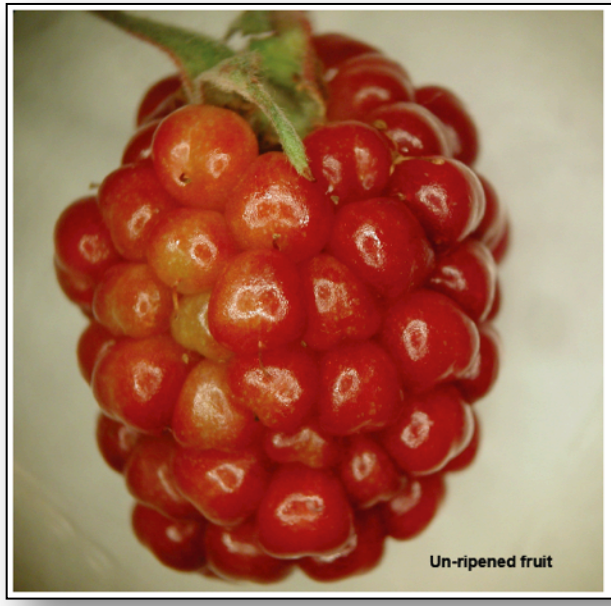
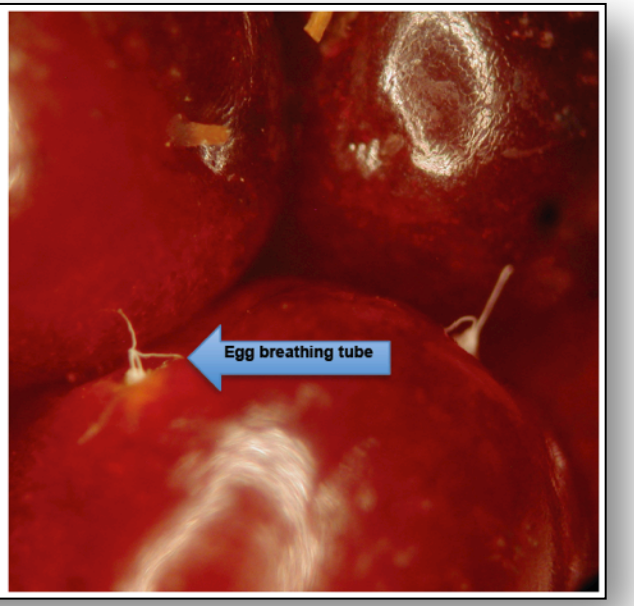
Pesticide Update: Conventional and Organic Chemical Control Options for 2018

SWD Adult Male



Infected Blackberry



Fruit Fly Egg 'Respitory Horns'

Save the Berries: Managing Spotted-Wing Drosophila

Best Western University Inn,
Canton NY

Peter Jentsch
Senior Extension Associate – Entomology

Spotted Wing Drosophila Management in NYS in 2017

- **Conventional & Organic Controls**
  - Timing, Materials, Efficacy
  - Rainfastness
- **Insecticide Rotation**
  - Mode of Action
- **Post Harvest Management of Fruit**
  - Horticultural Oil
  - Low Temperature

New Chemistries for Fruit Production: SWD

Exirel® Cyazypyr

Cyantraniliprole

Anthranilic Diamide Class (Group 28)

- Not labeled for Raspberry
- Limited 0.4 lb ai/A of CYAZYPYR® or cyantraniliprole
- Make no more than 2 applications of DuPont™ EXIREL™ (cyantraniliprole) or other Group 28 products per generation to the same insect species on a crop.
- No more than 2 successive applications within a 30-day period

Do not apply this product while bees are foraging.

New Chemistries for Fruit Production: SWD

Exirel® Cyazypyr

Cyantraniliprole

Anthranilic Diamide Class (Group 28)

- Exirel applied two days after egg-laying, leads to a significant reduction in the number of live larva of D. suzukii in blueberries.

- Ovi-larvicidal and larvicidal effect on eggs laid into berries to reduce larvae hatching from these eggs,

Dr. Rufus Isaacs (Michigan State University),

New Chemistries for Fruit Production: SWD

Exirel® Cyazypyr

Cyantraniliprole (Group 28)

Spotted Wing Drosophila Management in Blueberry
Dr. John Wise, Michigan State 2013

Product	Application interval (in days)	SWD larvae/lb fruit
Exirel™ 13.5 fl. oz./A+ NIS	7	3.8 d
Exirel™ 16.9 fl. oz./A+ NIS	7	6.2 d
Exirel™ 16.9 fl. oz./A+ NIS	14	11.9 bcd
Delegate 25 WG 6 oz./A+ NIS	14	24.9 ab
Untreated	N/A	31.9 a

Chemistries for Fruit Production: SWD

Class	IRAC Code	Examples	SWD Efficacy
Organophosphates	1B	Malathion	Excellent to good
Pyrethroids	3A	Brigade, Danitol, Mustang Max	Excellent
Spinosyns	5	Delegate, Entrust	Excellent to good
Neonicotinoids	4A	Assail	Good to poor
Carbamates	1A	Sevin	Good to poor
Diamide	28	Exirel*	Excellent to good

Managing Insecticide Use: www.fruit.cornell.edu/

June 2017 - Labeled Insecticides for Control of Spotted Wing Drosophila in New York Tree Fruit and Grapes – Quick Guide

Compiled by Art Agnello, Peter Jentsch, Greg Loeb, Tess Grasswitz & Juliet Carroll. Updated regularly.

Most tree fruit crops, especially apples, are currently considered at low risk of SWD infestation.
APPLES & PEARS – refer to the Cornell Guidelines for Commercial Tree Fruit Production, http://ipmguidelines.org/.

SWEET & TART CHERRY										
PRODUCT	**AI[1]**	**IRAC group[2]**	**EPA#**	**RATE/A**	**REI[3]**	**DTH[4]**	**Max Prod/A/yr (ai)**	**Total applic's**	**Spray Interval**	**Probable efficacy**
^@@Entrust 80WP Naturalyte (2ee)[a]	spinosad	5	62719-282	1.25-2.5 oz	4 hr	7 d	9 oz (0.45 lb)	refer to label	> 7 d	Good to Excellent#
^@@Entrust 2SC (2ee)[a]	spinosad	5	62719-621	4-8 fl oz	4 hr	7 d	29 fl oz (0.45 lb)	refer to label	> 7 d	Good to Excellent#
@@Delegate WG (2ee)	spinetoram	5	62719-541	4.5-7 oz	4 hr	7 d	28 oz (0.438 lb)	4	> 7 d	Moderate#
*Exirel	cyazypyr	28	352-859	13.5-20.5 fl oz	12 hr	3 d	61.5 fl oz (0.4 lb)	3	> 7 d	Excellent
*Asana XL (2ee)	esfenvalerate	3	352-515	4.8-14.5 fl oz	12 hr	14 d	72.7 fl oz (0.375 lb)	refer to label	-	Good to Excellent
*Danitol 2.4EC	fenpropathrin	3	59639-35	10.66-21.33 fl oz	24 hr	3 d	42.66 fl oz (0.8 lb)	2	> 10 d	Excellent
*Lambda-Cy EC (2ee)	lambda-cyhalothrin	3	70506-121	5.12 fl oz	24 hr	14 d	*25.6 fl oz (0.2 lb)	5 total, 4 post bloom	> 5 d	Good to Excellent
*Mustang Maxx Insecticide (2ee)	zeta-cypermethrin	3A	279-3426	4 fl oz	12 hr	14 d	24 fl oz (0.15 lb)	6	> 7 d	Excellent
^#Grandevo	*Chromobacterium subtsugae* strain PRAA4-1 and spent fermentation media	UN	84059-27	2-3 lb	4 hr	0 d	-	-	≤ 7 d	Fair to Poor
Tart Cherry Only										
*Imidan 70W	phosmet	1B	10163-169	2.13 lb	72 hr	7 d	7.5 lb (5.25 lb)	3	-	Excellent

[a] In organic production, Entrust must be rotated with insecticides with different modes of action, consider using Grandevo or products containing the active ingredients azadirachtin or pyrethrin.

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@@Delegate WG (2ee)	spinetoram	5	62719-541	4.5-7 oz	4 hr	7 d	28 oz (0.438 lb)	4	> 7 d	Moderate#
*Exirel	cyazypyr	28	352-859	13.5-20.5 fl oz	12 hr	3 d	61.5 fl oz (0.4 lb)	3	> 7 d	Excellent
*Asana XL (2ee)	esfenvalerate	3	352-515	4.8-14.5 fl oz	12 hr	14 d	72.7 fl oz (0.375 lb)	refer to label	-	Good to Excellent
*Danitol 2.4EC	fenpropathrin	3	59639-35	10.66-21.33 fl oz	24 hr	3 d	42.66 fl oz (0.8 lb)	2	> 10 d	Excellent
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*Mustang Maxx Insecticide (2ee)	zeta-cypermethrin	3A	279-3426	4 fl oz	12 hr	14 d	24 fl oz (0.15 lb)	6	> 7 d	Excellent
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Tart Cherry Only										
*Imidan 70W	phosmet	1B	10163-169	2.13 lb	72 hr	7 d	7.5 lb (5.25 lb)	3	-	Excellent

[a] In organic production, Entrust must be rotated with insecticides with different modes of action, consider using Grandevo or products containing the active ingredients azadirachtin or pyrethrin.

Managing Insecticide Use: www.fruit.cornell.edu/

RASPBERRIES & BLACKBERRIES										
PRODUCT	AI[1]	IRAC group	EPA#	RATE/A	REI[3]	DTH[4]	Max. Prod/A/yr (ai)	Total applic's	Spray Interval	Probable efficacy
^@Entrust Naturalyte (2ee)	spinosad	5	62719-282	1.25-2 oz	4 hr	1 d	9 oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
^@Entrust SC (2ee)	spinosad	5	62719-621	4-6 fl oz	4 hr	1 d	29 fl oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
@Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent#
Brigade WSG (2ee)	bifenthrin	3A	279-3108	8.0-16 oz	12 hr	3 d	2 lb (0.2 lb)	1 post bloom	-	Excellent
Brigade EC (2ee)	bifenthrin	3A	279-3313	3.2-6.4 fl oz	12 hr	3 d	12.8 fl oz (0.2 lb)	1 post bloom	-	Excellent
Danitol 2.4EC	fenpropathrin	3A	59639-35	16 fl oz	24 hr	3 d	32 fl oz (0.6 lb)	2	-	Excellent
Mustang Max Insecticide (2ee)	zeta-cypermethrin	3A	279-3249	4 fl oz	12 hr	1 d	24 fl oz (0.15 lb)	6	7 d	Excellent
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin	3A,4A	279-3440	6.4-10.3 fl oz	12 hr	3 d	10.3 fl oz (0.181 lb)	1 post bloom	7 d	Good to excellent
Malathion 5EC (2ee)	malathion	1B	19713-217	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 5EC (2ee)	malathion	1B	66330-220	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 8 Aquamul (2ee)	malathion	1B	34704-474	2.0 pts	12 hr	1 d	6 pts (6.0 lb)	3	7 d	Good
Malathion 57 (2ee)	malathion	1B	67760-40-53883	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Assail 30SG	acetamiprid	4A	8033-36-70506	4.5-5.3 oz	12 hr	1 d	26.7 oz (0.5 lb)	5	7 d	Good#
^Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
^Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
^AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

Managing Insecticide Use: www.fruit.cornell.edu/

RASPBERRIES & BLACKBERRIES										
PRODUCT	AI[1]	IRAC group	EPA#	RATE/A	REI[3]	DTH[4]	Max. Prod/A/yr (ai)	Total applic's	Spray Interval	Probable efficacy
^@Entrust Naturalyte (2ee)	spinosad	5	62719-282	1.25-2 oz	4 hr	1 d	9 oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
^@Entrust SC (2ee)	spinosad	5	62719-621	4-6 fl oz	4 hr	1 d	29 fl oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
@Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent#
Brigade WSG (2ee)	bifenthrin	3A	279-3108	8.0-16 oz	12 hr	3 d	2 lb (0.2 lb)	1 post bloom	-	Excellent
Brigade EC (2ee)	bifenthrin	3A	279-3313	3.2-6.4 fl oz	12 hr	3 d	12.8 fl oz (0.2 lb)	1 post bloom	-	Excellent
Danitol 2.4EC	fenpropathrin	3A	59639-35	16 fl oz	24 hr	3 d	32 fl oz (0.6 lb)	2	-	Excellent
Mustang Max Insecticide (2ee)	zeta-cypermethrin	3A	279-3249	4 fl oz	12 hr	1 d	24 fl oz (0.15 lb)	6	7 d	Excellent
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin	3A,4A	279-3440	6.4-10.3 fl oz	12 hr	3 d	10.3 fl oz (0.181 lb)	1 post bloom	7 d	Good to excellent
Malathion 5EC (2ee)	malathion	1B	19713-217	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 5EC (2ee)	malathion	1B	66330-220	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 8 Aquamul (2ee)	malathion	1B	34704-474	2.0 pts	12 hr	1 d	6 pts (6.0 lb)	3	7 d	Good
Malathion 57 (2ee)	malathion	1B	67760-40-53883	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Assail 30SG	acetamiprid	4A	8033-36-70506	4.5-5.3 oz	12 hr	1 d	26.7 oz (0.5 lb)	5	7 d	Good#
^Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
^Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
^AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

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RASPBERRIES & BLACKBERRIES										
PRODUCT	AI[1]	IRAC group	EPA#	RATE/A	REI[3]	DTH[4]	Max. Prod/A/yr (ai)	Total applic's	Spray Interval	Probable efficacy
^@Entrust Naturalyte (2ee)	spinosad	5	62719-282	1.25-2 oz	4 hr	1 d	9 oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
^@Entrust SC (2ee)	spinosad	5	62719-621	4-6 fl oz	4 hr	1 d	29 fl oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
@Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent#
Brigade WSG (2ee)	bifenthrin	3A	279-3108	8.0-16 oz	12 hr	3 d	2 lb (0.2 lb)	1 post bloom	-	Excellent
Brigade EC (2ee)	bifenthrin	3A	279-3313	3.2-6.4 fl oz	12 hr	3 d	12.8 fl oz (0.2 lb)	1 post bloom	-	Excellent
Danitol 2.4EC	fenpropathrin	3A	59639-35	16 fl oz	24 hr	3 d	32 fl oz (0.6 lb)	2	-	Excellent
Mustang Max Insecticide (2ee)	zeta-cypermethrin	3A	279-3249	4 fl oz	12 hr	1 d	24 fl oz (0.15 lb)	6	7 d	Excellent
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin	3A,4A	279-3440	6.4-10.3 fl oz	12 hr	3 d	10.3 fl oz (0.181 lb)	1 post bloom	7 d	Good to excellent
Malathion 5EC (2ee)	malathion	1B	19713-217	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 5EC (2ee)	malathion	1B	66330-220	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 8 Aquamul (2ee)	malathion	1B	34704-474	2.0 pts	12 hr	1 d	6 pts (6.0 lb)	3	7 d	Good
Malathion 57 (2ee)	malathion	1B	67760-40-53883	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Assail 30SG	acetamiprid	4A	8033-36-70506	4.5-5.3 oz	12 hr	1 d	26.7 oz (0.5 lb)	5	7 d	Good#
^Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
^Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
^AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

5 Classes

Managing Insecticide Resistance: www.fruit.cornell.edu/

RASPBERRIES & BLACKBERRIES										
PRODUCT	AI[1]	IRAC group	EPA#	RATE/A	REI[3]	DTH[4]	Max. Prod/A/yr (ai)	Total applic's	Spray Interval	Probable efficacy
^@Entrust Naturalyte (2ee)	spinosad	5	62719-282	1.25-2 oz	4 hr	1 d	9 oz (0.45 lb)	3 per crop	6 d	Good to Excellent#
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@Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent#
Brigade WSG (2ee)	bifenthrin	3A	279-3108	8.0-16 oz	12 hr	3 d	2 lb (0.2 lb)	1 post bloom	-	Excellent
Brigade EC (2ee)	bifenthrin	3A	279-3313	3.2-6.4 fl oz	12 hr	3 d	12.8 fl oz (0.2 lb)	1 post bloom	-	Excellent
Danitol 2.4EC	fenpropathrin	3A	59639-35	16 fl oz	24 hr	3 d	32 fl oz (0.6 lb)	2	-	Excellent
Mustang Max Insecticide (2ee)	zeta-cypermethrin	3A	279-3249	4 fl oz	12 hr	1 d	24 fl oz (0.15 lb)	6	7 d	Excellent
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin	3A,4A	279-3440	6.4-10.3 fl oz	12 hr	3 d	10.3 fl oz (0.181 lb)	1 post bloom	7 d	Good to excellent
Malathion 5EC (2ee)	malathion	1B	19713-217	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 5EC (2ee)	malathion	1B	66330-220	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 8 Aquamul (2ee)	malathion	1B	34704-474	2.0 pts	12 hr	1 d	6 pts (6.0 lb)	3	7 d	Good
Malathion 57 (2ee)	malathion	1B	67760-40-53883	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Assail 30SG	acetamiprid	4A	8033-36-70506	4.5-5.3 oz	12 hr	1 d	26.7 oz (0.5 lb)	5	7 d	Good#

4 Classes

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RASPBERRIES & BLACKBERRIES										
PRODUCT	AI[1]	IRAC group	EPA#	RATE/A	REI[3]	DTH[4]	Max. Prod/A/yr (ai)	Total applic's	Spray Interval	Probable efficacy
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^Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
^Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
^AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

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Brigade EC (2ee)	bifenthrin	3A	279-3313	3.2-6.4 fl oz	12 hr	3 d	12.8 fl oz (0.2 lb)	1 post bloom	-	Excellent
Danitol 2.4EC	fenpropathrin	3A	59639-35	16 fl oz	24 hr	3 d	32 fl oz (0.6 lb)	2	-	Excellent
Mustang Max Insecticide (2ee)	zeta-cypermethrin	3A	279-3249	4 fl oz	12 hr	1 d	24 fl oz (0.15 lb)	6	7 d	Excellent
Triple Crown	bifenthrin, imidacloprid, zeta-cypermethrin	3A,4A	279-3440	6.4-10.3 fl oz	12 hr	3 d	10.3 fl oz (0.181 lb)	1 post bloom	7 d	Good to excellent
Malathion 5EC (2ee)	malathion	1B	19713-217	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 5EC (2ee)	malathion	1B	66330-220	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Malathion 8 Aquamul (2ee)	malathion	1B	34704-474	2.0 pts	12 hr	1 d	6 pts (6.0 lb)	3	7 d	Good
Malathion 57 (2ee)	malathion	1B	67760-40-53883	3.0 pts	12 hr	1 d	9 pts (6.0 lb)	3	7 d	Good
Assail 30SG	acetamiprid	4A	8033-36-70506	4.5-5.3 oz	12 hr	1 d	26.7 oz (0.5 lb)	5	7 d	Good#
^Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
^Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
^AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

Managing Insecticide Resistance: Raspberry

Example of IRM conventional program: Mode of Action (MoA)

MoA-w – Pyrethroids: IRAC 3A

Baythroid XL, Brigade 2EC, Danitol, TripCr, Mustang Max (7d / 6 apps.)

MoA-x – Organophosphates: IRAC 1B

Malathion (7d / 3 apps.)

MoA-y – Spinetoram: IRAC 5

Entrust, Delegate (4d / 6apps.)

MoA-z – Neonicotinoids: IRAC 4A

Provado (Pre-mix), Assail (7d / 5apps.)

Managing Insecticide Resistance: Raspberry

Example of a IRM conventional program:

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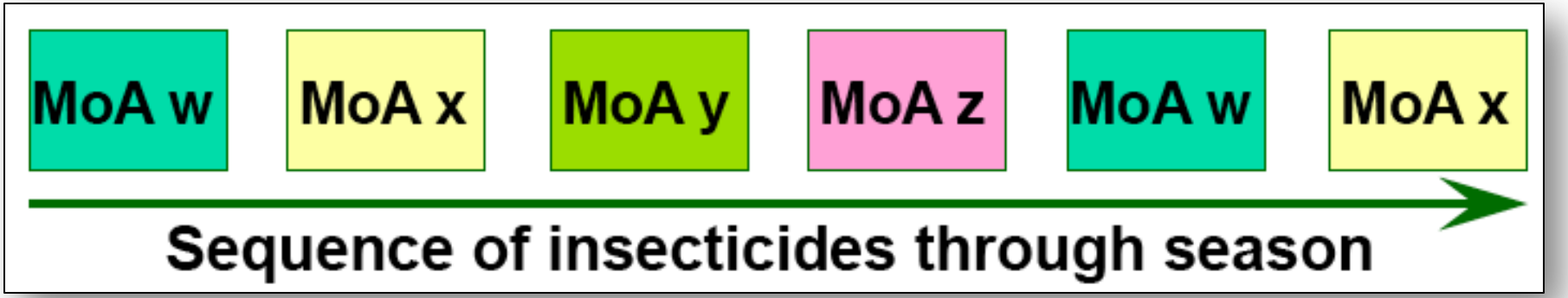

Managing Insecticide Resistance: Raspberry

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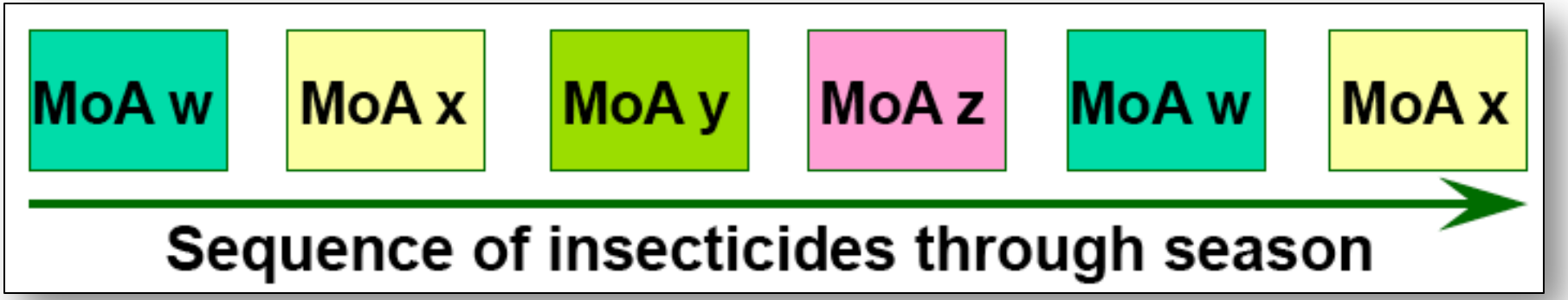


J 10 15 19 23 27 30 A 3 7 11 15 19 23 27 S 1 5 9 13 17 21 25

Survey on insecticide efficacy against SWD, collated by Rufus Isaacs, MSU November, 2013

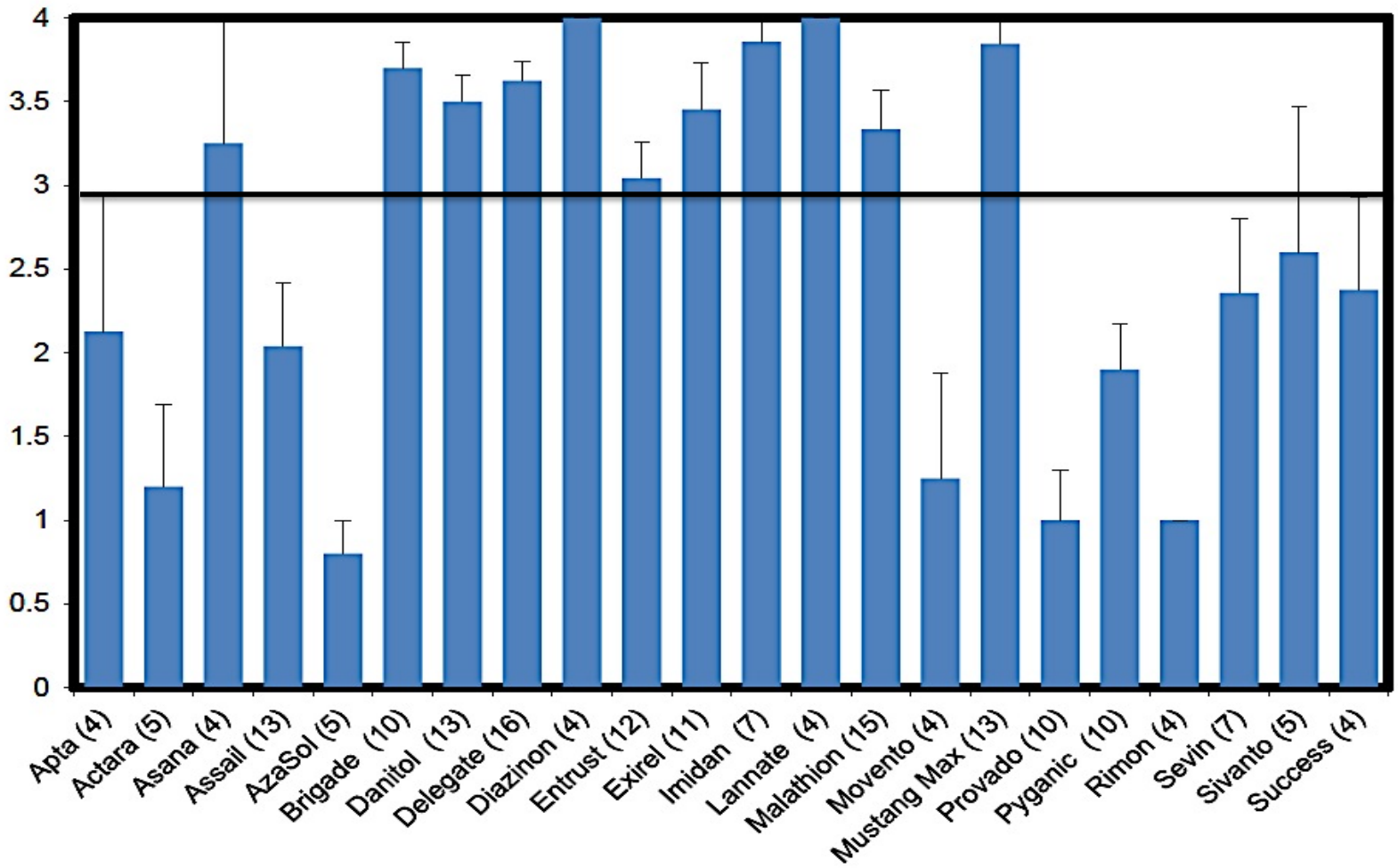


Figure 1. Average ± S.E. efficacy rankings for 22 insecticides that have been tested against SWD in various fruit crops. Insecticides were ranked as not effective (score = 0), weakly active (1), fair (2), good (3), or excellent (4). Only insecticides that had 4 or more submitted are included in the figure, and the number of entries is shown in parentheses below the bars.

Success and Failure in West Central Michigan 2017 Cherry Production

- Growers who **stretched insecticide intervals to 9 to 10 days**, particularly within two weeks of harvest, had **larval contamination**.
- Growers that stretched **excellent products seven to eight days did not have contamination** this season.
- No grower had contamination at harvest when insecticides were applied every **eight days or less, if the product choice was excellent.**
- Products outside of the excellent rating that were **stretched seven or more days resulted in contaminated fruit**.

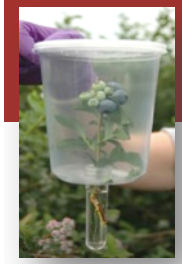
Success and Failure in West Central Michigan 2017 Cherry Production

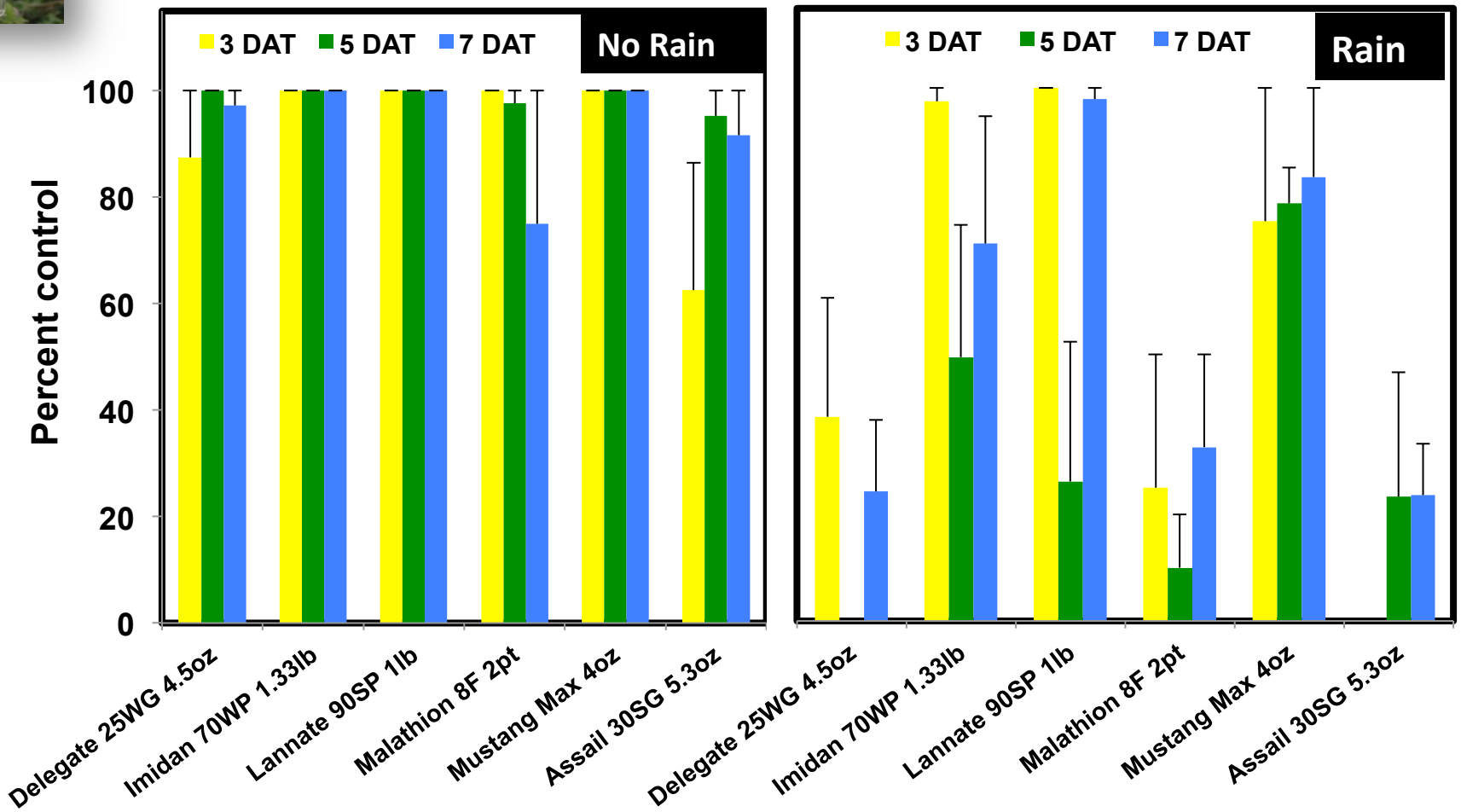
- **Successful control of SWD:** Applications began about three weeks before predicted harvest, keeping tight intervals (six to eight days) using excellent rated insecticides. Consideration for re-application of insecticide shortly after rain events.

- **Failure: Growers beginning 'early',** four weeks from harvest and trying to stretch the same number of sprays further to keep costs down, suffered SWD larval contamination.

Effect of Rain on Some Common Insecticides in Blueberry

From Rufus Isaacs, MSU





0.8 inches of rain on treated bushes
1 day after application

MICHIGAN STATE UNIVERSITY

SUMMARY

- Insecticides are presently the primary method of control for SWD
- Choose insecticide with excellent efficacy ratings to manage SWD
- Consider insecticide rainfastness and weather forecasts to optimize SWD management
- Reapply insecticide within 24hr. to maintain residual activity after rain events

Rainfastness of insecticides

- **Several factors influence impact of precipitation on a pesticide's performance.**
- First is the **plant-penetrative attributes** of the various compounds.
- Some pesticide chemistries, like **organophosphates**, have limited penetrative potential in plant tissue, and thus are considered primarily as surface materials.
- Some compounds, such as **carbamates, oxadiazines and pyrethroids**, penetrate plant cuticles, providing some resistance to wash-off.

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

- **Spinosyns, diamides, avermectins** and some **Insect Growth Regulators (IGR)**, readily penetrate plant cuticles and have translaminar movement in leaf tissue.

- **Neonicotinoid** insecticides, are systemic and can have translaminar (moves from top surface to bottom of leaf) as well as acropetal movement in the plant's vascular system (moves from center to growing tips of leaves).

- **Penetration** into plant tissue is generally expected **to enhance rainfastness of pesticides**.

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

- **The second factor is the inherent toxicity of an insecticide** to the target pest and the persistence of the compound in the environment.

- In some cases, a compound may be susceptible to wash-off, but its **environmental persistence and inherent toxicity to the target pest compensates for the loss of residue, thus delaying the need for immediate re-application (Organophosphates).**

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

The third factor is the amount of precipitation.

- **Organophosphate** insecticides have the highest susceptibility to wash-off from precipitation, but following light rainfall their high field-rate toxicity to most target pests overcomes the necessity for immediate re-application.

- **Carbamate, IGR and oxadiazine insecticides are moderately susceptible to wash-off and vary widely** in their toxicity to the range of relevant fruit pests.

- **Diamide, spinosyn, avermectin and pyrethroid** insecticides have proven to be moderate to highly rainfast on most fruit crops.

- **Neonicotinoid** insecticides *are moderately susceptible to wash-off,* with residues that have moved systemically into plant tissue being *highly rainfast*, and surface residues less so.

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

Insecticide persistence, plant penetration and rainfastness rating			
Compound class	**Persistence (residual on plant)**	**Plant penetration characteristics**	**Rainfast rating**
Organophosphates	Medium - Long	Surface	Low
Carbamates	Short	Cuticle Penetration	Moderate
Pyrethroids	Short	Cuticle Penetration	Moderate - High

Insecticide persistence, plant penetration and rainfastness rating			
Compound class	**Persistence (residual on plant)**	**Plant penetration characteristics**	**Rainfast rating**
Neonicotinoids	Medium	Translaminar & Acropetal	Moderate
Oxadiazines	Medium	Cuticle Penetration	Moderate
Avermectins	Medium	Translaminar	Moderate
IGRs	Medium - Long	Translaminar	Moderate
Spinosyns	Short - Medium	Translaminar	Moderate - High
Diamides	Medium - Long	Translaminar	Moderate - High

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

- For most insecticides, a **drying time of two to six hours is sufficient to "set" the compound in or on the plant.**

- With neonicotinoids, for which plant penetration is important, drying time can significantly influence rainfastness.

- For **neonicotinoids, up to 24 hours is needed for optimal plant penetration**, thus the time proximity of precipitation after application should be considered carefully.

- Spray adjuvants, materials intended to aid the retention, penetration or spread on the plant, can also improve the performance of insecticides.

Rainfall influences performance of insecticides on the codling moth (Lepidoptera: Tortricidae) in apples. John C. Wise,1 Daniel Hulbert, Christine Vandervoort. Can. Entomol. 149: 118–128 (2017)

Rainfastness of insecticides

Blueberry insecticide precipitation wash-off re-application decision chart - spotted wing Drosophila. Expected spotted wing Drosophila control in blueberries, based on each compound's inherent toxicity to SWD, maximum residual and wash-off potential from rainfall.

Insecticides	Rainfall = 0.5 inch		Rainfall = 1.0 inch		Rainfall = 2.0 inches	
	*1 day	*7 days	*1 day	*7 days	*1 day	*7 days
Imidan	Sufficient insecticide residue	Insufficient insecticide residue	Sufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue
Mustang Max	Sufficient insecticide residue	Insufficient insecticide residue	Sufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue
Lannate	Sufficient insecticide residue	Insufficient insecticide residue	Sufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue
Malathion	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue
Delegate	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue
Assail	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue	Insufficient insecticide residue

- Number of days after insecticide application that the precipitation event occurred.
- Insufficient insecticide residue = Insufficient insecticide residue remains to provide significant activity on the target pest, and thus re-application is recommended.
- Sufficient insecticide residue = Sufficient insecticide residue remaining to provide significant activity on the target pest, although residual activity may be reduced.

John C. Wise et al. 2017

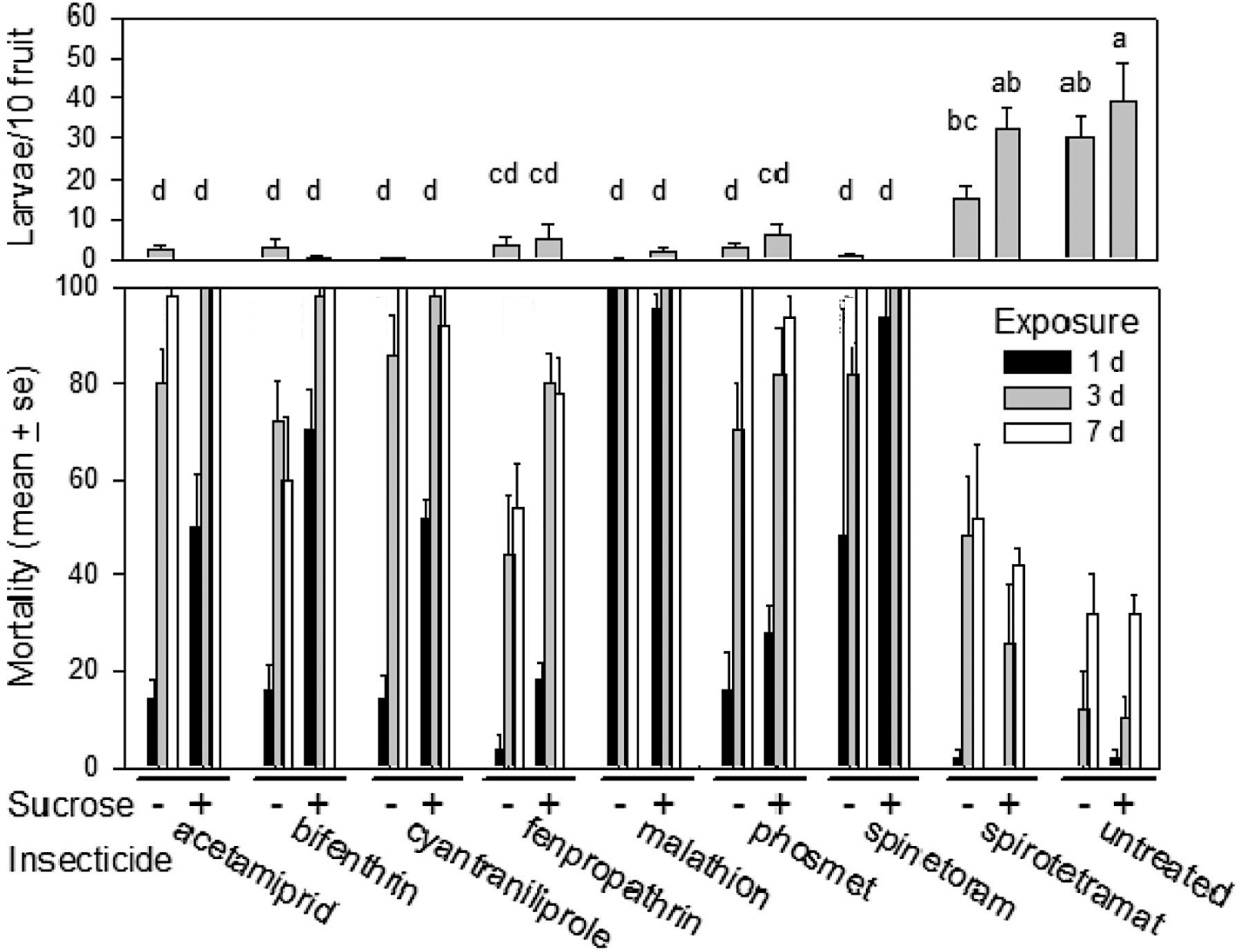
Rainfastness of insecticides

Rainfastness rating chart: General characteristics for insecticide chemical classes						
Insecticide class	Rainfastness ≤ 0.5 inch		Rainfastness ≤ 1.0 inch		Rainfastness ≤ 2.0 inches	
	Fruit	Leaves	Fruit	Leaves	Fruit	Leaves
Organophosphates	Low	Moderate	Low	Moderate	Low	Low
Pyrethroids	Moderate/High	Moderate/High	Moderate	Moderate	Low	Low
Carbamates	Moderate	Moderate/High	Moderate	Moderate	Low	Low
IGRs	Moderate	Moderate/High	Moderate	Moderate	Low	Low
Oxadiazines	Moderate	Moderate/High	Moderate	Moderate	Low	Low
Neonicotinoids	Moderate, Systemic	High, Systemic	Low, Systemic	Low, Systemic	Low, Systemic	Low, Systemic
Spinosyns	High	High	High	Moderate	Moderate	Low
Diamides	High	High	High	Moderate	Moderate	Low
Avermectins	Moderate, Systemic	High, Systemic	Low,Systemic	Moderate, Systemic	Low	Low

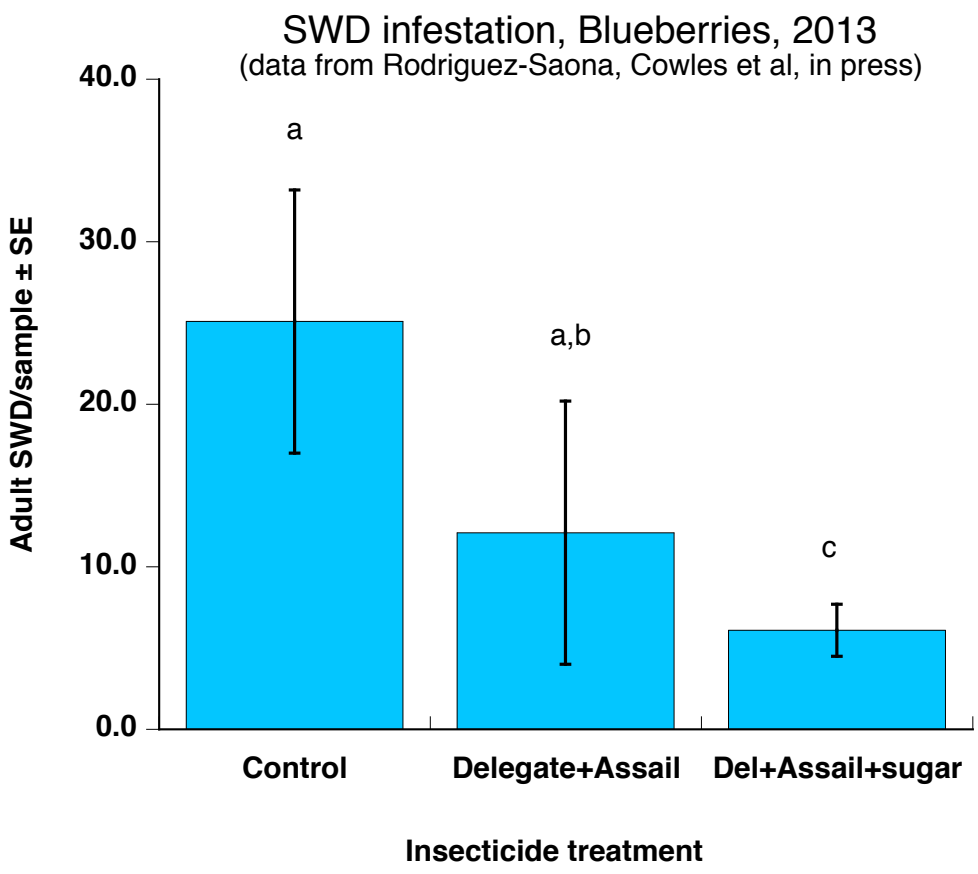
Highly rainfast = ≤ 30% residue wash-off
Moderately rainfast = ≤ 50% residue wash-off
Low rainfast = ≤ 70% residue wash-off
Systemic = Systemic residues remain within plant tissue

Sucrose Improves Insecticide Activity Against Drosophila Suzukii (Diptera: Drosophilidae)

Richard S. Cowles , Cesar Rodriguez-Saona , Robert Holdcraft , Gregory M. Loeb , Johanna E. Elsensohn , Steven P. Hesler



Enhancing Mortality with Sugar



Cultivar: 'Bluecrop'

Treatments: 4 wk spray program
- -Alternate Delegate & Assail
- -Delegate & Assail plus sugar

Plot size: 2 rows, 32 bushes

Replicates: 4

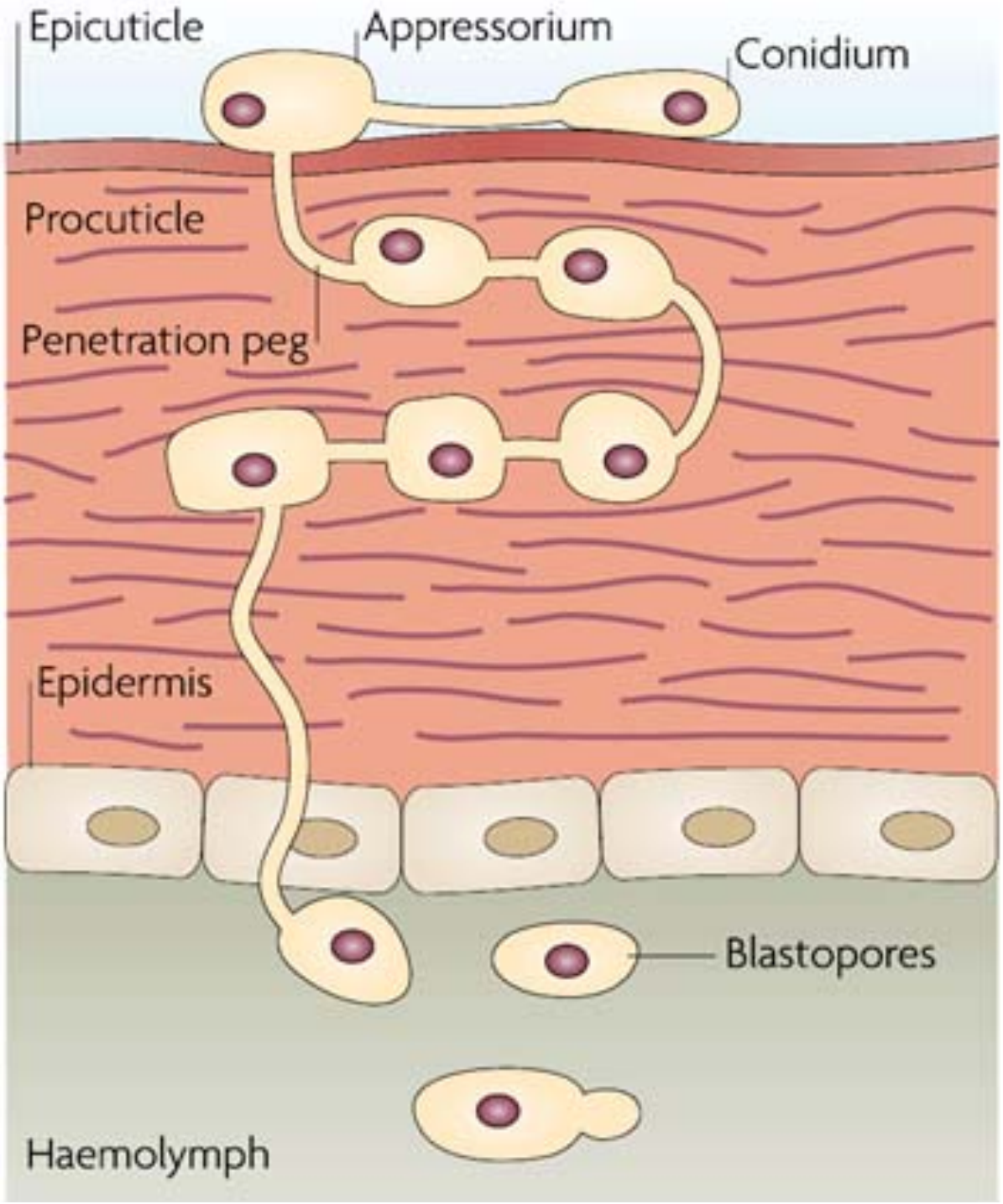
Sugar: 2 lb. / 100 gal.

Credit: Greg Loeb Lab, NYSAES Geneva, NY

Biological Control Primer:
Microbe Entomopathogens and Commercial Formulation Studies

Beauveria bassiana Basl.-Criv. (Hypocreales; Clavipitaceae)

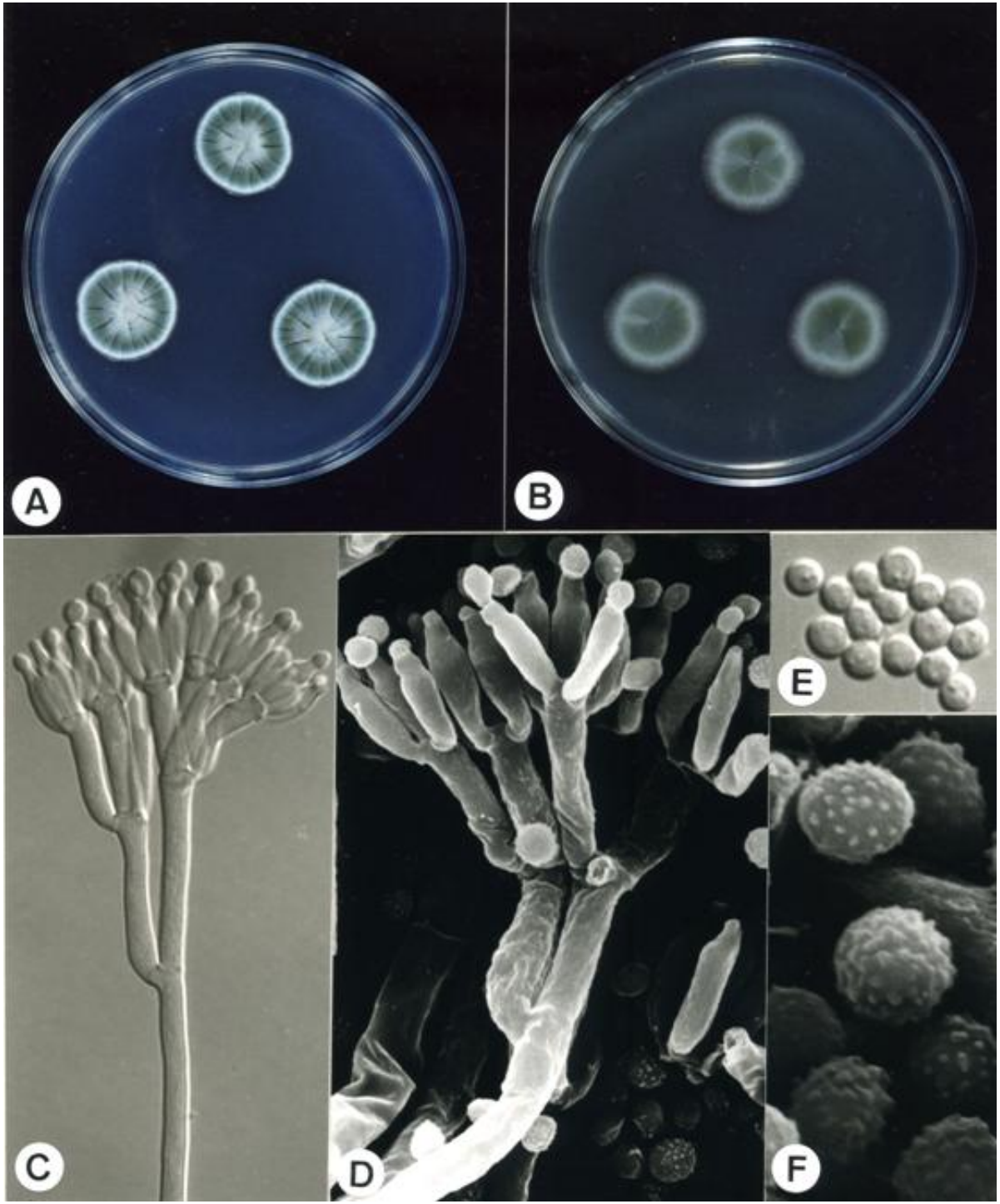
- Fungal parasite that causes White Muscardine Disease in insects.
- Microscopic spores of fungi come into contact with insect host, which germinate and penetrate the cuticle.
- Fungus then grows inside of insect, killing it within a matter of days.
- White fruiting bodies emerge from insect, releasing spores.
- Anamorph of *Cordyceps bassiana.*



The in vivo development cycle of the entomopathogenic fungi Beauveria bassiana

- Conidia (spores) adhere to the host cuticle, then the conidia germinate and the germ tube and appressorium (penetration structure) are produced.
- The cuticle is penetrated by a combination of mechanical pressure and the action of cuticle-degrading enzymes.
- **The fungus grows by vegetative growth in the host haemocoel and external conidia are produced upon the death of the host**

Can fungal biopesticides control malaria?
Matthew B. Thomas & Andrew F. Read
Nature Reviews Microbiology 5, 377-383 (May 2007)



Plates of *B. bassiana*

A. Dorsal surface

B. Ventral surface

C. Fruiting structures

D. Fruiting structures

E. Conidia

Objectives:

- Determine the lethality of *B. bassiana* on **SWD adults, larvae, and pupae.**
- Determine the effect of *B. bassiana* on **oviposition.**
- Determine if transfer between gravid **females and offspring** occurs, and if so, does it affect the next generation's size?
- Determine if generalized **strain** (GHA) performs as well as Diptera-specific strain (HF23 - BalEnce).

Objectives:

Beauveria bassiana

Mycoinsecticide

- **Mycotrol® ESO***
  (GHA Strain) made by BioWorks
  - Organic Version of BotaniGard ES
  - 11.3% (2 x 10^{13} spores per quart)

- **balEnce**
  - Diptera-specific strain
  - Strain HF23...1.12% (5.6 x 10^{9} cfu/ml)

Methods and Materials (con't)

- Insects were **reared** in test tubes with 1 Tbs *Drosophila* media, 1.5 Tbs Distilled Water, and 0.5 tsp Active Dry Yeast at 23° C for up to 14 days.

- F2 Adults were removed for experimentation at or before 24 hours of pupal eclosion. **Healthy adults were selected** at random for experimentation after removal from colonies.

- **Washed and dried blueberries were sprayed** at highest labeled rates **(Mycotrol O=2 qt/A, BalEnce=1 qt/A)**. Using airbrush at 20 psi air pressure, sprayed until point of drip on surface of fruit.

- Berries **allowed 2 hours to dry** under fume hood (reentry interval of both materials).

- 25 random male SWD and 25 random females SWD removed from colony and introduced to berries (**50 flies/treatment/rep**.).

Methods and Materials (con't)

- At **48 hours, insects removed** and **eggs were counted**. Live insects were counted and placed in isolation. **All dead insects separated into isolation to observe potential fungal growth.**

- **Isolation chambers** kept at 23° C and 100% humidity to encourage visible fungal growth.

- **After 10 days, insects examined for *B. bassiana,* positive ID's attained through spore microscopy.**

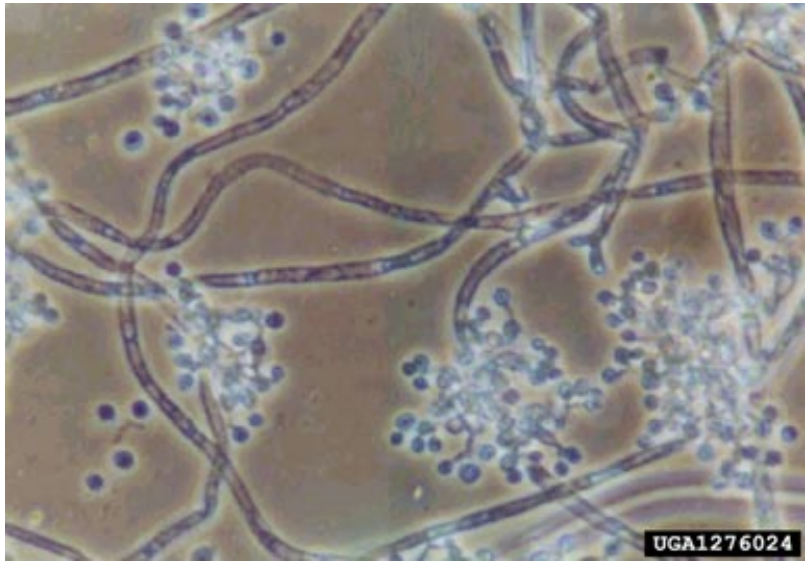


Photo: Svetlana Y. Gouli, University of Vermont, Bugwood.org

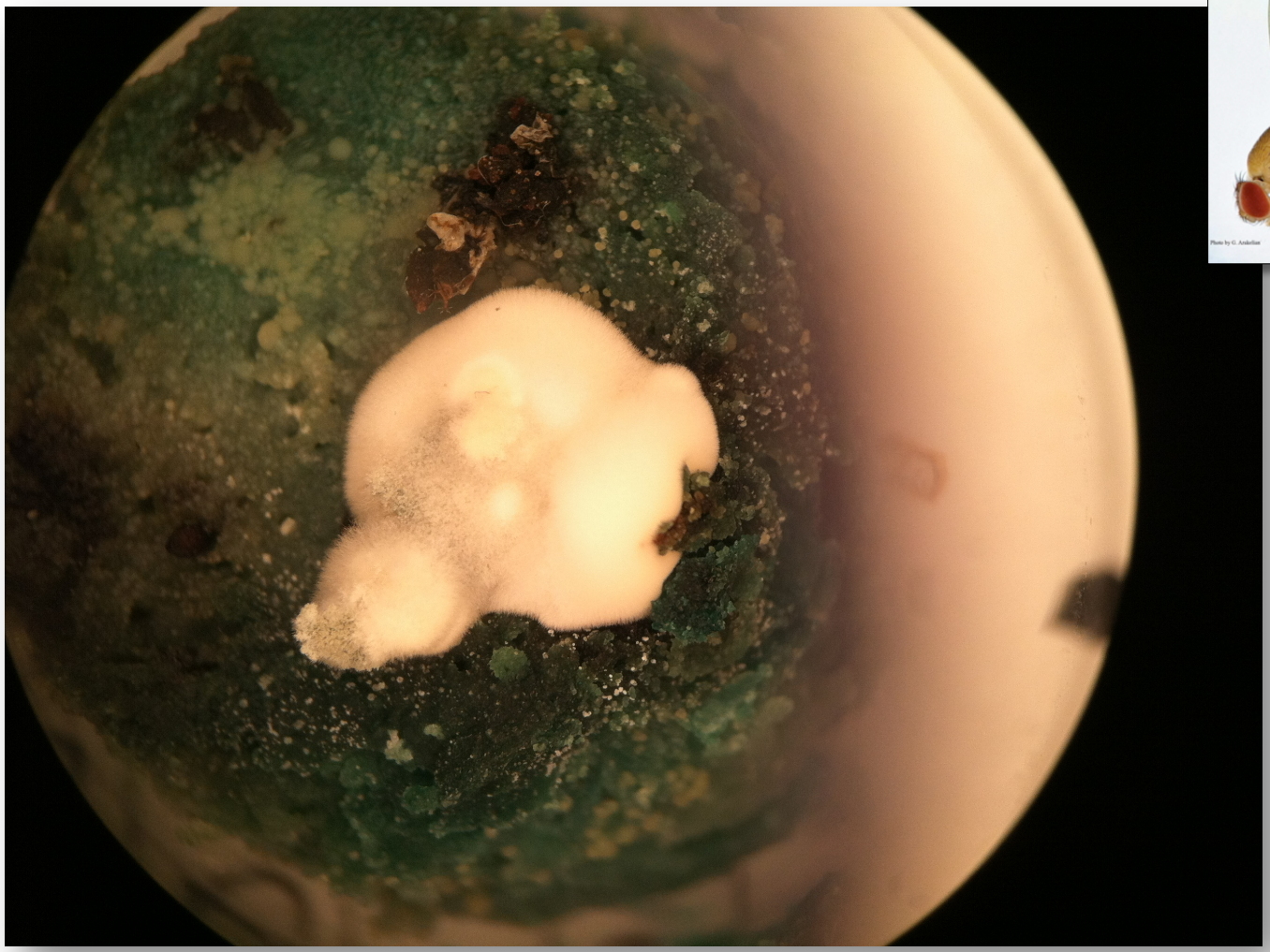
Mycotrol-O mycopesticide. (*Beauveria bassiana)* to control *D. suzukii* adults

Advanced stage of fungal growth (~10 days of exposure). Most of the spores have already detached.

Mycotrol-O mycopesticide. (*Beauveria bassiana)* to control *D. suzukii* adults

Recently deceased SWD adult (~5 days of exposure). Signs of fungal growth present on head (around antennae) and abdomen.

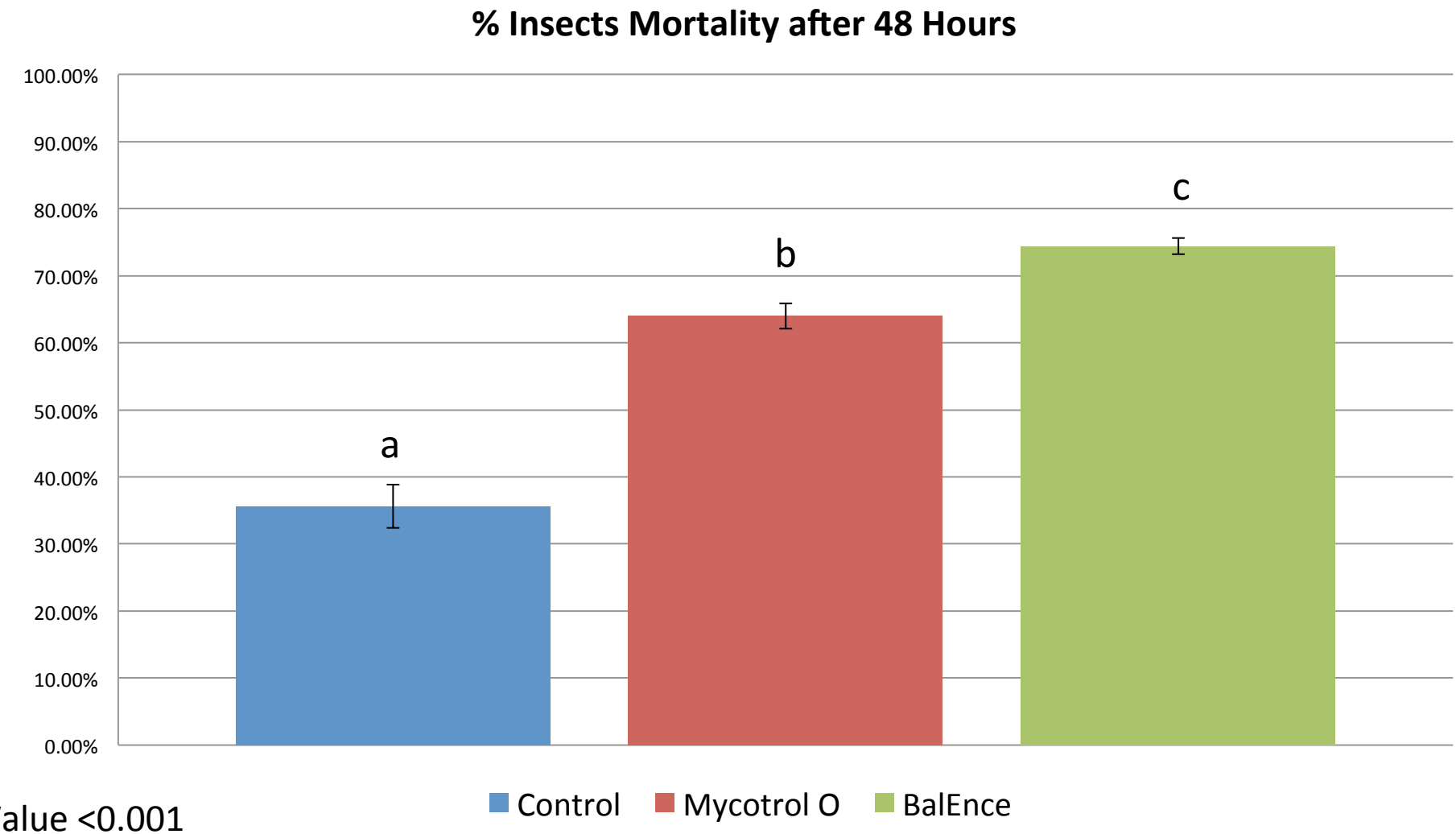
(*Beauveria bassiana)* Infesting *D. suzukii* larvae



Advanced stage of fungal growth (~10 days of exposure) completely engulfing a cluster of 3rd instar Larvae.

Beauveria bassiana to manage D. suzukii larvae

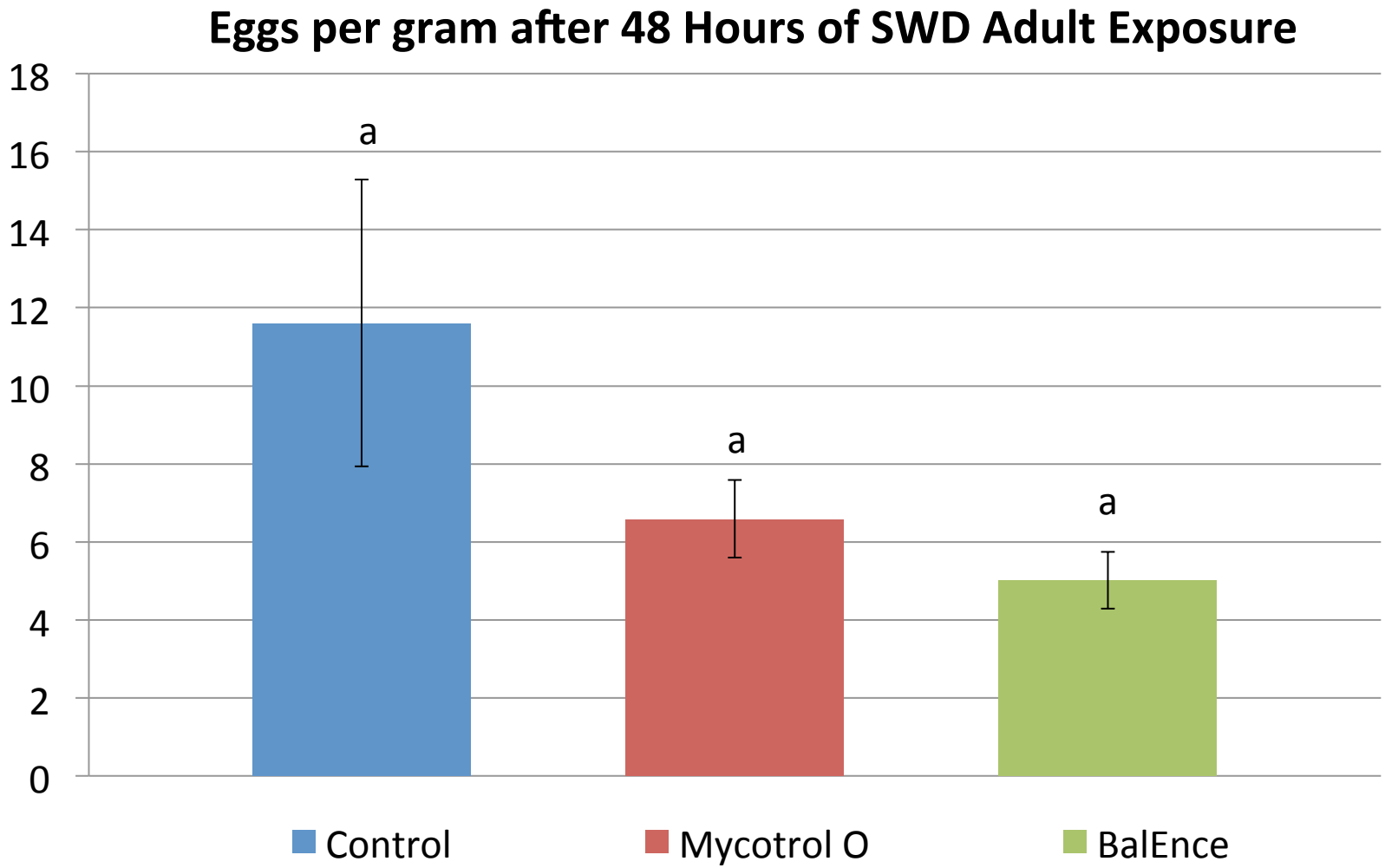
Results: Significant increase in **mortality of adults on treated berries** compared to untreated check. BalEnce provided higher mortality when compared to Mycotrol O.



P Value <0.001

Beauveria bassiana to manage D. suzukii larvae

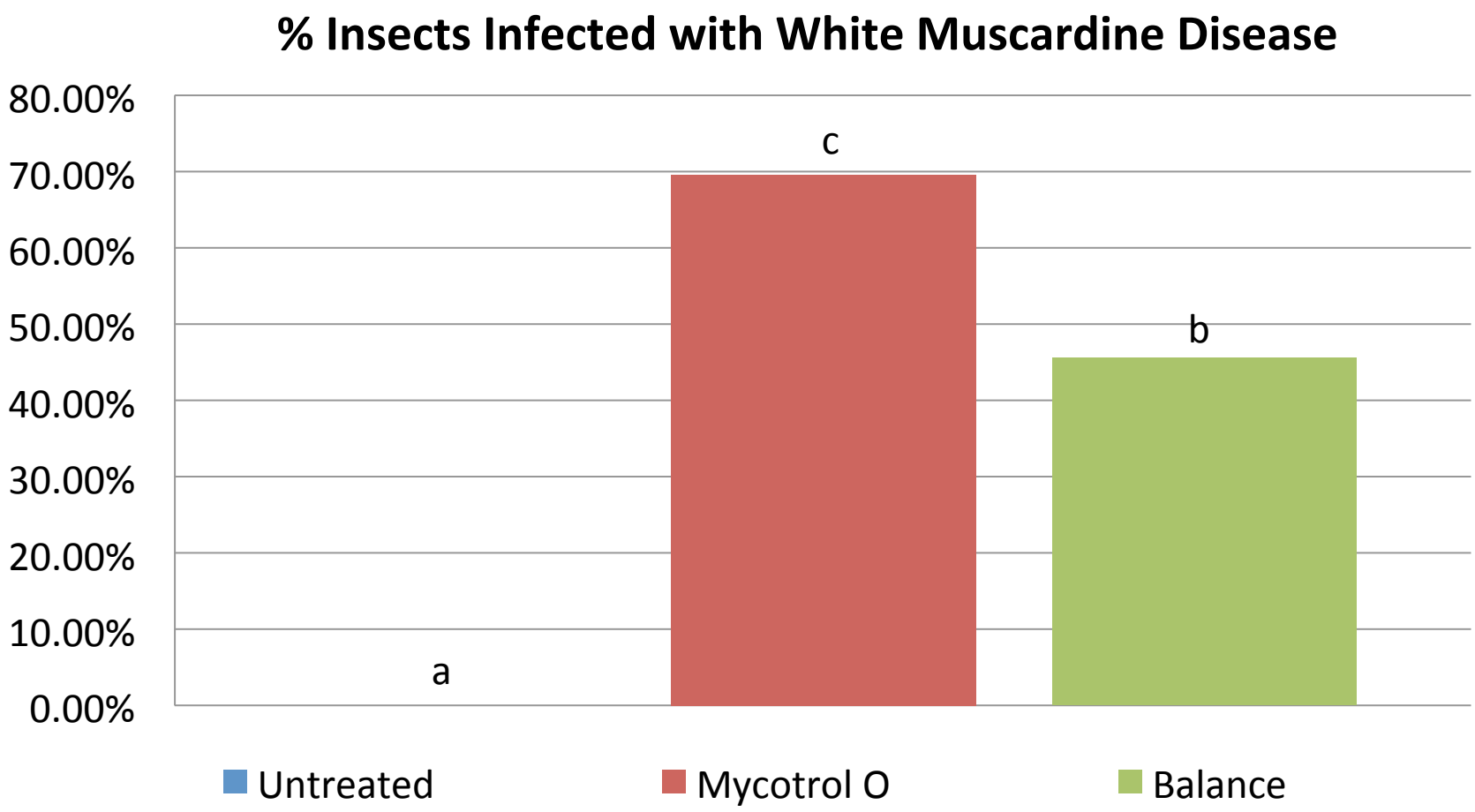
Results: Numeric decrease in ovipostional activity (NS).



P Value 0.1687

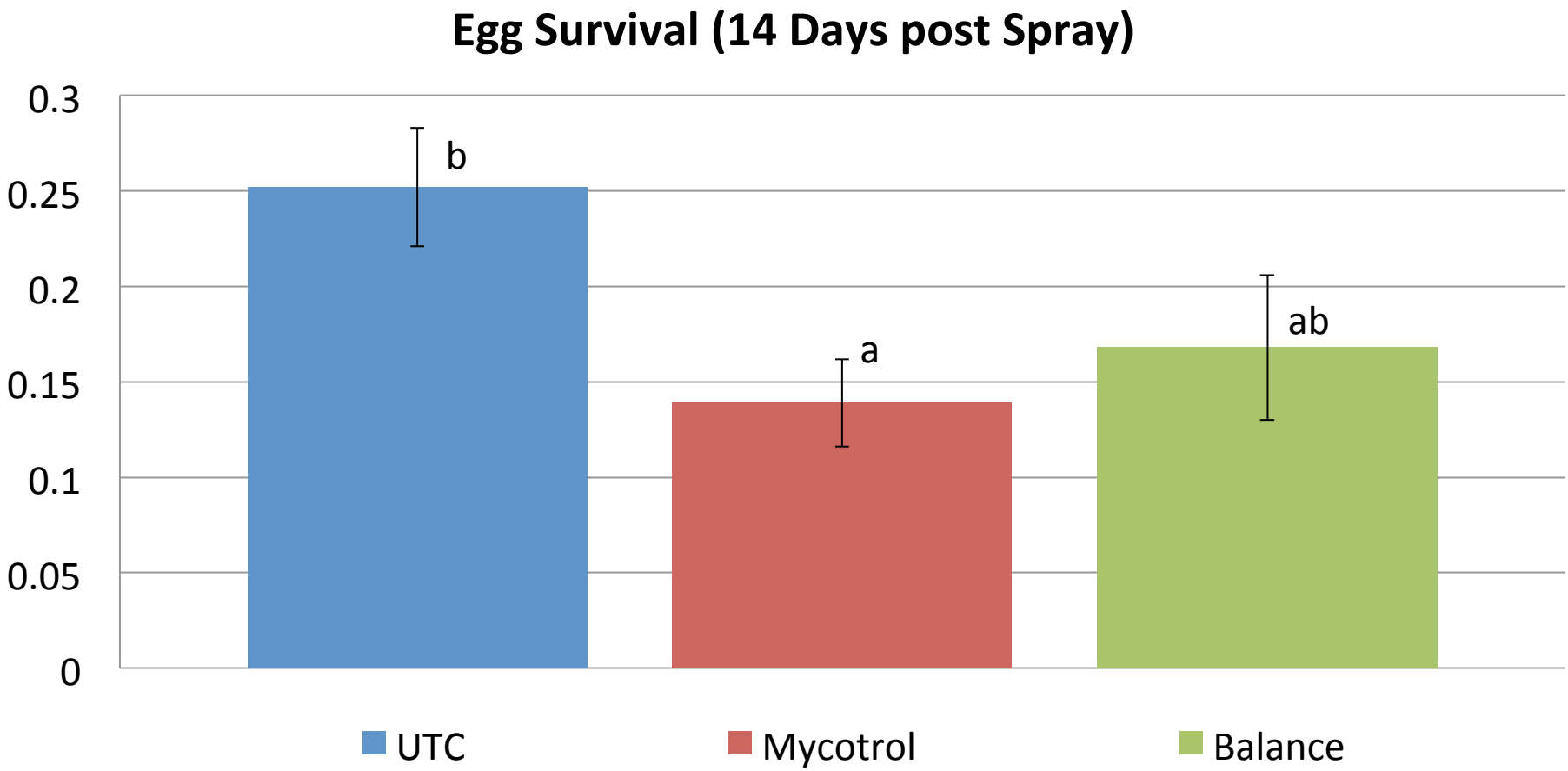
Beauveria bassiana to manage D. suzukii larvae

Results: SWD larva exposed to *B. bassiana* developed disease significantly more than untreated check. Mycotrol O appeared more virulent.



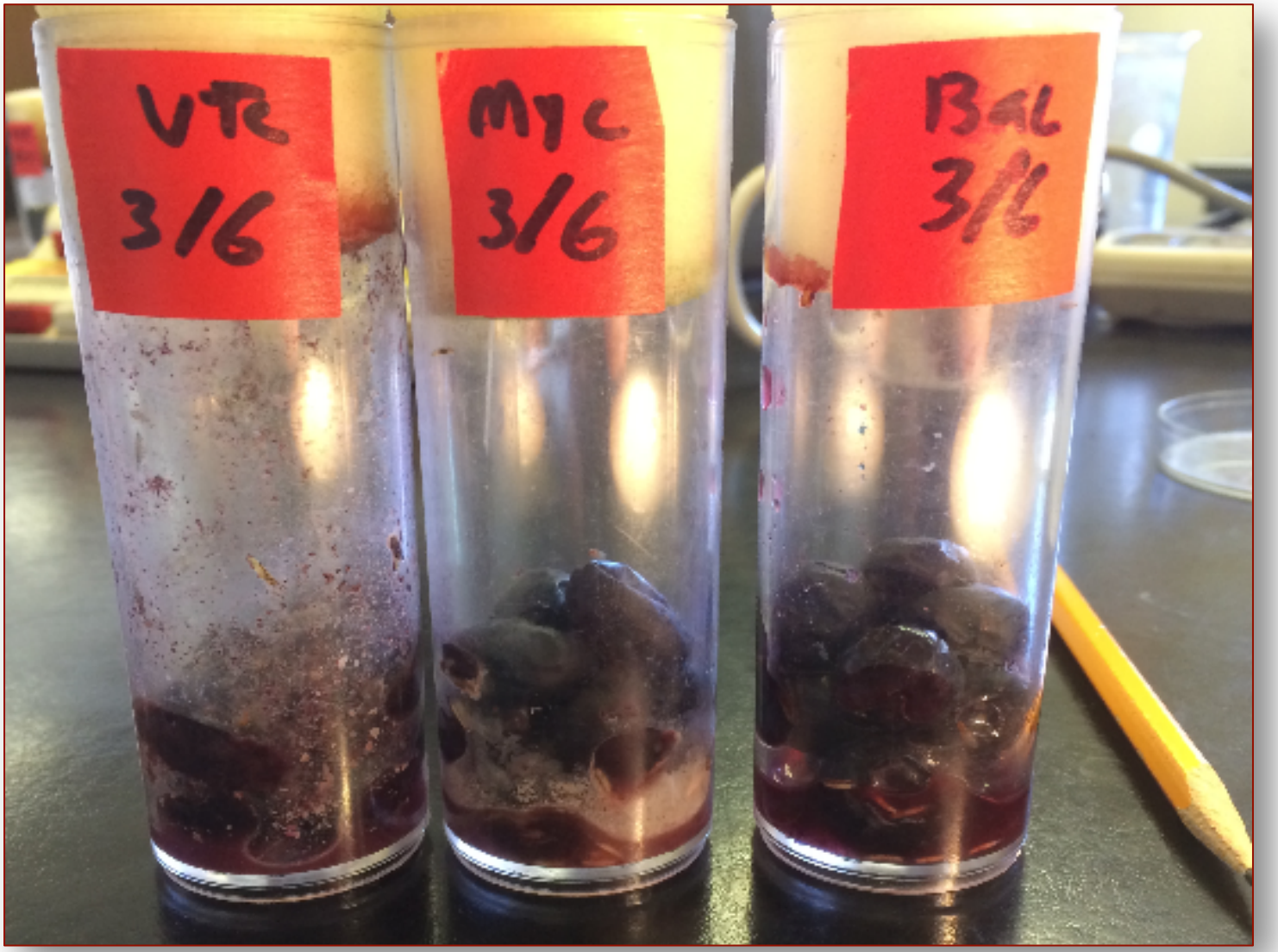
Beauveria bassiana to manage D. suzukii larvae

Results: Eggs laid in berries exposed to *B. bassiana* were somewhat less likely to mature to adulthood than those laid in untreated berries



Data transformed prior to ANOVA from percentages. P Value: 0.07

Breakdown of Untreated (UTC) Fruit at 14 d. relative to *B. bassiana* treated fruit



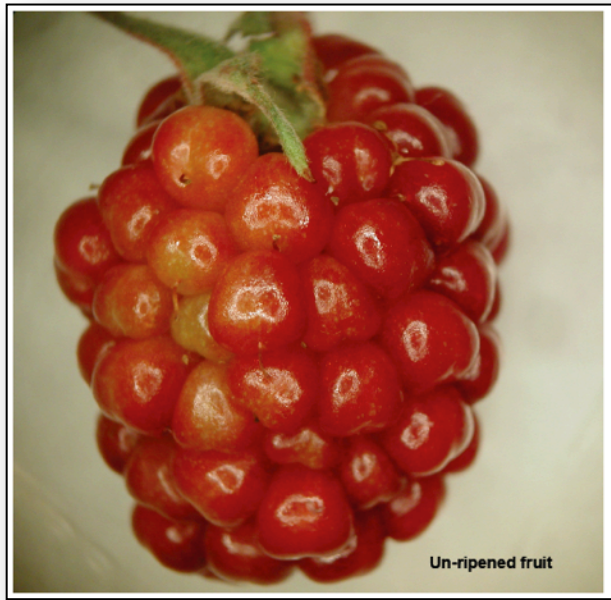
Conclusions

- Both *B. bassiana* formulations cause mortality within 48hrs.
.
- Neither formulation works quickly enough to decrease egg-laying significantly.
- Insects exposed to Mycotrol O appear to express mature *B. bassiana* more readily than those exposed to BalEnce.
- Eggs that are laid on *B. bassiana* exposed berries are less likely to mature.

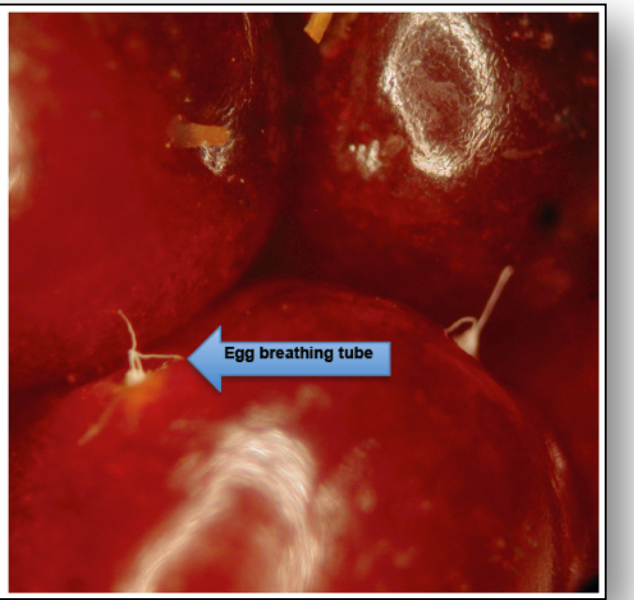
Spotted Wing Drosophila

Post Harvest Study: Control of SWD After Harvest

SWD Adult Male



Infected Blackberry



Fruit Fly Egg 'Respitory Horns'

2016 Hudson Valley Commercial Fruit Growers' School

Best Western Plus

Kingston, NY

February 12th, 2016

Peter Jentsch

Senior Extension Associate – Entomology

Post Harvest Study:
Control of SWD In Raspberry After Harvest

Post Harvest Small Fruit Storage:

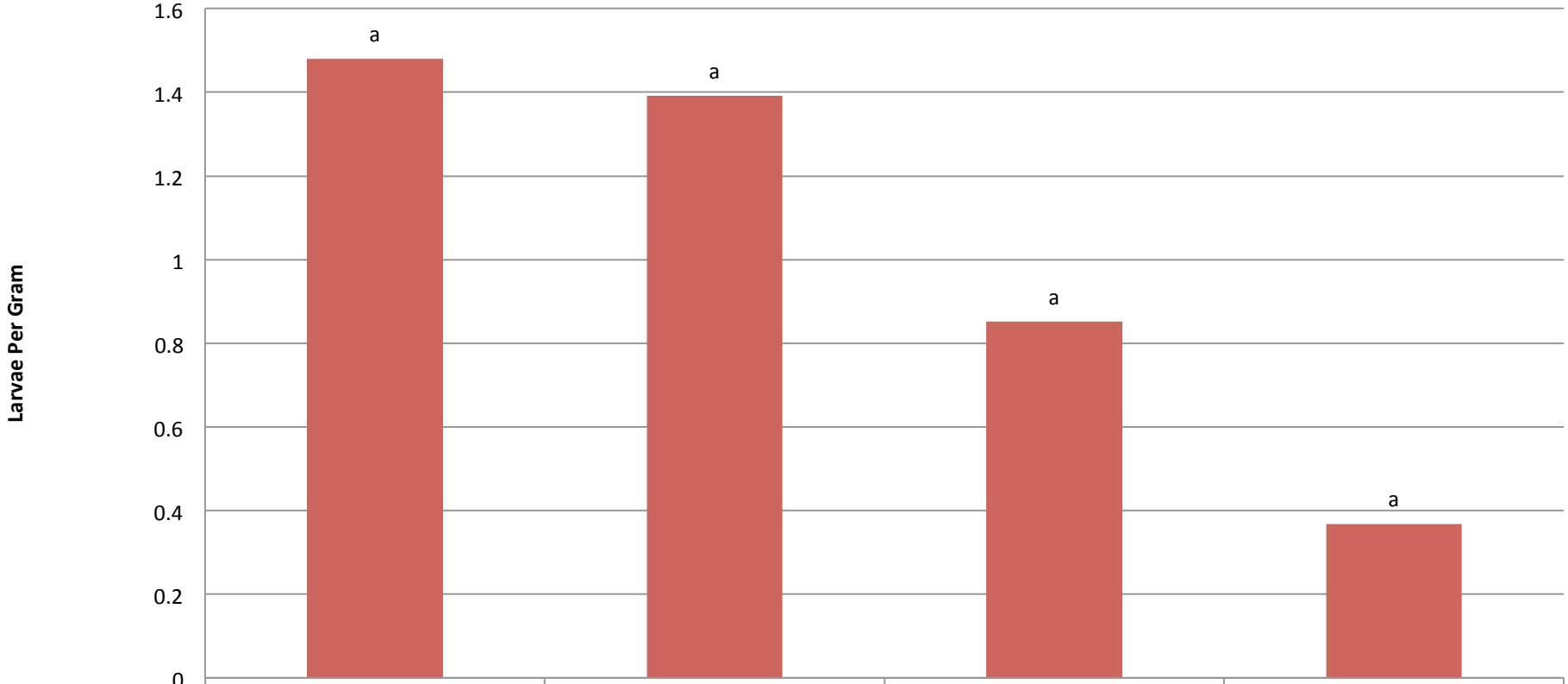
- Larva survival in fruit is temperature dependent.
- Low temperature can reduce post-harvest impact of larval survivability in raspberry.
- Fruit exposed to temperatures at 34F and 38F for 72 hours showed significant impact on larval surviversship.
- Infested commercially grown fruit should be placed at 34F prior to sale to provide nearly 100% larva mortality.

Post Harvest Use of Horticutural Oil Drench

- A 1% horticutural oil fruit immersion drench for 5 to 10 minutes reduces SWD surviversship, providing larva mortality.

Post Harvest Study:
Control of SWD In Raspberry After Harvest

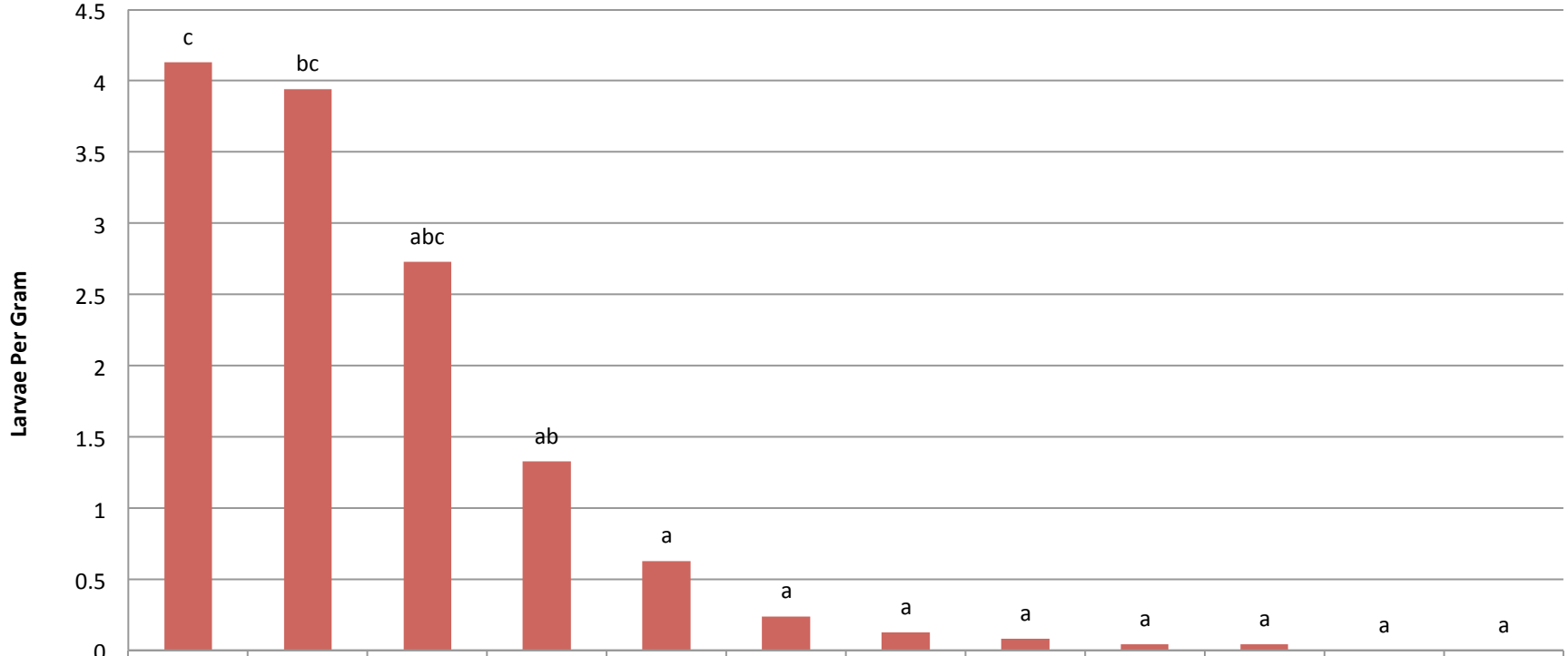
Evaluating 1% Oil Immersion of Raspberry on SWD Larva Survival



	UTC	Oil 1 min	Oil 5 Min	Oil 10 Min
Larvae Per Gram	1.48	1.391	0.852	0.368

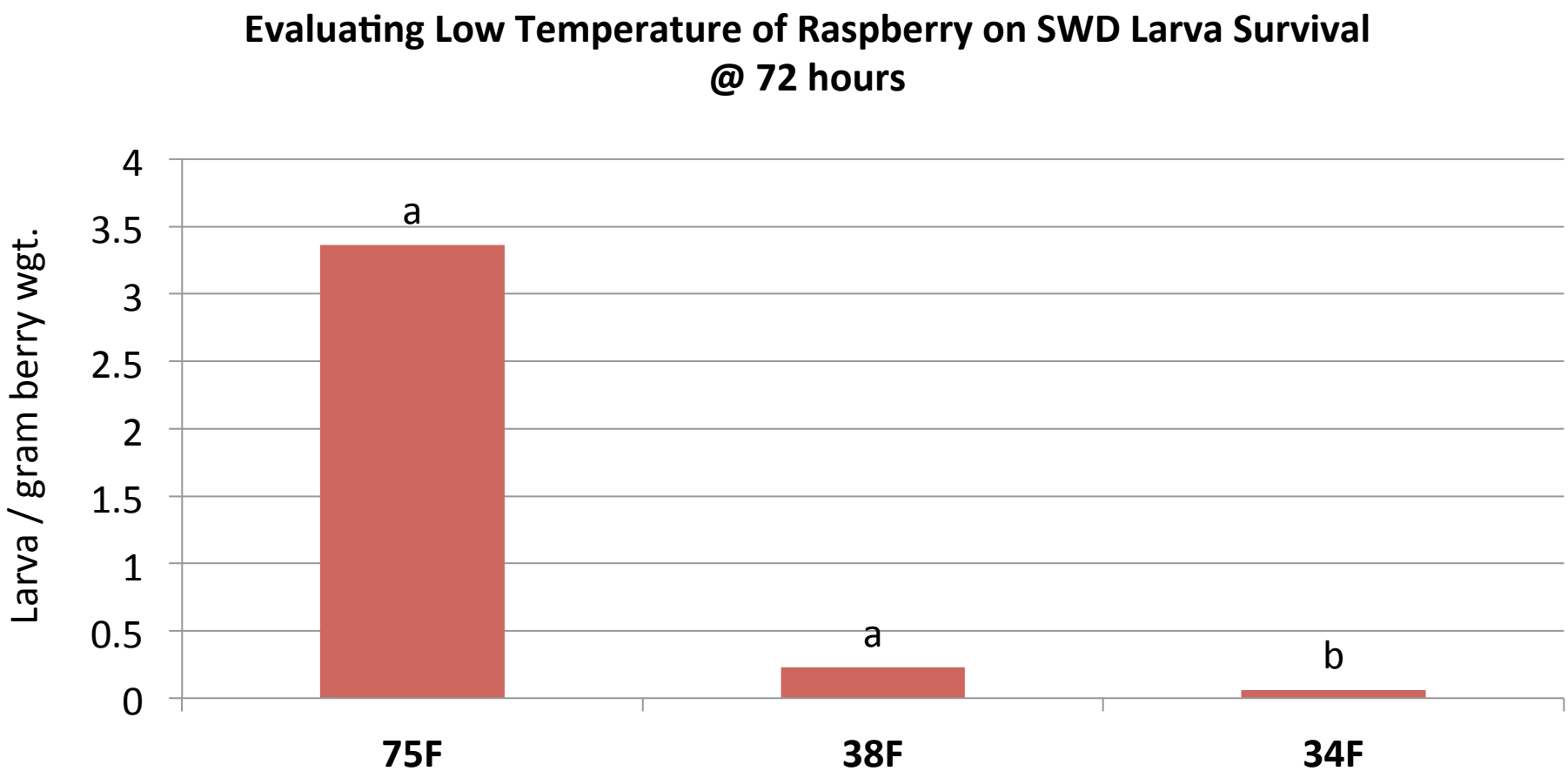
Post Harvest Study:
Control of SWD In Raspberry After Harvest

Evaluating Low Temperature & 1% Oil Immersion of Raspberry on SWD Larva Survival



	Oil 1 min Room Temp	UTC Room Temp	Oil 5 Min Room Temp	Oil 10 Min Room Temp	UTC 38 F	Oil 1 min 38 F	UTC 34 F	Oil 1 min 34 F	Oil 5 Min 38 F	Oil 5 Min 34 F	Oil 10 Min 38 F	Oil 10 Min 34 F
Larvae Per Gram	4.128	3.942	2.727	1.325	0.627	0.24	0.125	0.083	0.043	0.043	0	0

Post Harvest Study:
Control of SWD In Raspberry After Harvest



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Conclusions:

- Larval survival in fruit is temperature dependent.
- Low temperature (34-37°F) had significant impact on larval survivability in raspberry
- Temperatures at 34F for 72 hours showed significant impact on larval surviversship.
- SWD damaged berries exposed to a immersion in 1% horticultural oil showed reduced surviversship at 5 and 10 minutes.
- A 10 min. immersion in 1% oil, held at 34F & 38F for 72 hrs. provided 100% larval mortality.