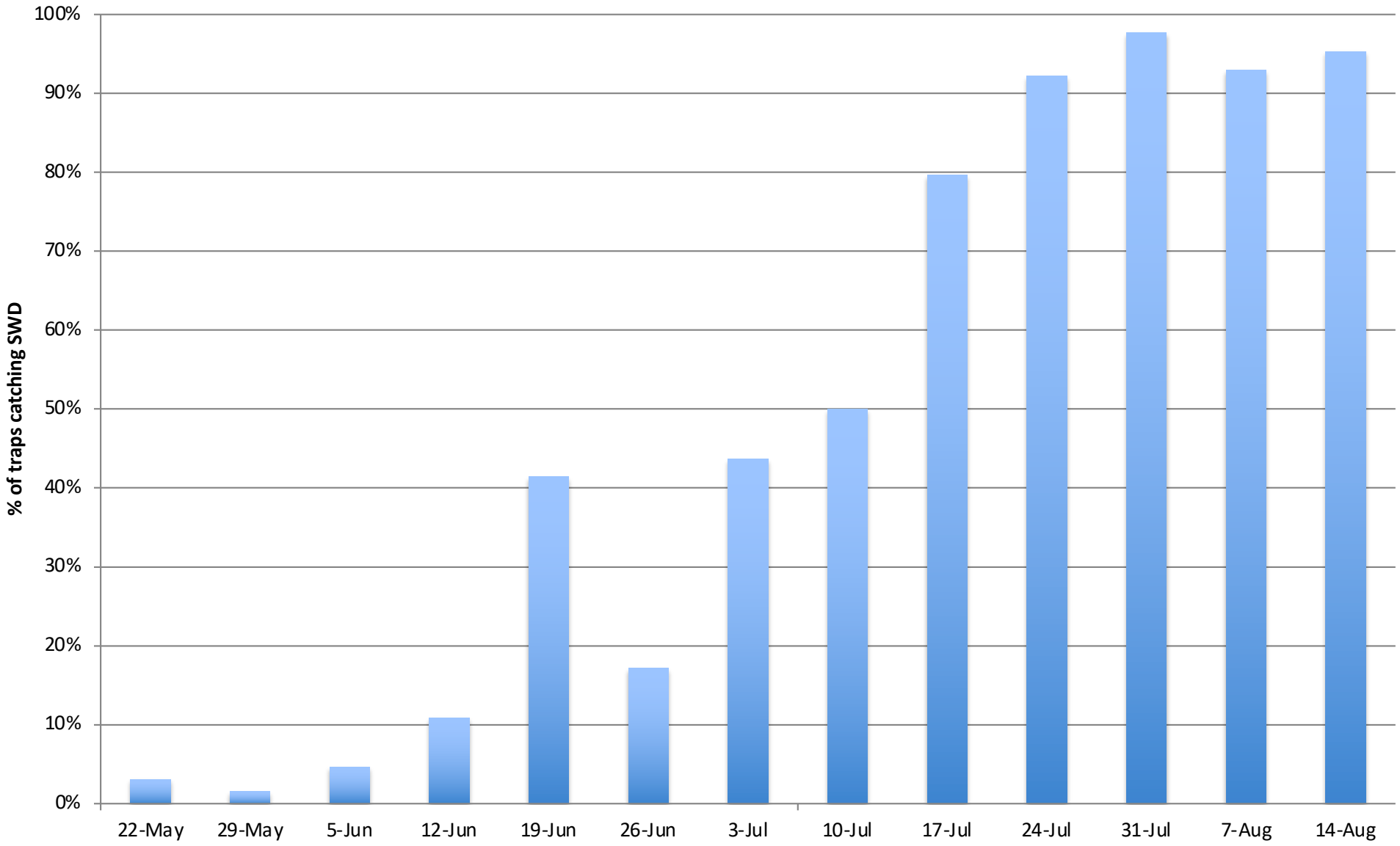
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

First catch:
5/24-5/31

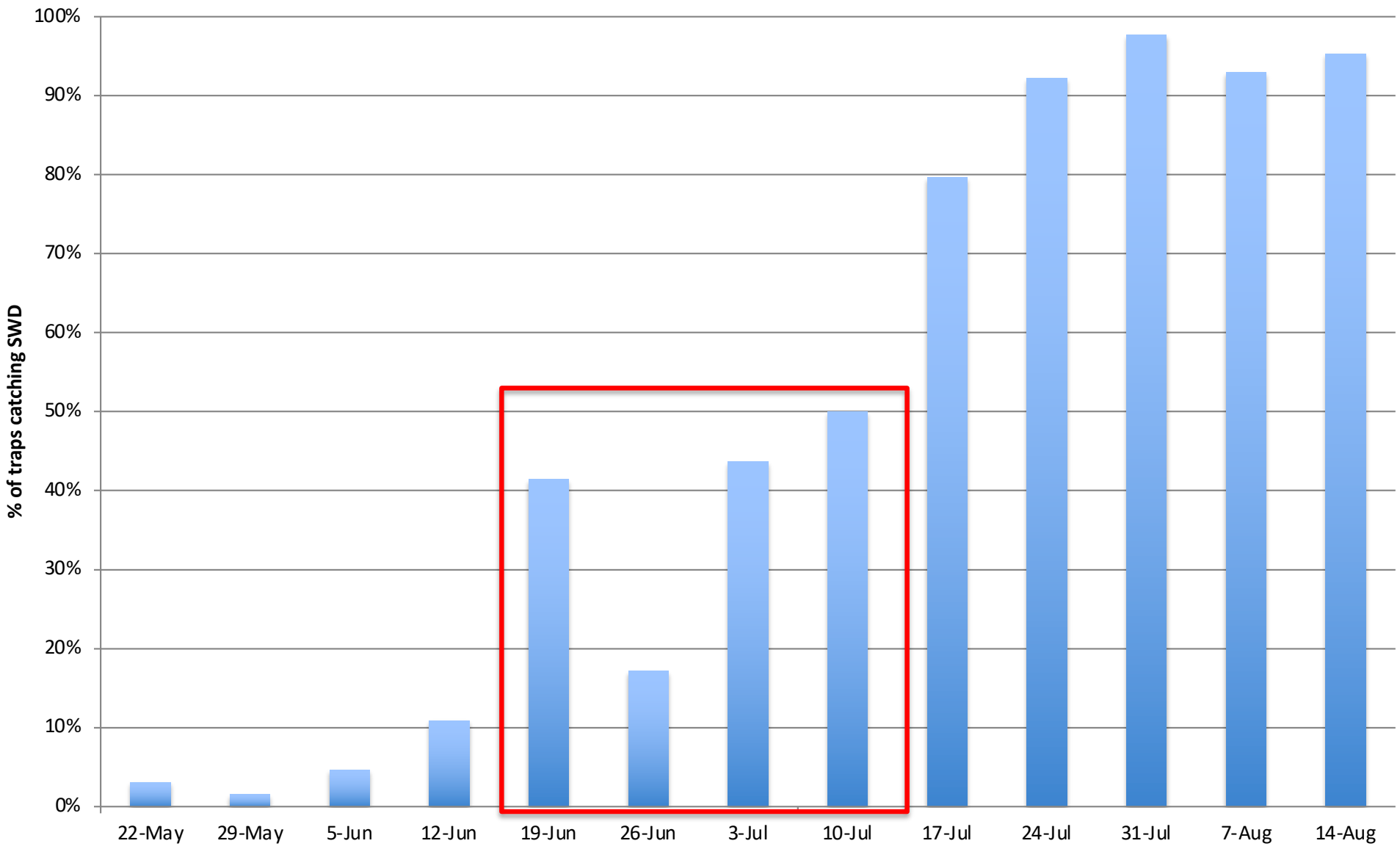
First Catch: What Does it Mean?

- Timing of first catch did not influence overall populations or success of harvesting clean fruit
  - No correlation between first catch and potential for infestation in any MI region
  - Farms with early/late 1st catch were infested
- First catch also is not good indicator of when to begin SWD sprays
  - Earliest first catch: May 22
  - Latest first catch: June 19
  - When should we begin SWD sprays?
- Other indicators we can use to begin SWD sprays?
  - Do we need to continue to trap for SWD?
    - If so, how many traps to we need for a 'regional' trap catch?

2017 NW SWD Trap Catch Data



2017 NW SWD Trap Catch Data



Rule of Thumb to Start SWD Programs

- Begin programs when regional trap catch is consistent rather than using first catch
  - When 30-50% of regional traps are catching SWD
- Based on 2017 trap catch data, programs should have started 19 June - 26 June
- Caveat: If fruit is turning straw/blush prior to these dates, begin programs earlier
  - 2018 research will address fruit color question

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
WC 9	22-May	1	19-Jul	71	11-Jul	No
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

8/10 orchards infested prior to harvest

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
WC 9	22-May	1	19-Jul	71	11-Jul	No
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
WC 9	22-May	1	19-Jul	71	11-Jul	No
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

3/10 orchards infested prior to harvest

Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No
WC 1	19-Jun	1	26-Jul	25	19-Jul	No
WC 2	19-Jun	1	21-Jul	11	14-Jul	No
WC 3	12-Jun	1	11-Jul	2	19-Jul	Yes
WC 4	19-Jun	8	19-Jul	5	12-Jul	No
WC 5	22-May	1	11-Jul	2	18-Jul	Yes
WC 6	12-Jun	1	21-Jul	2	14-Jul	No
WC 7	22-May	1	24-Jul	640	17-Jul	No
WC 8	19-Jun	8	6-Jul	2	11-Jul	Yes
WC 9	22-May	1	19-Jul	71	11-Jul	No
WC 10	19-Jun	10	N/A	0	12-Jul	No
SW 1	31-May	1	10-Jul	1	4-Jul	No
SW 2	24-May	1	10-Jul	16	5-Jul	No
SW 3	24-May	1	26-Jun	2	3-Jul	Yes
SW 4	24-May	2	N/A	0	7-Jul	No
SW 5	31-May	2	26-Jun	14	5-Jul	Yes

2/5 orchards infested prior to harvest

Observations

- Harvest timing is an important factor in delivering clean fruit
  - In most cases, earlier harvest = fewer infestations
- In NW MI, many spray programs were close to 'excellent' and still had infested fruit
    - In NW MI, 9D intervals are *too stretched* if harvest is late July – early August
  - Two infested orchard in SW MI had 18-21D intervals between sprays = reason for infestation

On-Farm Insecticide Trial:
When do Growers Use Best Materials?

When Should Growers Use Most Effective Insecticide?

- Two strategies:
  - Use best materials early to reduce overall SWD populations to achieve better control near harvest
  - Use best material later/near harvest to reduce populations as they rise
- Three programs (2 farms/trmt = 6 total farms):
  - Imidan, Imidan, Delegate, Delegate
  - Delegate, Delegate, Imidan, Imidan
  - Delegate + NuFilm P, Delegate + NuFilm P, Imidan, Imidan

Results

- Imidan, Imidan, Delegate, Delegate:
  - Orchard 1 = 1 larva (7/26)
  - Orchard 2 = 1 larva (7/26)
- Delegate*, Delegate*, Imidan, Imidan:
  - Orchard 3 = 0 larvae
  - Orchard 4 = 2 larvae (7/10)
- Delegate + NuFilm, Delegate + NuFilm, Imidan, Imidan
  - Orchard 5 = 0 larvae
  - Orchard 6 = 0 larvae
- *Delegate sprays had NuFilm P
- Cannot draw good conclusions from this trial?

Optimal Insecticide Programs: Field Efficacy Trial

N.L. Rothwell, L.J. Gut, J. Wise, K.L. Powers, E.A. Pochubay

Efficacy Trial Goal for 2017

- Develop insecticide spray programs that include tank mixes to maximize residual in the orchard to reduce spotted wing drosophila (SWD), *Drosophila suzukii,* infestation.

- Conducted trial on 7-year old Montmorency trees
- Airblast sprayer @ 60gpa

Insecticide Treatments

- Exirel 17D / Imidan 10D / Exirel 3D
- Delegate 17D / Imidan 10 D / Mustang Max 3D
- Delegate 17D / Imidan 10 D / Danitol 3D
- Exirel 21D / Imidan 14 D / Exirel 7D
- Imidan 21D / Mustang Max 14 D / Imidan 7D
- Harvanta 21D / Imidan 14 D / Harvanta 7D
- Mustang Max + Assail 20D / Mustang Max + Assail 10D
- Mustang Max + Harvanta 20D / Mustang Max + Harvanta 10D
- Mustang Max + Imidan 20D / Mustang Max + Imidan 10D
- UTC

Table 1. Efficacy Results from NWMHRC; Harvest Sample (7/24/17)

Treatment	Avg. # of larvae in 3 gallons of fruit	Fisher's PLSD (0.05)
Delegate 17D / Imidan 10D / Danitol 3D	0	a
Exirel 21D / Imidan 14D / Exirel 7D	0	a
Mustang Max and Harvanta 20D / Mustang Max and Harvanta 10D	0	a
Mustang Max and Imidan 20D / Mustang Max and Imidan 10D	0.25	ab
Mustang Max and Assail 20D / Mustang Max and Assail 10D	0.25	ab
Imidan 21D / Mustang Max 14 D / Imidan 7D	0.25	ab
Delegate 17D / Imidan 10D / Mustang Max 3D	0.5	ab
Harvanta 21D / Imidan 14D / Harvanta 7D	0.5	ab
Exirel 17D / Imidan 10D / Exirel 3D	1	ab
Untreated Control	5.5	c

Table 2. Efficacy Results from NWMHRC; 1 week Post-Harvest Sample (7/31/17)

Treatment	Avg. # of larvae in 3 gallons of fruit	Fisher's PLSD (0.05)
Delegate 17D / Imidan 10D / Danitol 3D	1.5	a
Exirel 17D / Imidan 10D / Exirel 3D	2.5	ab
Exirel 21D / Imidan 14D / Exirel 7D	2.75	ab
Mustang Max and Harvanta 20D / Mustang Max and Harvanta 10D	7.25	b
Mustang Max and Imidan 20D / Mustang Max and Imidan 10D	7.25	b
Delegate 17D / Imidan 10D / Mustang Max 3D	7.25	b
Mustang Max and Assail 20D / Mustang Max and Assail 10D	8.5	b
Harvanta 21D / Imidan 14D / Harvanta 7D	15.25	bc
Imidan 21D / Mustang Max 14D / Imidan 7D	15.5	bc
UTC	154.75	c

Efficacy Results

- All treatments were significantly different than the UTC in the harvest timing sample
  - 1) Delegate 17D / Imidan 10D / Danitol 3D, 2) Exirel 21D / Imidan 14D, and 3) Mustang Max and Harvanta 20D /Mustang Max and Harvanta 10D = no larvae
- Jet Ag at a 1% solution followed by Delegate improved the efficacy of Delegate compared to Delegate alone
- Yeast did not improve the efficacy
- One week post harvest sample Delegate 17D / Imidan 10D / Danitol 3D was numerically best program
- Exirel 17D / Imidan 10D/ Exirel 3D and the Exirel 21D Imidan 14D / Exirel 7D programs had statistically fewer larvae
- Good efficacy results in trees with small canopies

Current Thinking

- In no choice tests, more larvae in cherries that are just ripening than ripe fruit
  - Similar findings in Lee et *al*., 2011
  - Fruit that is just ripening *NEEDS* to be protected
- In choice tests, infested Montmorency had higher numbers of SWD than non-infested cherries
- Based on this preliminary information, we need to determine WHEN to start SWD spray program

In Theory

- If we begin SWD programs late(r):
  - SWD lay eggs in *just ripening, unprotected* fruit
  - Infested fruit attract more flies and more SWD lay eggs in tree/orchard = calling in more SWD
  - In dense canopies, SWD flies do not need to move to alternate hosts for shade/humidity = keep laying eggs
  - High potential for exponential SWD population growth in orchard
  - Early SWD infestation in unripe fruit + attracting more flies to infested trees/orchards + flies stay put in canopy = higher chance of infested fruit at harvest

Research Goals for 2018

- Determine when to start SWD programs:
  - In non-sprayed orchards, collect fruit for SWD infestation and color
    - Working with T. Einhorn to develop color rating system
      - Establish quantitate measurements to identify when fruit is susceptible to SWD
      - Put GDD to color parameters
        - » Growers will know when to start protecting fruit
    - Sub-sets of fruit will be used in choice and no choice tests to refine SWD preference
    - Use SWD traps in orchard to determine if there is a relationship between adult trap count and infestation

Sentinel Fruit

- 5 containers with 10 clean tart cherries placed into grower orchards for one week then removed and observed for larvae

2016	11-Jul	17-Jul	25-Jul	4-Aug
Average # of flies per trap	0.3	2.3	2.7	13.6
Average # larvae in 10 fruit	0.0	0.2	0.5	2.8

2017	3-Jul	10-Jul	18-Jul	26-Jul
Average # of flies per trap	0.5	1.3	5.9	8.7
Average # larvae in 10 fruit	0.1	0.1	0.6	2.0

Goals, cont.

2018 Efficacy Trial: Determine when to begin SWD Program

Trt 1	Petal fall	Shucksplit	1st cover	2nd cover	3rd cover	4th cover	Pre-harvest	Harvest
Trt 2	Shucksplit	1st cover	2nd cover	3rd cover	4th cover	Pre-harvest	Harvest	
Trt 3	1st cover	2nd cover	3rd cover	4th cover	Pre-harvest	Harvest		
Trt 4	2nd cover	3rd cover	4th cover	Pre-harvest	Harvest			
Trt 5	3rd cover	4th cover	Pre-harvest	Harvest				
Trt 6	4th cover	Pre-harvest	Harvest					
Trt 7	Pre-harvest	Harvest						
Trt 8	Harvest							

Goals, Cont.

- Pruning trials:
  - Do nothing to 2017 pruning treatments (no pruning, 25% more and 25% less) to determine new growth on 2018 SWD populations/yield
    - Annual pruning/SWD management recommendations
  - Overlay 3 pruning treatments with SWD spray program (pruning + insecticide)
    - Evaluate efficacy
    - Evaluate spray coverage

Recommendations for 2018

- Prune out at least 6 branches in Montmorency trees 15-yr +
- Mow orchards every two weeks
- Start spray programs when fruit starts to turn color: straw to pink (~ 4wks prior to harvest)
  - Use materials rated excellent
  - Use full covers
  - Do not stretch insecticide intervals beyond 7D, particularly if harvest is late July – early August

Thank you!

- NWMHRC lab
  - Erin Lauwers, Abby Lalonde, and Christie Kandel
- NWMHRC farm crew
- Gut lab @ MSU

Project GREEEN

Michigan State Horticultural Society

MONTMORENCY TART CHERRIES

Attract and Kill Potential for Managing SWD

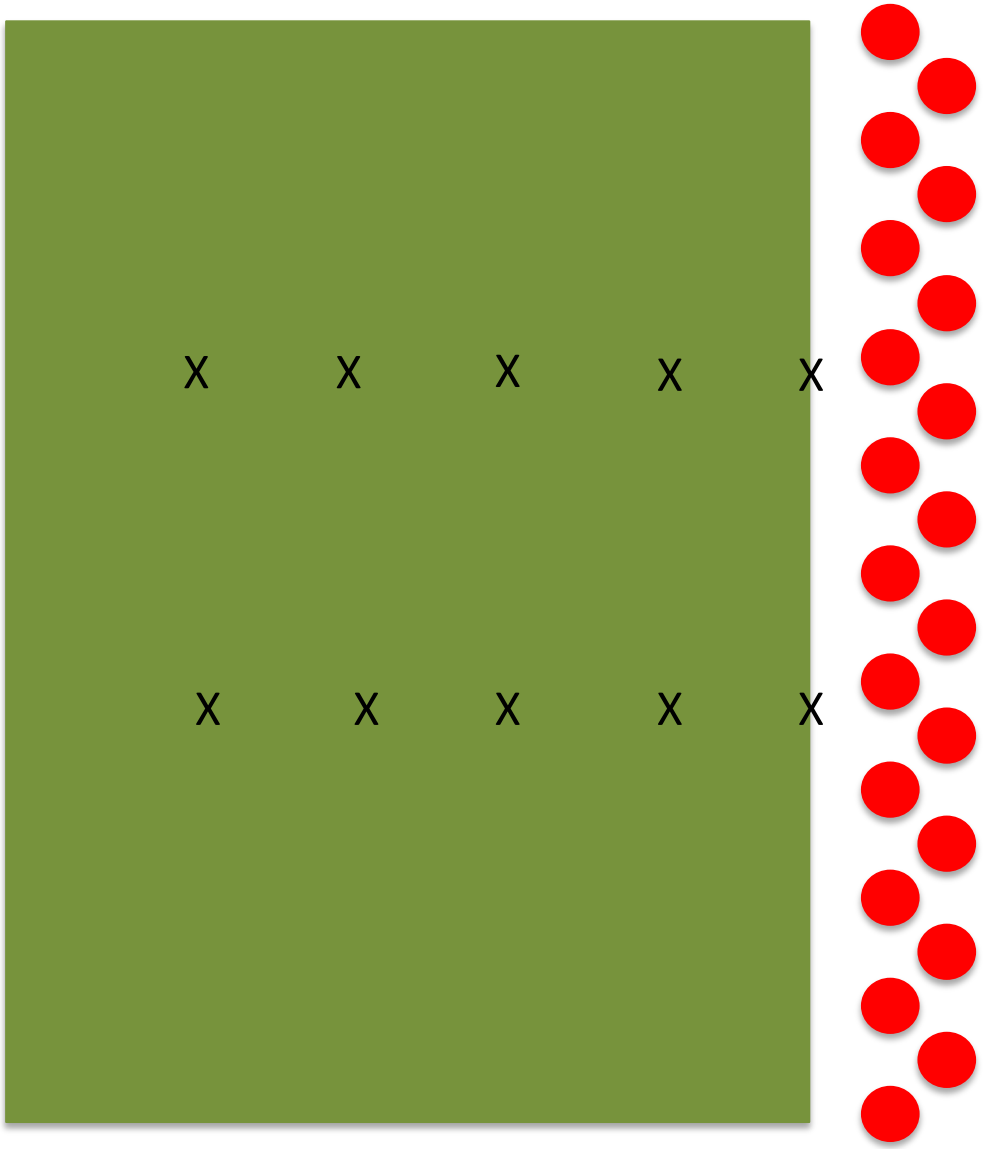
Dr. Nikki Rothwell,

Dr. Tracy Leskey

Attract and Kill

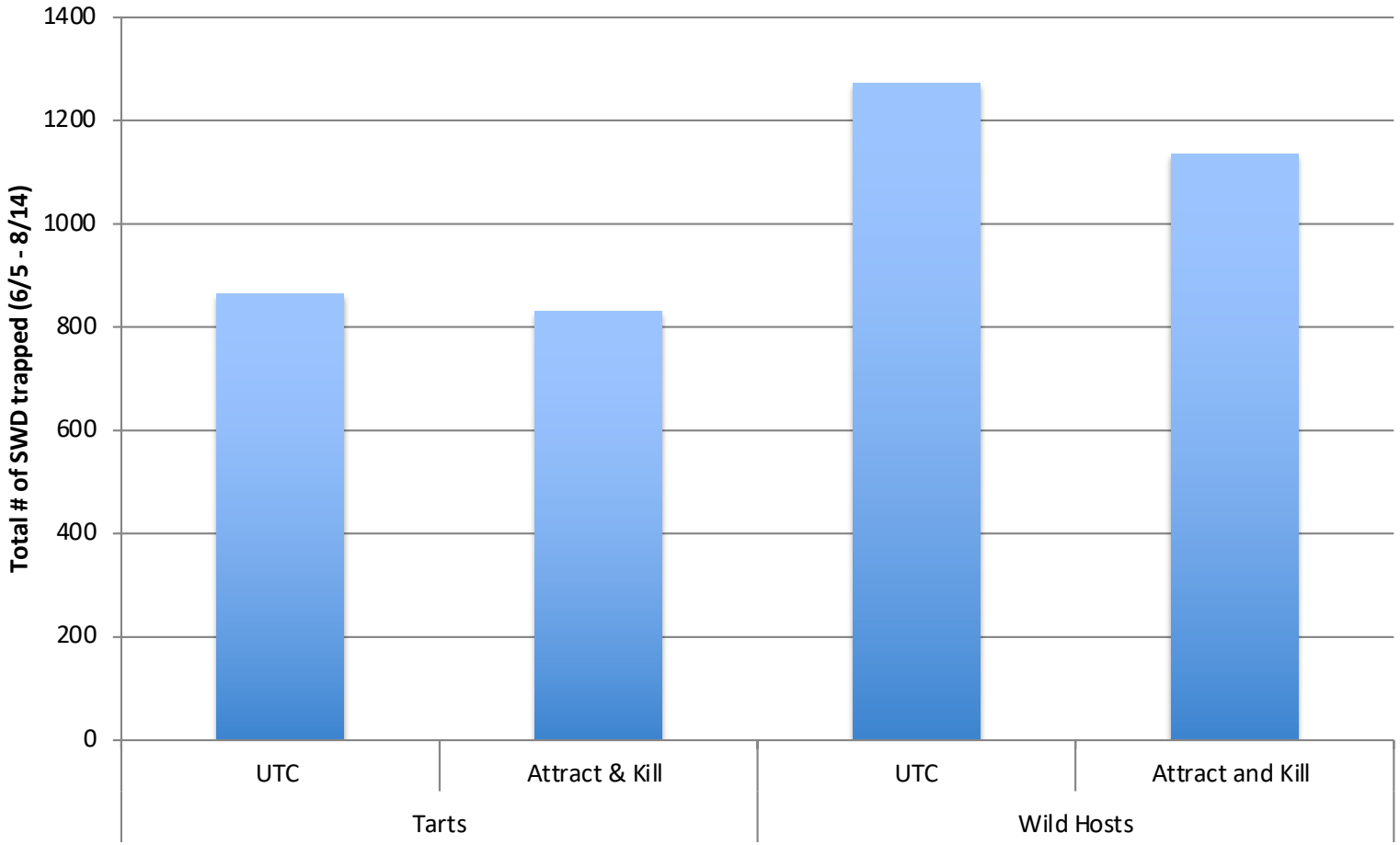
- Can we stop or slow SWD from entering a tart cherry orchard with a “wall” of attract and kill spheres?
  - Red sphere with an insecticide cap

Experiment Design

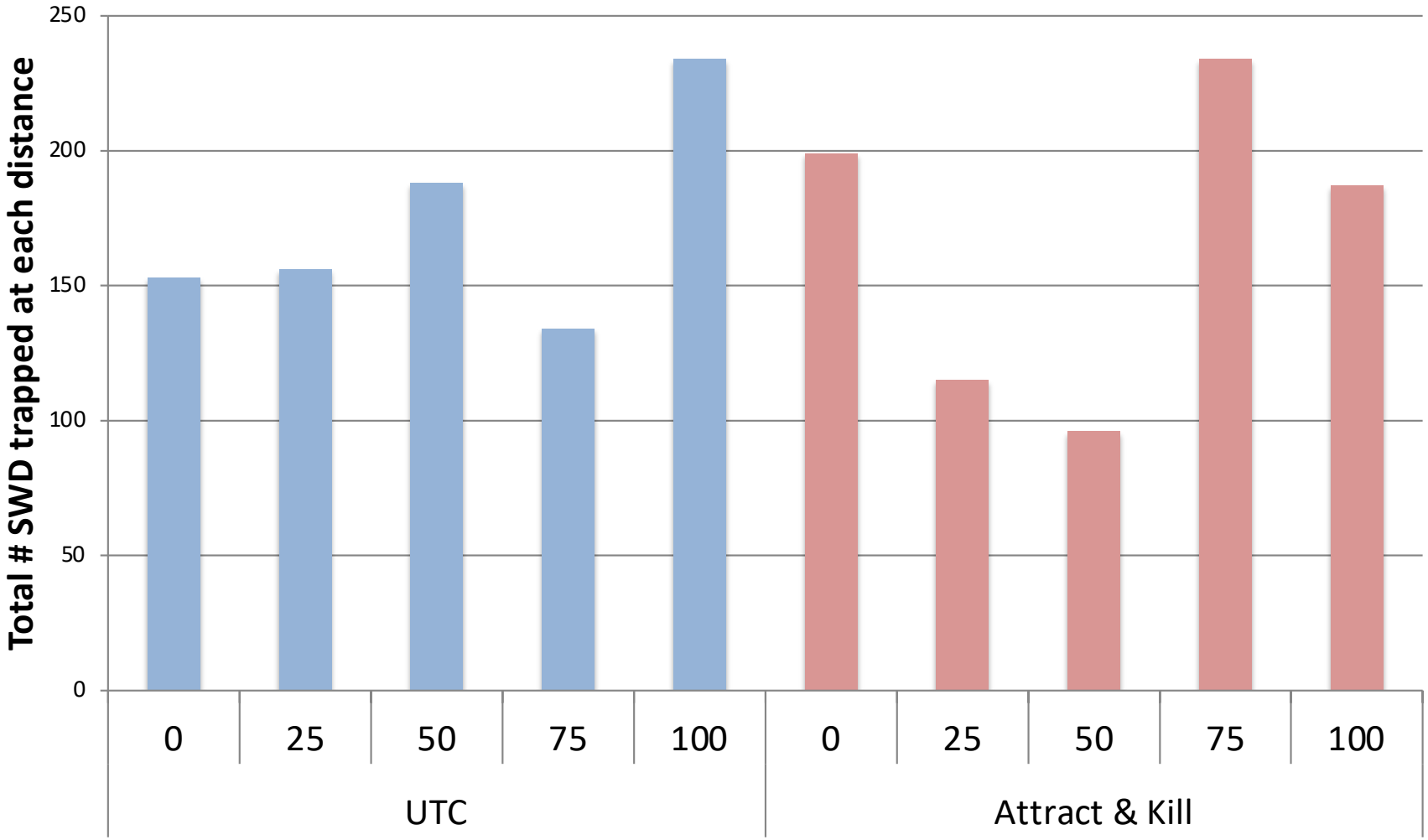


- 220 attract and kill spheres ~1m apart along orchard edge (in wild hosts)
- Traps placed in two transects into tart cherry orchard at 0, 25, 50, 75 and 100 meters
  - Exchanged and counted weekly
- Collect fruit weekly when ripening begins
  - Check for larvae

Total # of SWD Trapped



Total # SWD trapped at each distance



of Larvae found in 30 cherries