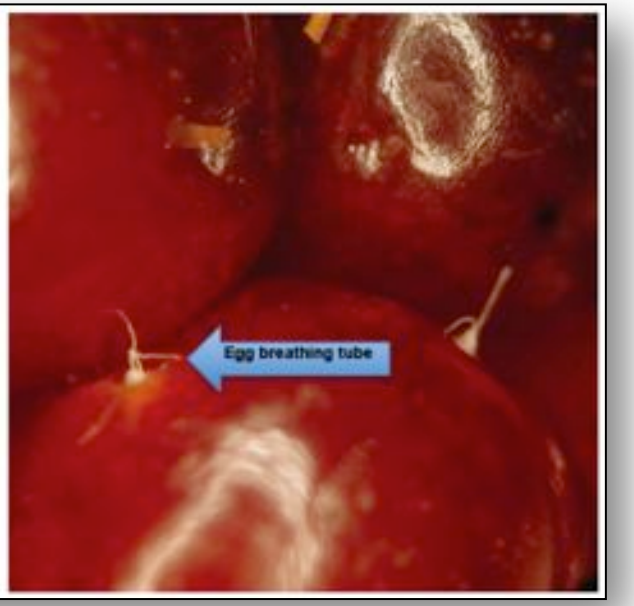
Spotted Wing Drosophila

SWD Adult Male

Infected Blackberry



Fruit Fly Egg 'Respitory Horns'

589th Meeting of the New England Vegetable and Berry Growers' Association
And New England Cooperative Extension
Saturday, January 31, 2015
Hudson Lodge of Elks, Hudson, MA

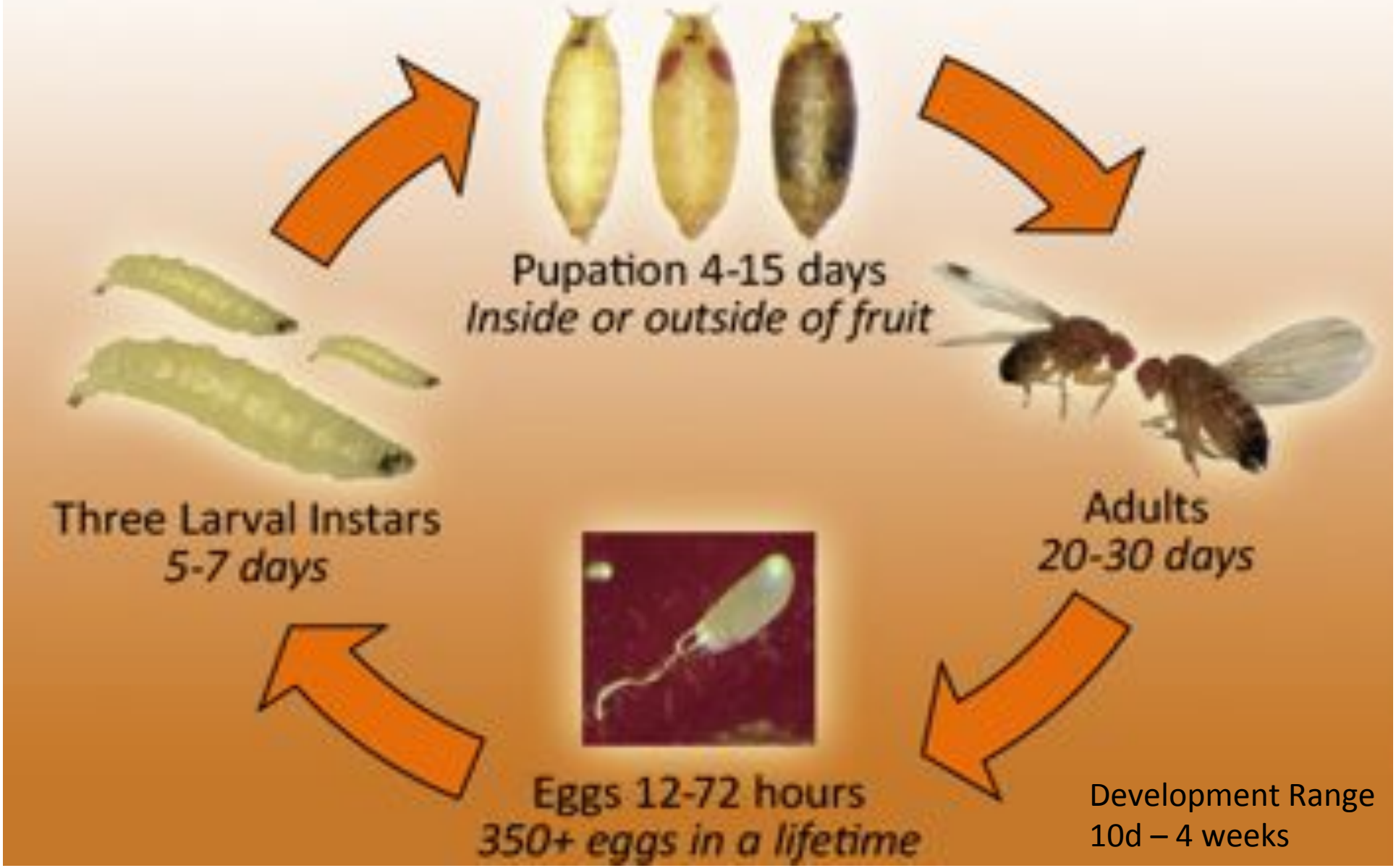
Peter Jentsch
Senior Extension Associate – Entomology

Cornell University
College of Agriculture and Life Sciences

Hudson Valley Research Laboratory

Life Cycle of the Spotted Wing Drosophila

Drosophila suzukii (Matsumura)



Development Range
10d – 4 weeks

Female Drosophila species

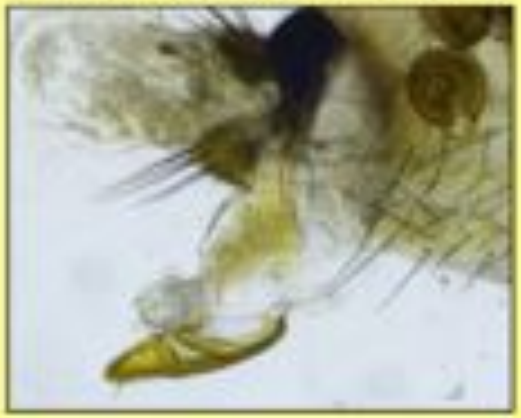
UC Berkeley & UC Cooperative Extension *Photos:* M. Hauser, CDFA

Spotted Wing Drosophila (D. suzukii)

SWD has a large, saw-like, serrated ovipositor with two even rows of teeth that are much darker than rest of ovipositor

Other Drosophila spp.

have smaller, more rounded ovipositors, sometimes with irregular, poorly defined teeth



Male Spotted Wing Drosophila (SWD)

UC Berkeley & UC Cooperative Extension

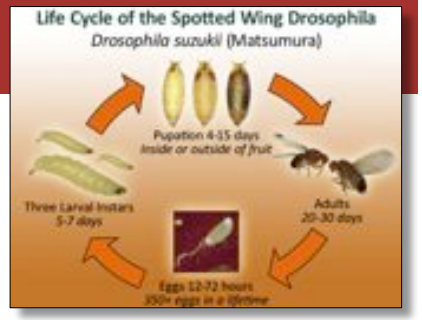
Photos: M. Hauser, CDFA

Double stripes on tarsi of front legs

Leading edge of wing has dark spot

Unbroken abdominal bands

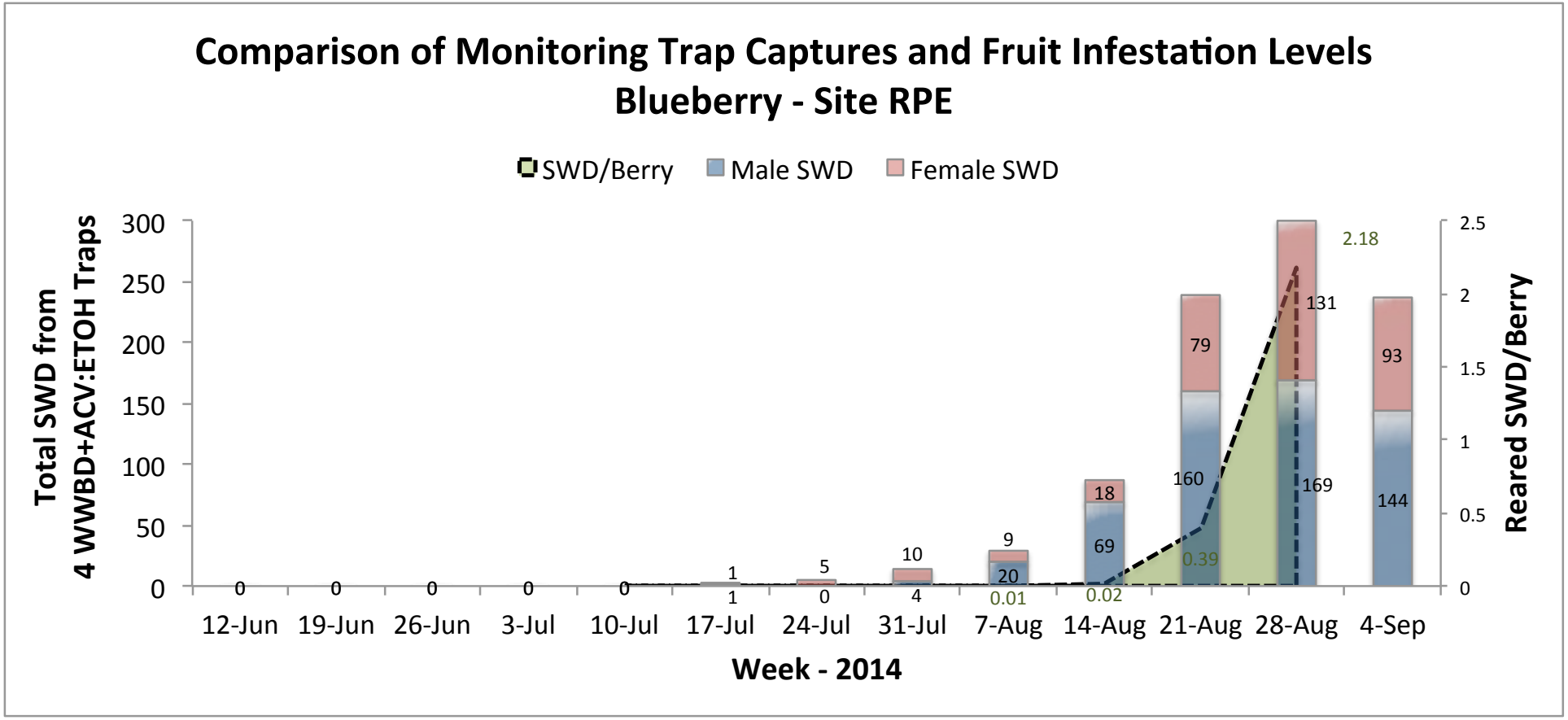
Factors Contributing to Insecticide Resistance



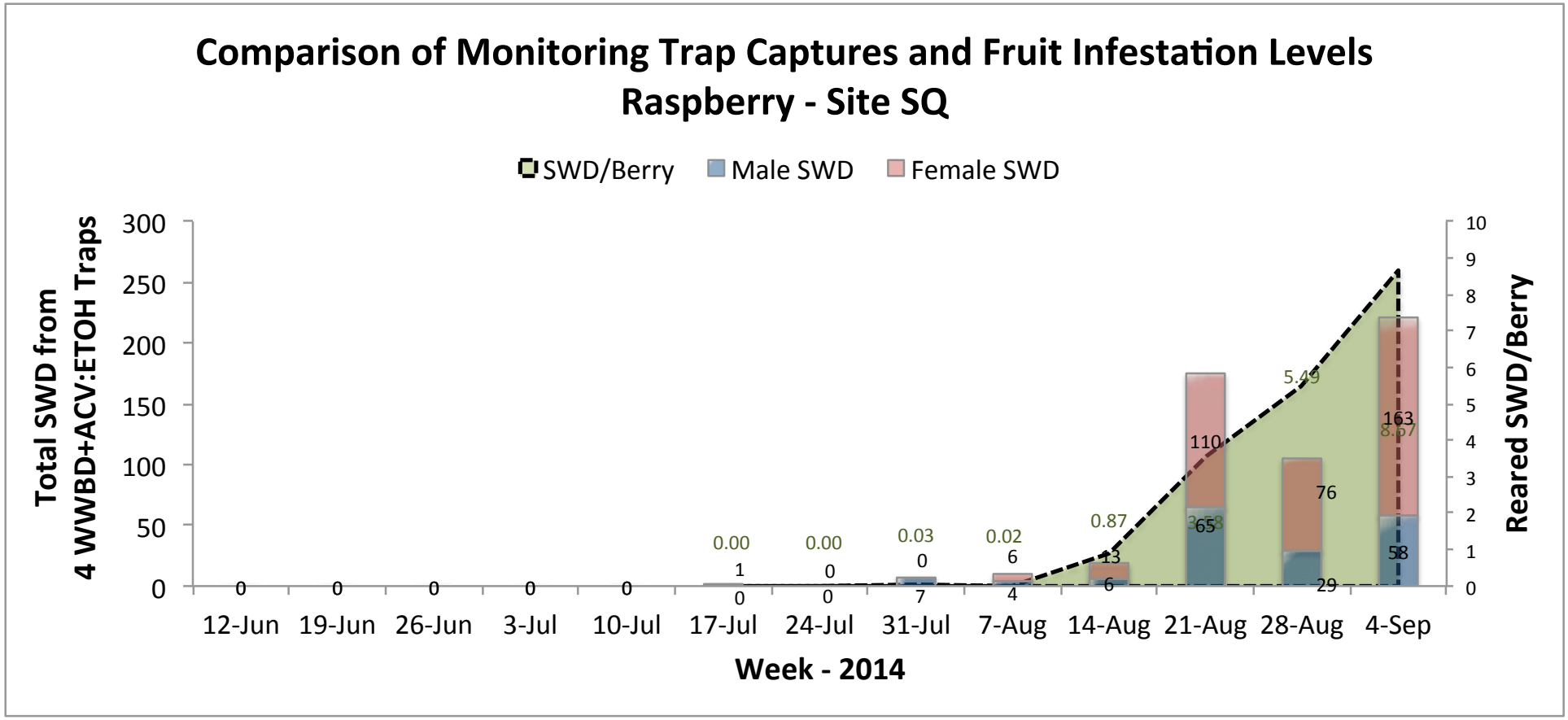
- **Single cycle in 10d to 4 weeks**
- **13 generations / year (Japan)**
- **Range of 3-10 generations in NY**
- **SWD has a very high probability of insecticide resistance development.**

Monitoring

- **Whole wheat bread dough (fermenting bait)**
  -water, sugar, yeast, whole wheat, apple cider vinegar (ACV)
  -drowning solution of ACV

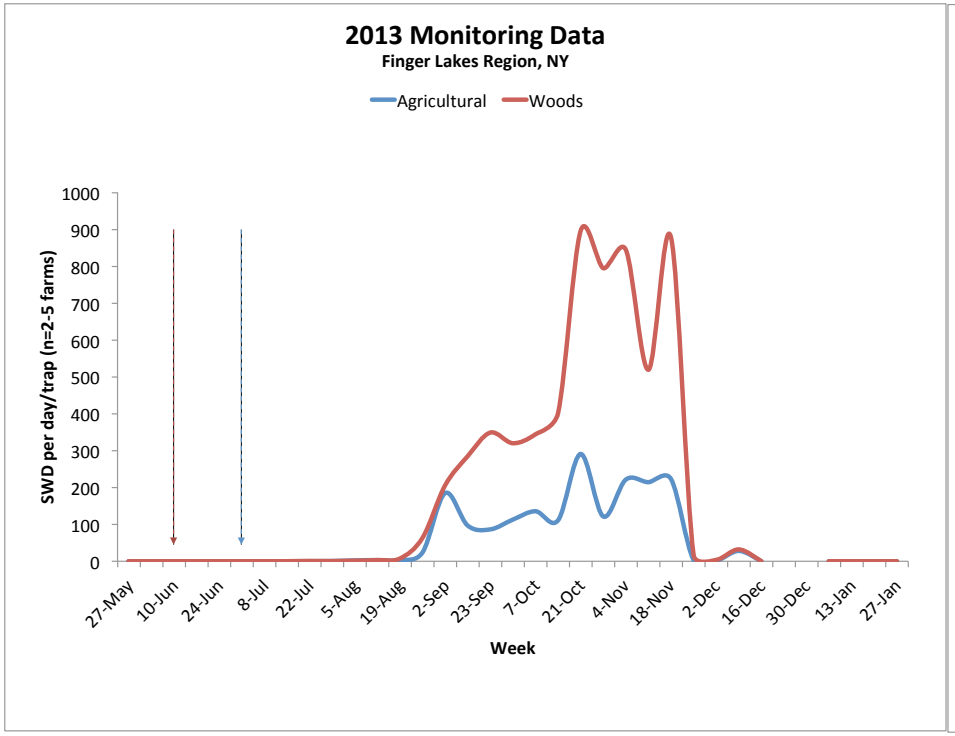


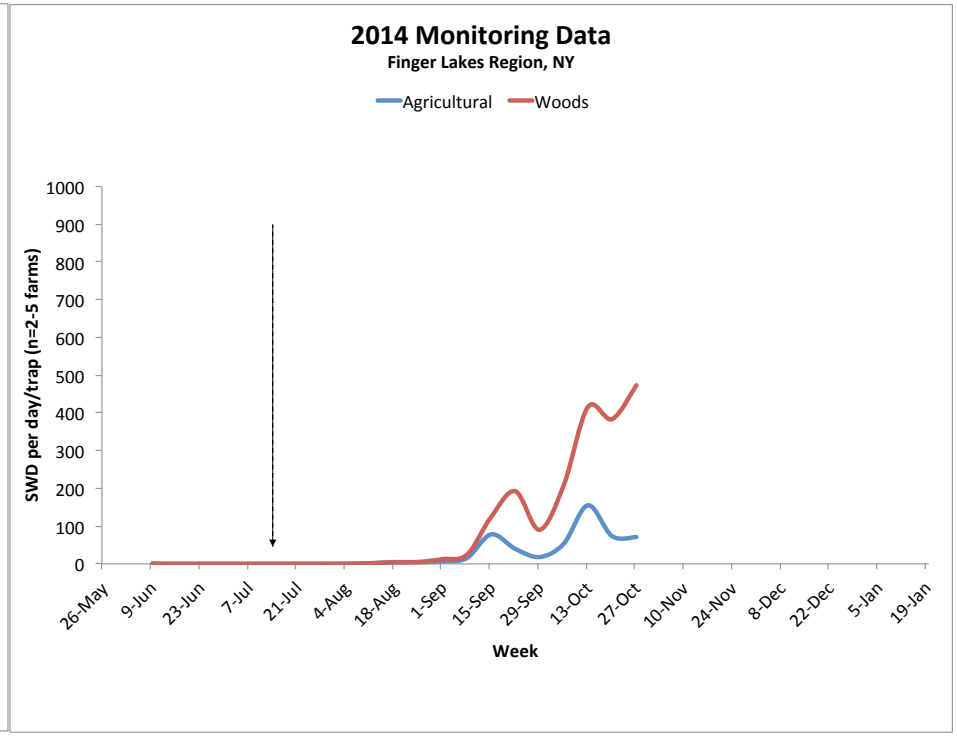
Credit: Greg Loeb Lab, NYSAES Geneva, NY



Credit: Greg Loeb Lab, NYSAES Geneva, NY

SWD SEASONAL DYNAMICS IN THE NORTHEAST





Credit: Greg Loeb Lab, NYSAES Geneva, NY

CLASSES OF SWD INSECTICIDES

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

***Just received EPA label for blueberries, not raspberries**

Credit: Greg Loeb Lab, NYSAES Geneva, NY

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

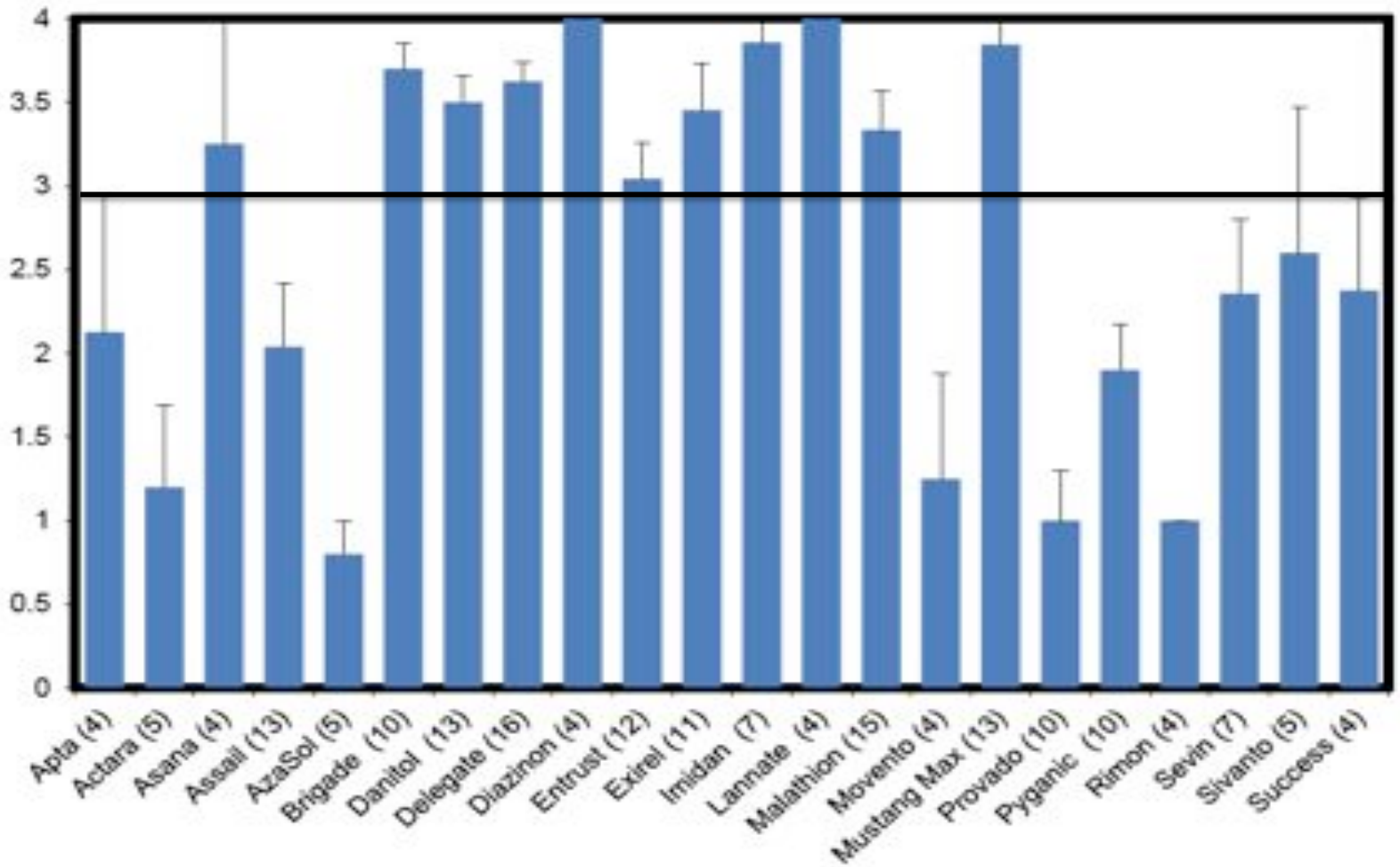
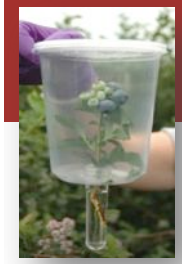
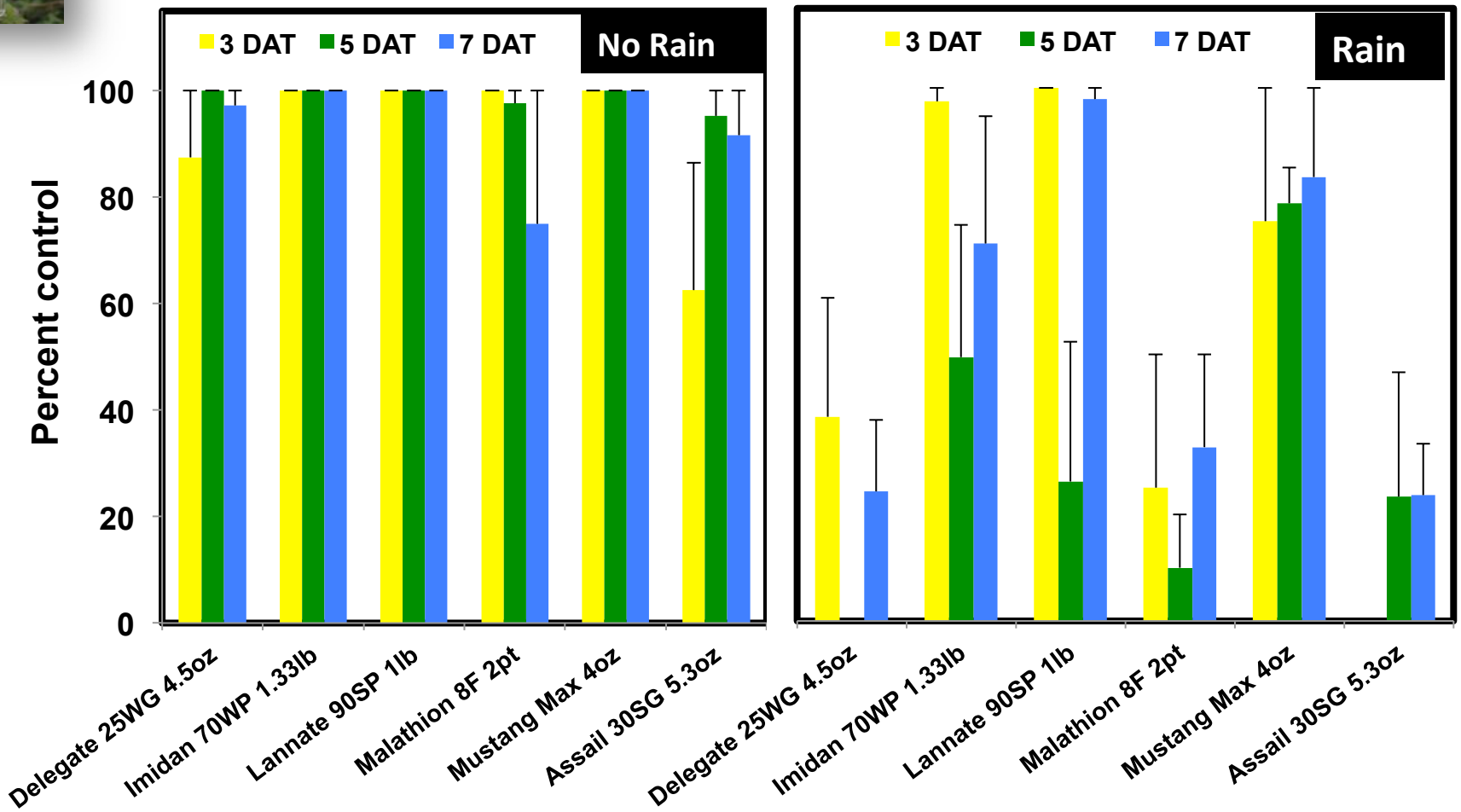


Figure 1. Average ± S.E. efficacy rankings for 22 insecticides that have been tested against SWD in various fruit crops. Insecticides were ranked as not effective (score = 0), weakly active (1), fair (2), good (3), or excellent (4). Only insecticides that had 4 or more submitted are included in the figure,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

Effect of Rain on Some Common Insecticides

From Rufus Isaacs, MSU

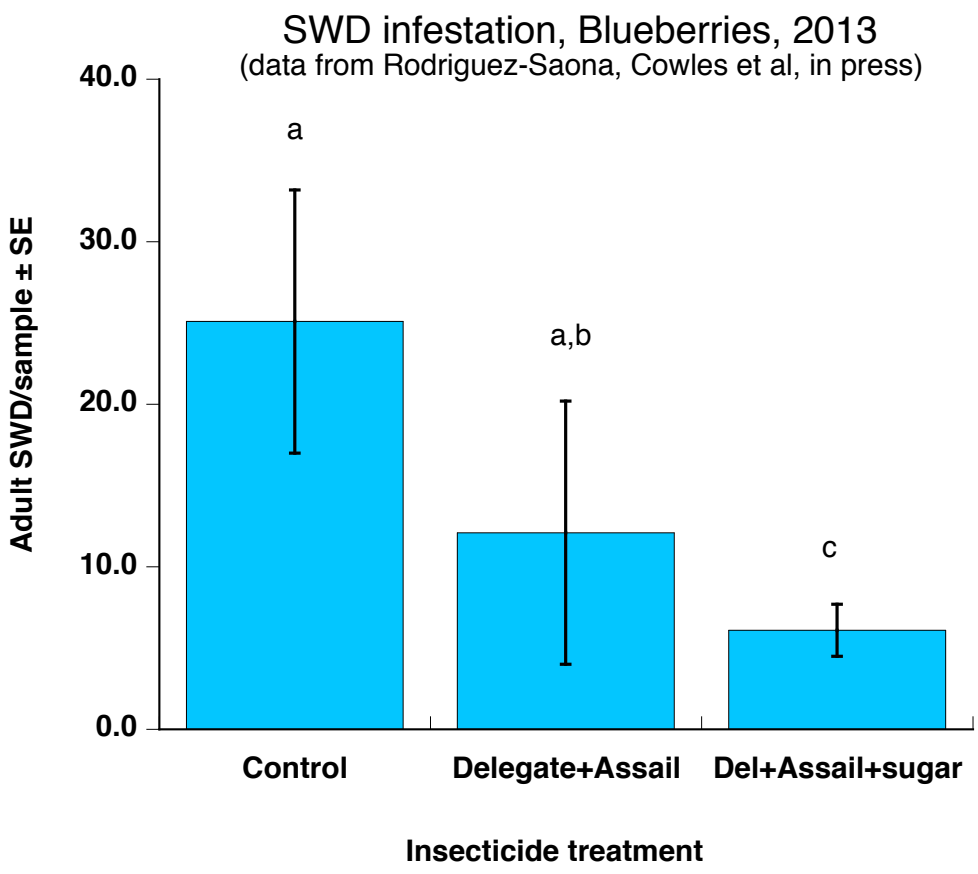




0.8 inches of rain on treated bushes
1 day after application

MICHIGAN STATE UNIVERSITY

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

SUMMARY

- Insecticides are presently the primary method of control for SWD
- Consider rotating insecticide IRAC classes every 10-14 days to maintain insecticide susceptibility
- Consider the weather forcasts and insecticide to maintain residual activity
- Sugar may increases efficacy of some insecticides

Post Harvest Study:
Control of SWD After Harvest

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Senior Extension Associate – Entomology

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College of Agriculture and Life Sciences

Hudson Valley Research Laboratory

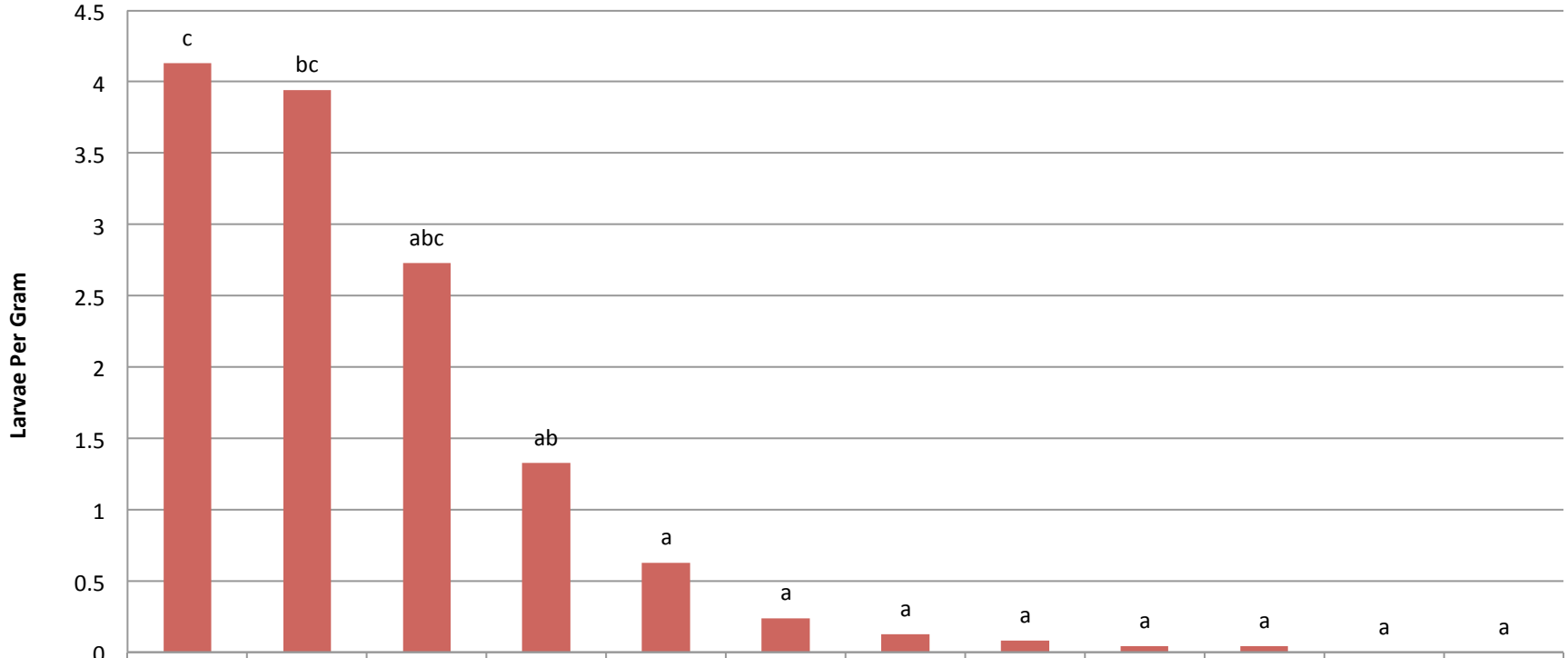
Post Harvest Study:
Control of SWD In Raspberry After Harvest

Larval survival in fruit is temperature dependent.

- Low temperature can reduce the post-harvest impact of larval survivability in raspberry
- Fruit exposed to temperatures at 34F and 38F for 72 hours showed significant impact on larval survivership.
- Use of 1% horticutural oil showed reduced survivership when fruit is immersed for 5 and 10 minutes with fruit held at 34F & 38F for 72 hrs. providing nearly 100% larval mortality.

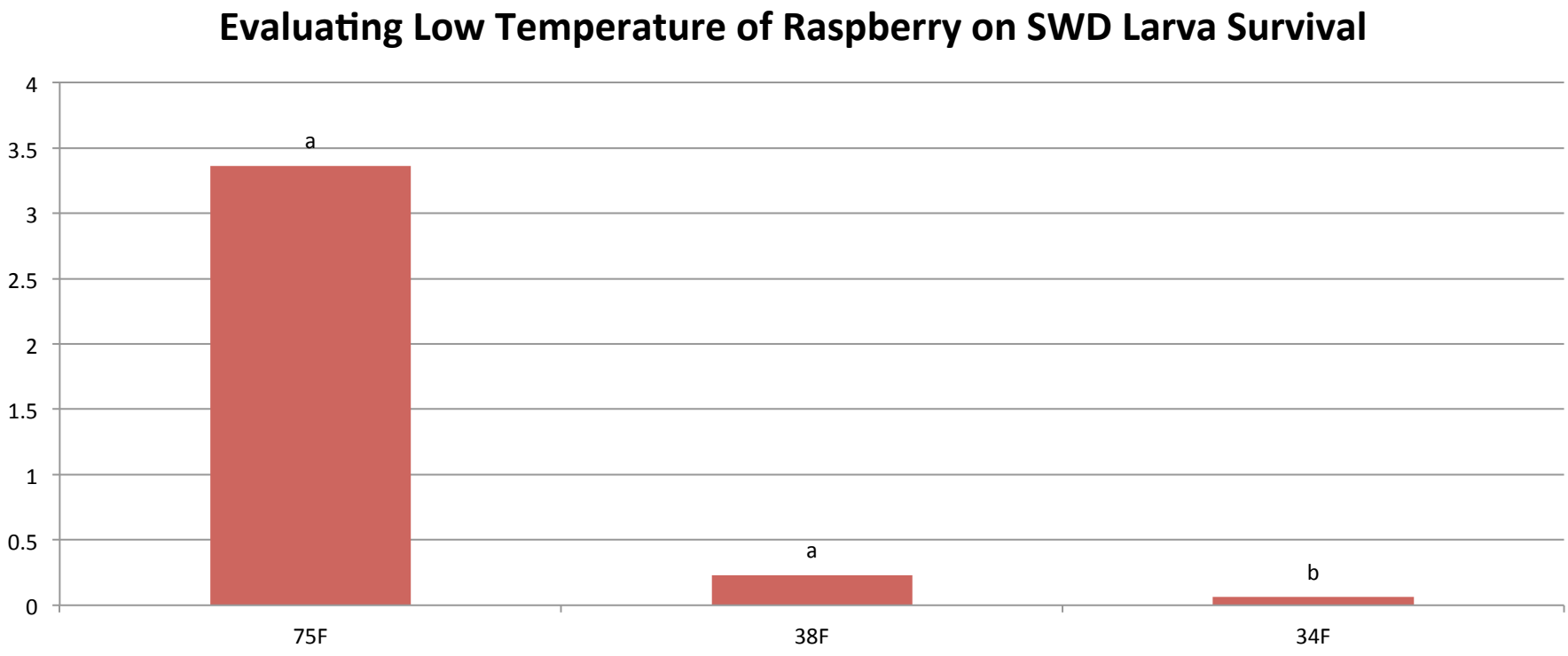
Post Harvest Study:
Control of SWD In Raspberry After Harvest

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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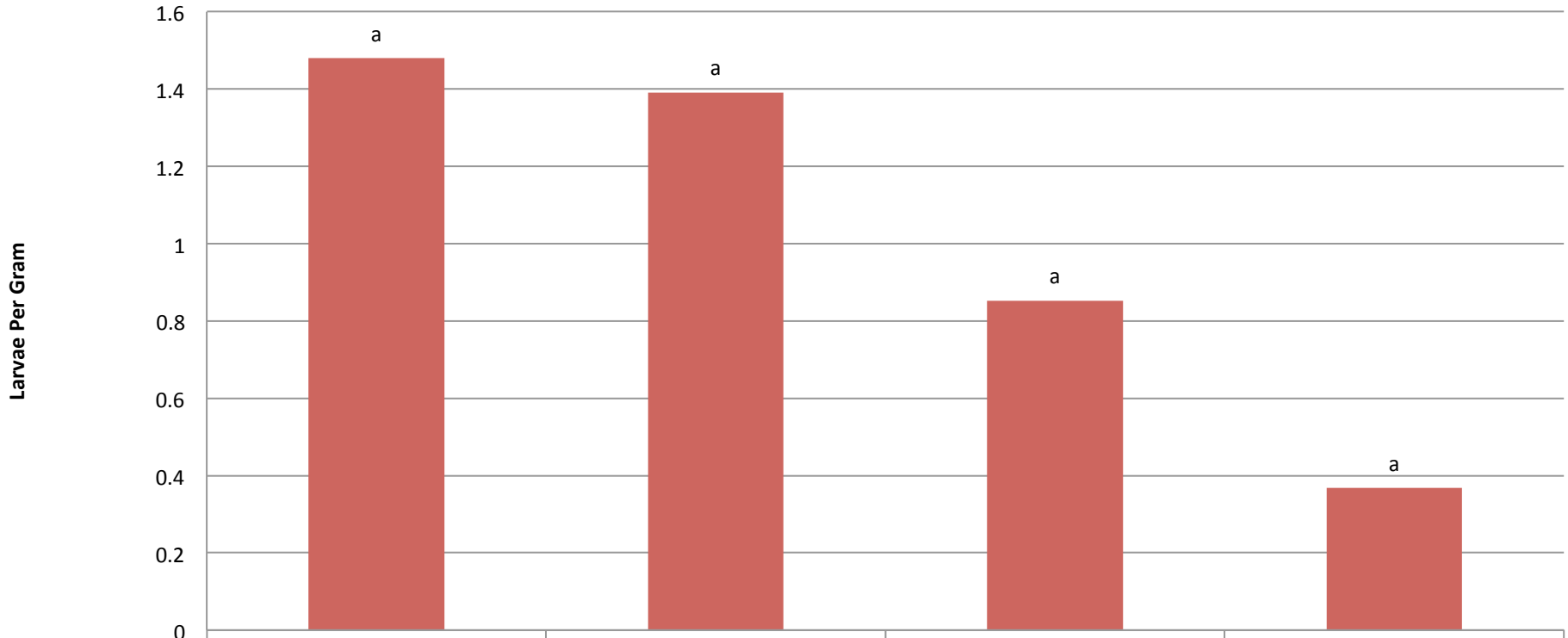
Post Harvest Study:
Control of SWD In Raspberry After Harvest

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

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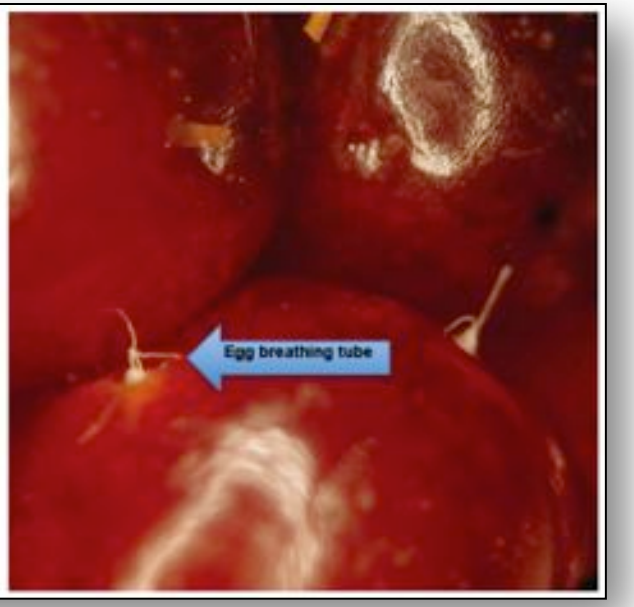
Post Harvest Study:
Control of SWD In Raspberry After Harvest

Conclusions:

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

Managing Insecticide Resistance: Program Rotation Considerations



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Managing Insecticide Resistance: Program Rotation Considerations

- Potential for SWD to Develop Resistance to Insecticides
- Classes of NYS Labeled Insecticides for SWD
- Rotation of Insecticide Classes: Examples

Managing Insecticide Resistance: Program Rotation Considerations

Insecticide Resistance or **Pesticide resistance** is a decrease in susceptibility of a pest population to a pesticide that was previously effective at controlling the pest.

The failure of a product to perform in a real situation, referred to as **field resistance**. Resistance occurs through **natural selection**: resistant organisms survive and pass on their genetic traits to their offspring.

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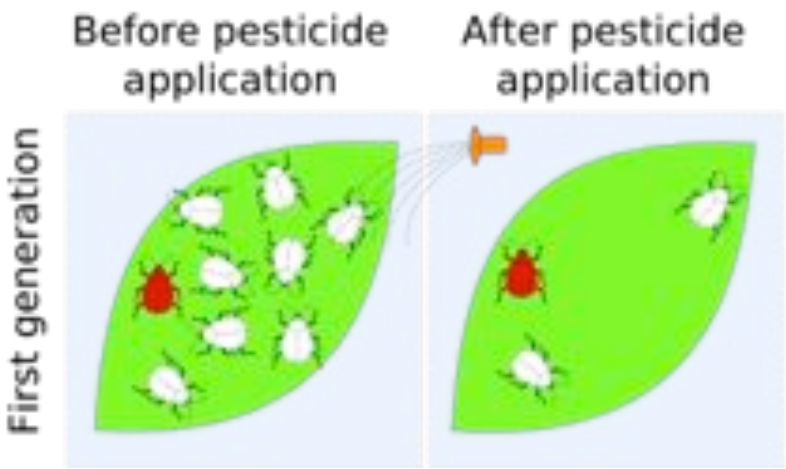

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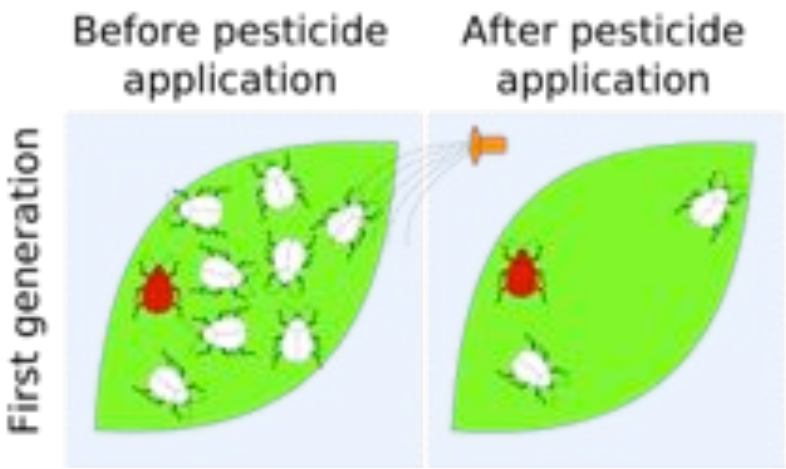
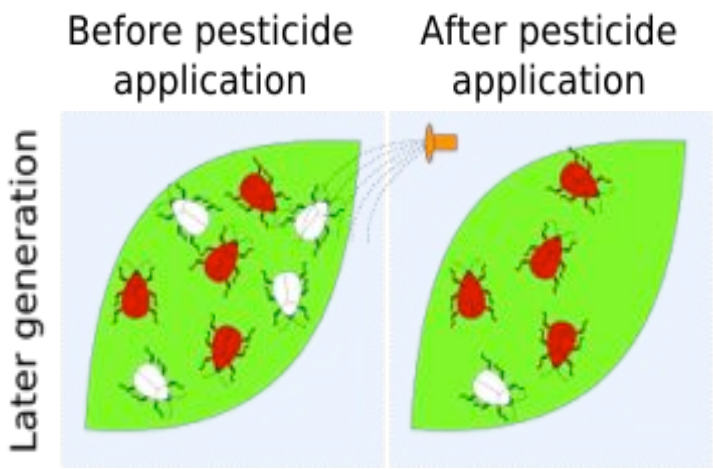




Factors Contributing to Insecticide Resistance

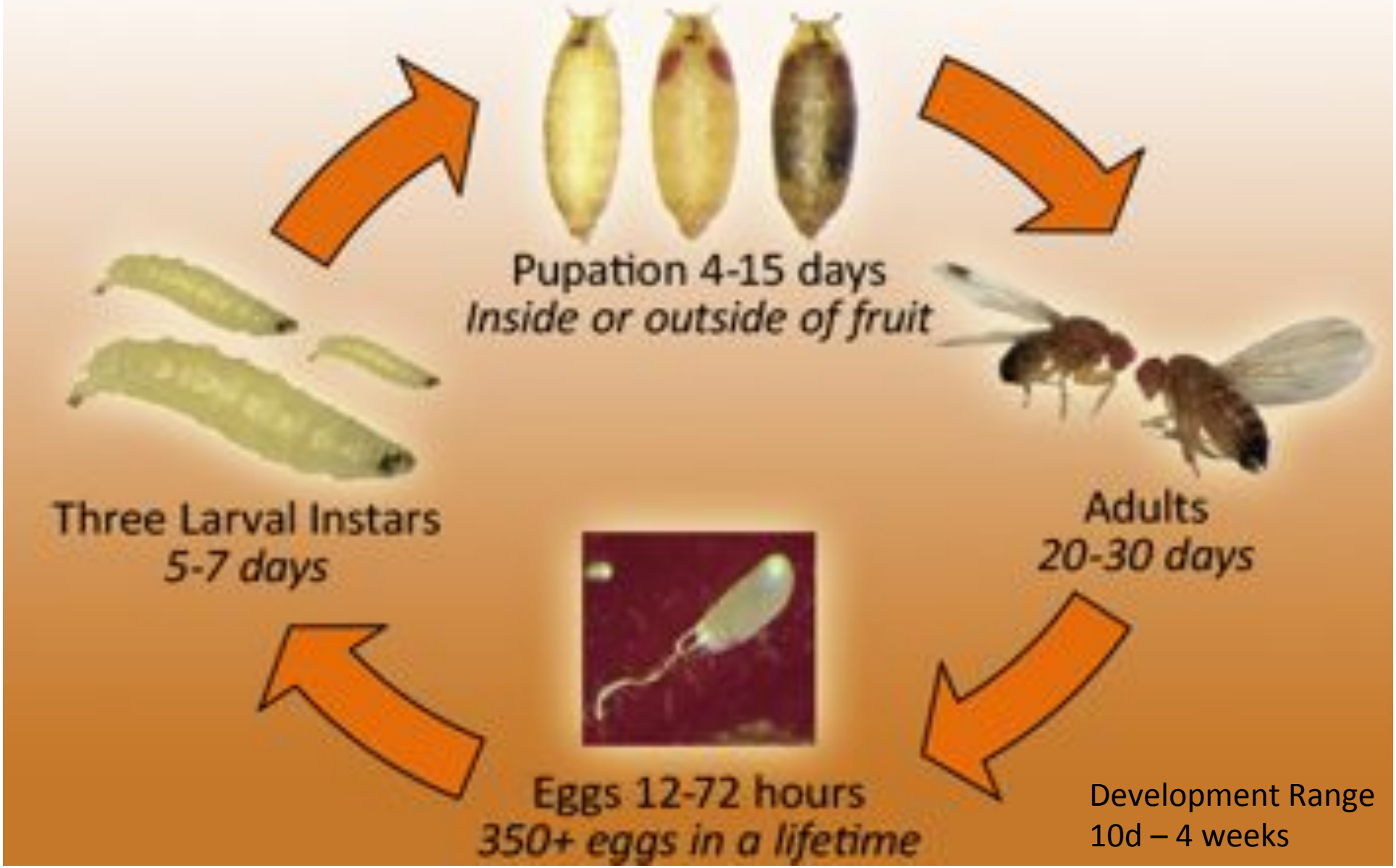
1. **Mutations** developed by insecticide use give rise to a change in the insect physiology, altering the target binding site.

   Insect species that are usually capable of **producing large number of offspring**, increases the probability of random mutations, increasing insecticide resistance.

2. The **speed with which a species develops** (generation time) and the **number of offspring** that are produced contribute to increasing the speed of resistance development.

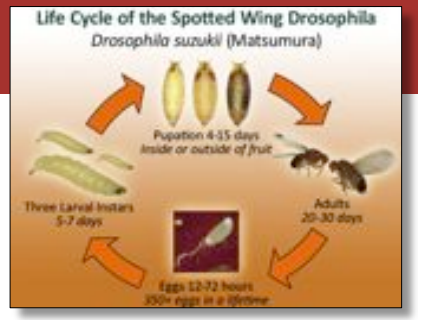
Life Cycle of the Spotted Wing Drosophila

Drosophila suzukii (Matsumura)



Development Range
10d – 4 weeks

Factors Contributing to Insecticide Resistance



- **Range of 3-10 generations in NY**

- **SWD has a very high probability of insecticide resistance development.**

Managing Insecticide Resistance (IRM)

- How do we manage resistance??
- Resistance management programs challenging.
- Limitations for successful SWD IRM include:
  - Number of insecticide tools (too few)
  - Number of insecticide classes
  - Label restrictions
    - DTH, PHI, Apps./season, Total A.I. per season

Managing Insecticide Resistance

- **Blackberry and raspberry,** action threshold is 1st adult detection using a *3-4 day application interval program*.

- **Blueberry management** should begin within 7-21 days of 1st adult, action threshold is 1st egg detection using a *7-day application interval program.*

- **IRAC Class Rotation:** A single IRAC class of insecticide should be used for each generation; rotate to different class every 10d (Warm: summer) to 3-4 weeks (Cool: Spring & Fall).

- http://www.irac-online.org/documents/moa-classification/?ext=pdf

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
[2]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[5]
[2]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[5]
[2]Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent[5]
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[5]
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[2]Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
[2]AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

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

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[10]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[7]
[10]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[7]
[10]Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent[7]
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[7]
[9]Pyganic EC 1.4	pyrethrin	3A	1021-1771	1 pt – 2 qts	12 hr	0 d	-	-	-	Fair to Poor
[9]Pyganic EC 5.0	pyrethrin	3A	1021-1772	4.5 – 18 fl oz	12 hr	0 d	-	-	-	Fair to Poor
[9]AzaSol	azadirachtin	UN	81899-4	6 oz in 50 gal	4 hr	0	-	-	-	Fair to Poor

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
[2]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[5]
[2]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[5]
[2]Delegate WG (2ee)	spinetoram	5	62719-541	3-6 oz	4 hr	1 d	19.5 oz (0.305 lb)	6	4 d	Excellent[5]
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[5]
*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

R

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

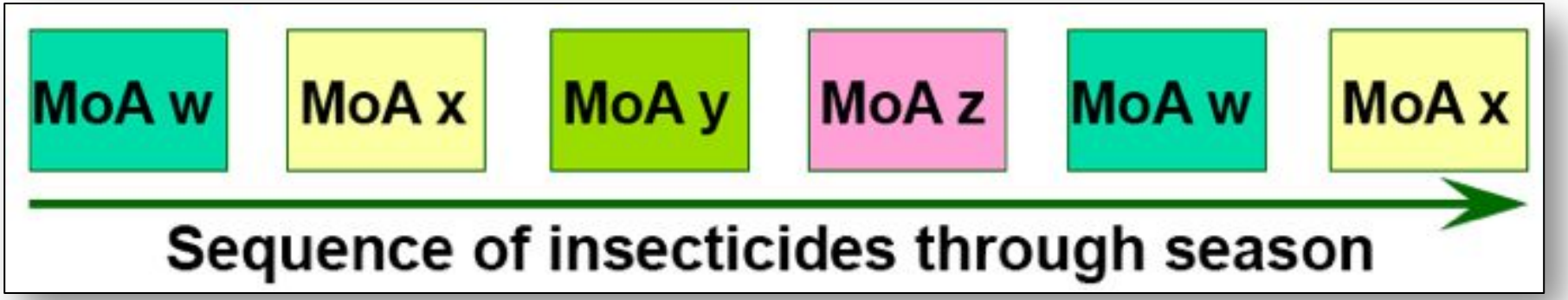
Example of a IRM conventional program:

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
Delegate (4d / 6apps.)

MoA-z – Neonicotinoids: IRAC 4A
Provado (Pre-mix), Assail (7d / 5apps.)



Managing Insecticide Resistance: Raspberry

MoA-w – Pyrethroids: IRAC 3A

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

MoA-x – Organophosphates: IRAC 1B

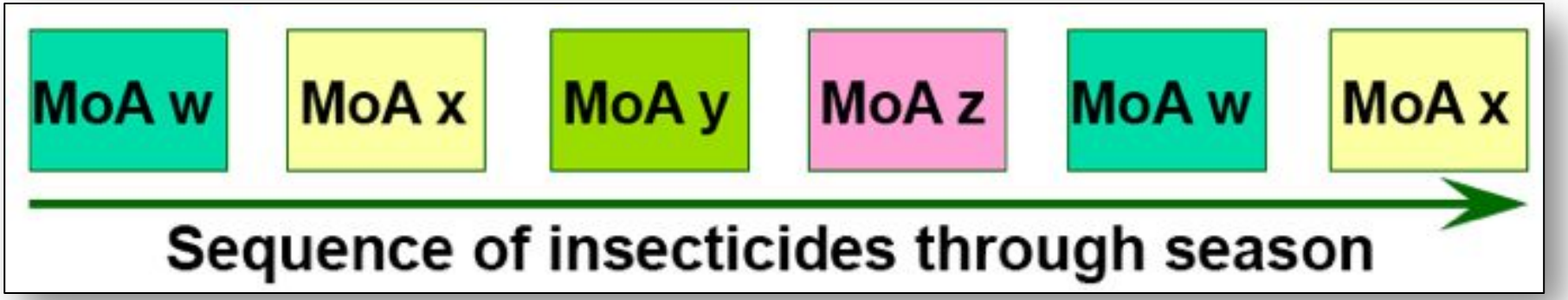
Malathion (7d / 3 apps.)

MoA-y – Spinetoram: IRAC 5

Delegate (4d / 6apps.)

MoA-z – Neonicotinoids: IRAC 4A

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



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Managing Insecticide Resistance: Raspberry

Using 'Alternate Row Middle' Applications to Optimize Use of Insecticide

Biologically based Spotted Wing Drosophila management

Hannah Burrack, Rufus Isaacs, Vaughn Walton
Nik Wiman, Samantha Tochen, Daniel Dalton, Betsey Miller, Jimmy Klick, Wei Yang, Denny Bruck, Jana Lee, Hannah Burrack, Claudio Ioriatti, Gianfranco Anfora, Alberto Grassi, Peter Shearer, Kent Daane, Xingeng Wang

Managing Insecticide Resistance: Raspberry

Efficacy of **alternate row sprays** in raspberries

Every row (E) sprays

Alternate row (A) sprays

- A-sprays did not result in yield loss in low pressure years
- A-sprays reduced application time, chemical costs and area sprayed by 50%

Managing Insecticide Resistance: Raspberry

MoA-w – Pyrethroids: IRAC 3A

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

MoA-x – Organophosphates: IRAC 1B

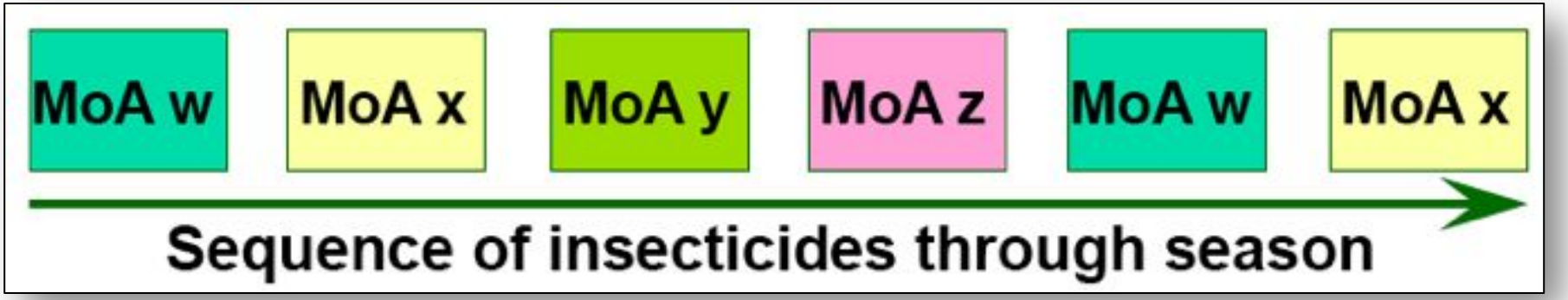
Malathion (7d / 3 apps.)

MoA-y – Spinetoram: IRAC 5

Delegate (4d / 6apps.)

MoA-z – Neonicotinoids: IRAC 4A

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



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Thank You

Technical staff and assistants