Managing Brown Marmorated Stink Bug and Spotted Wing Drosophila in NYS

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Photograph: **Christopher Hedstrom** USDA-APHIS Quarantine Facility, Corvallis, Oregon

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2019 Lake Ontario Winter Fruit Schools
Tuesday, February 5th, 2019
Newark Garden Hotel, Newark, NY

Brown Marmorated Stink Bug Management

- BMSB Ecology & Biology
- Monitoring / Scouting
- Stink Bug Injury Diagnostics
- Insecticide Efficacy Studies
- Biological Control
- Novel / Innovation Mgt. Research

Hudson Valley Stink Bug Complex (Pentatomidae)
Species Of Economic Importance

Stink Bug Biology

- Large 'Shield' bug body form (3.5 cm)
- Proboscis (moutparts) shielded prior to insertion into fruit
- Body held above the surface of foliage and fruit
- Tarsi hold insect on small segments onto smooth surfaces
- Limited exposure to residual insecticides

Hudson Valley Stink Bug Complex (Pentatomidae)
Species Of Economic Importance

Brown Stink Bug, *Euschistus servus* (Say)

- Native to North America
- Feeds on broad leaf plant & seed (Mullen, Dock, Plantain)
- Moves to apple borders during periods of drought
- Pyrethroids, Pre-mix Neonic + Pyrethroid

Green Stink Bug, *Acrosternum hilare* (Say).

- Native to North America
- Arborial dwelling, feed on seed, stems and foliage
- Moves to apple borders during periods of drought

Brown marmorated stink bug, *Halyomorpha halys* (Stål)

- Newly invasive in North America
- Arborial dwelling, feed on seed, stems and foliage
- Moves to apple borders during periods of high population, drought

Hudson Valley Stink Bug Complex
Species Of Economic Importance

Brown Stink Bug, *Euschistus servus* (Say)

Adult Stink bug damage

GT TC P Bloom PF 1C 2C 3C 4C 5C 6C 7C 8C

21 March 21 April 27 April 1 May 14 May 28 May 10 June 25 June 5 July 15 July 1 Aug. 15 Aug. 1 Sept.

Green Stink Bug, *Acrosternum hilare* (Say).

Adult Stink bug damage

GT TC P Bloom PF 1C 2C 3C 4C 5C 6C 7C 8C

21 March 21 April 27 April 1 May 14 May 28 May 10 June 25 June 5 July 15 July 1 Aug. 15 Aug. 1 Sept.

Brown marmorated stink bug, *Halyomorpha halys* (Stål)

Adult SB Presence | Adult & Nymph Stink bug damage

GT TC P Bloom PF 1C 2C 3C 4C 5C 6C 7C 8C

21 March 21 April 27 April 1 May 14 May 28 May 10 June 25 June 5 July 15 July 1 Aug. 15 Aug. 1 Sept.

Citizen Science Project Participation (Homeowners)

BMSB has been detected in all but 6 of 62 counties in NYS

Factors for BMSB Success: Overwintering

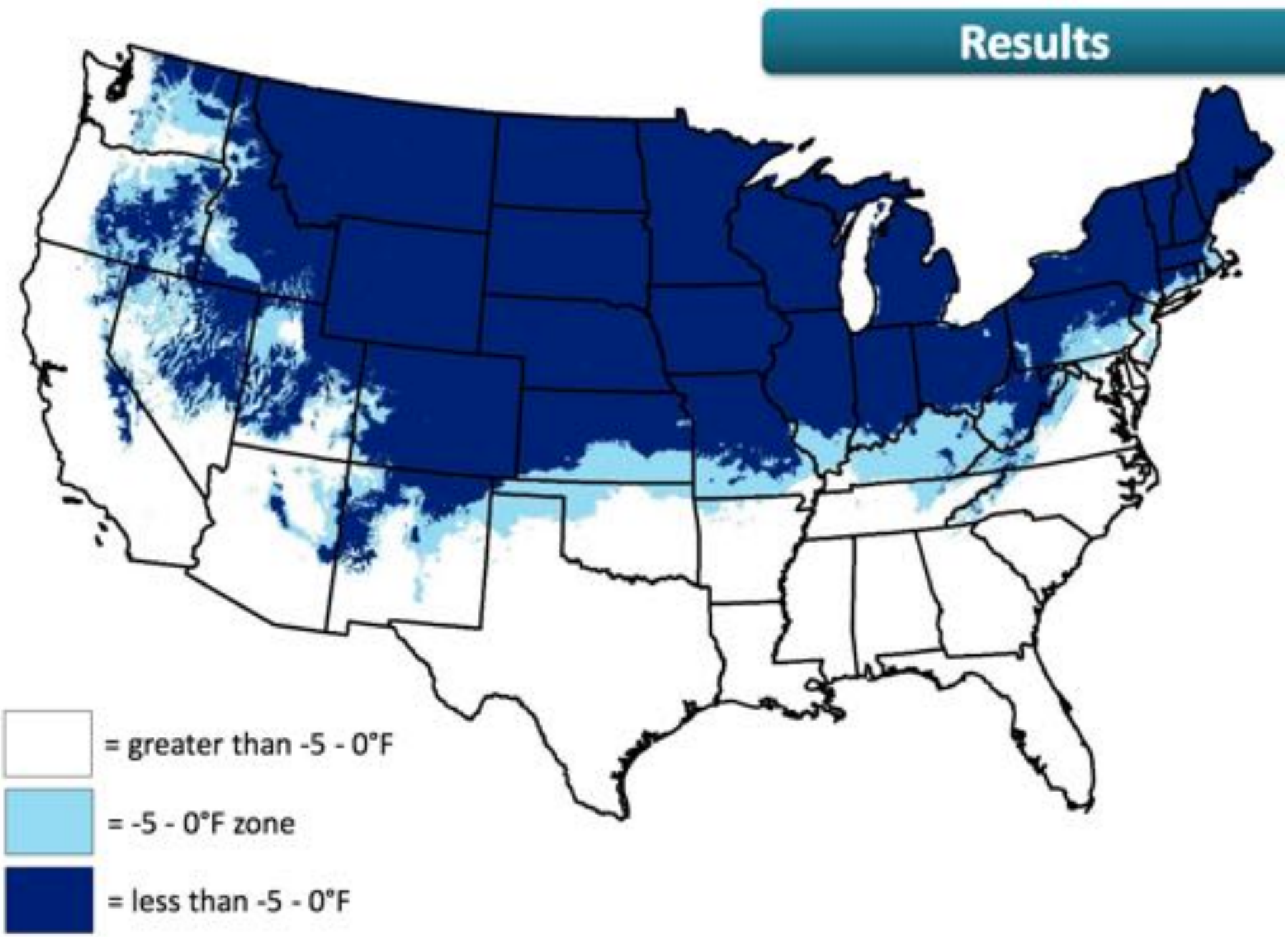
Overwintering habitat

- A small percent of the population will aggregate in buildings where temperature extremes allow for survival in northern climates, **potentially creating localized cluster points for Ag. infestations.**

- The majority of BMSB reside in the woodland habitat (Standing Dead Oak (*Quercus* spp.), Locust (*Robinia* spp.) Lee, Doo-Hyung et al. 2014)

- In woodland habitat, temperatures below -18°C or -0.4°F will kill 90% of the population (Kuhar, T. 2016)

Results



The Brown Marmorated Stink Bug in the Ag. & Urban Environment

Detected in 44 *states* and 4 Canadian provinces

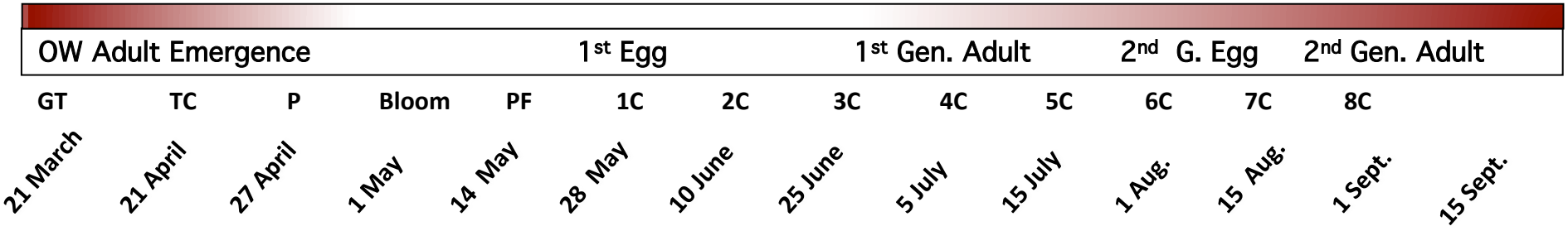
Updated: 1/18/2018

Factors for BMSB Success: # of Generations

- **Sunlight / Day length** (BMSB adult mating)
  - **13.5h day length** for mating and egg laying to begin
  - Geneva, NY April 29th – Aug 13th
  - HVRL Highland May 1st – Aug. 11th

Factors for BMSB Success: # of Generations

- **Degree Day Accumulations**
  - It requires **538 degree days** (DD – based 50ºF) to develop from egg to adult.
  - An additional **148 DD** are required for female maturation **at 77ºF.**
  - Total of **686 DD_{50}** for 1 generation;
  - **1224 DD_{50}** for a **2nd complete the adult OW population**



Brown Marmorated Stink Bug Management

- BMSB Ecology & Biology
- **Monitoring / Scouting**
- **Stink Bug Injury Diagnostics**
- **Insecticide Efficacy Studies**
- **Biological Control**
- **Novel / Innovation Mgt. Research**

State-wide Trap Monitoring of BMSB in NY

USDA #10 Lure & MDT Using Tedders Traps

Vented trap container holding duel lure

Killing strip of Vapona; bungi cord straps

Pyrimid black base to mimmic tree trunk

Screened base to **reduce weeds** and provide contrast for crawling SB

Placed along decidious woodland / orchard edge

AgBio-inc.com
Trap, lures, kill strip

Treatment Threshold: 10 adults / trap / week

Green & Brown Marmorated Stink Bug: Monitoring

Tedders Trap
*duel pheromone

Sticky Card Trap
*duel pheromone

AtK Trap (Vestegaard)
*duel pheromone
*deltamethrin-Incorporated net

Threshold: 10 adults / trap / week

Green & Brown Marmorated Stink Bug: Monitoring

Green & Brown Marmorated Stink Bug: Monitoring

Brown Marmorated Stink Bug Management

- BMSB Ecology & Biology
- Monitoring / Scouting
- **Stink Bug Injury Diagnostics**
- Insecticide Efficacy Studies
- Biological Control
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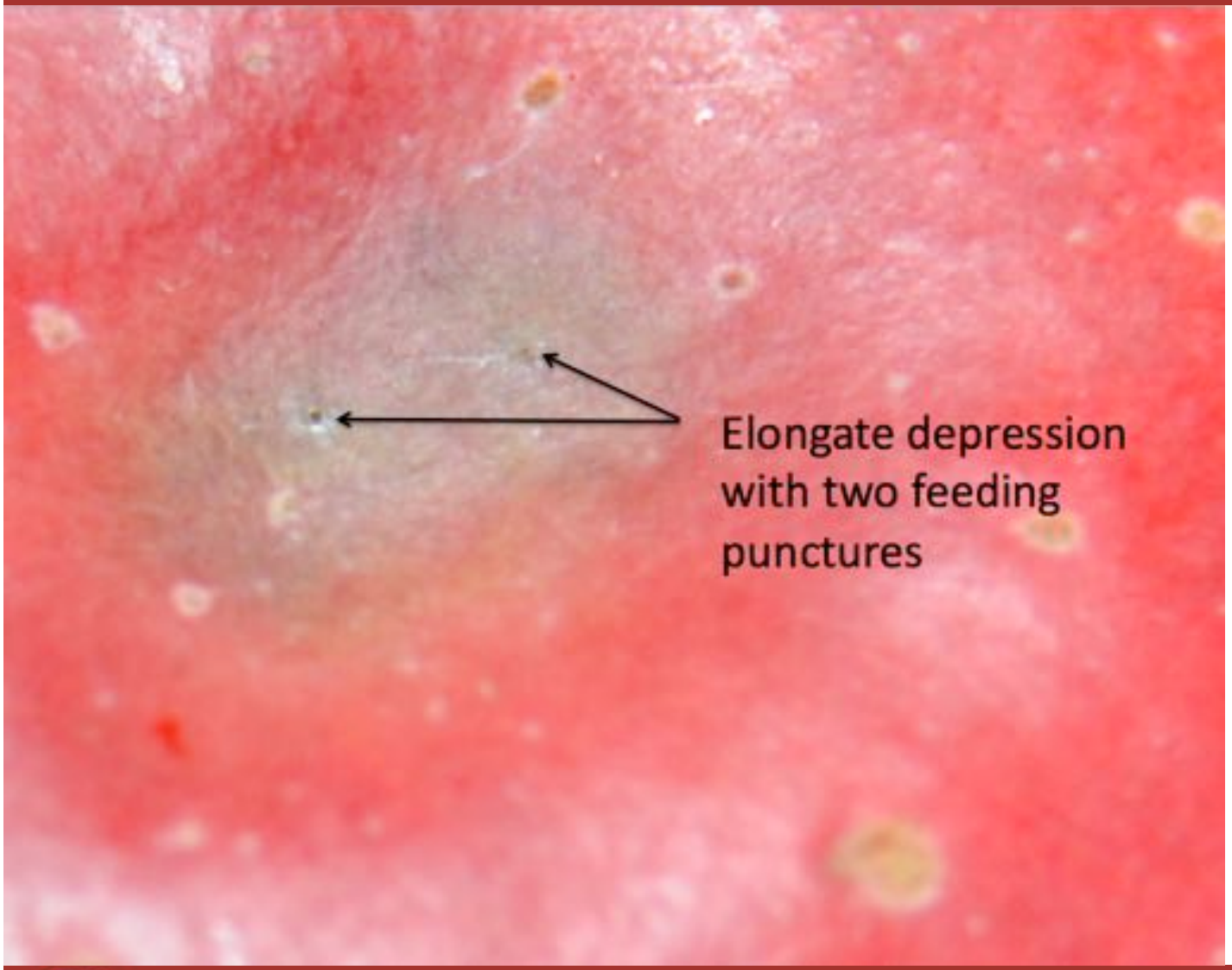
BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot



Stink Bug:

- Discolored shallow depression
- Corking to skin surface
- **Feeding puncture**

BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot

Hail injury:

- Discolored shallow depression
- Corking to skin surface
- **No feeding puncture**

BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot

Bitter Pit:

- Discolored shallow depression
- **Corking not to skin surface**
- **No feeding puncture**

BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot

Apple Maggot:

- Sting Depression
- **No skin Discoloration**
- **No corking**
- Oxidized tunneling or trails

Brown Marmorated Stink Bug Management

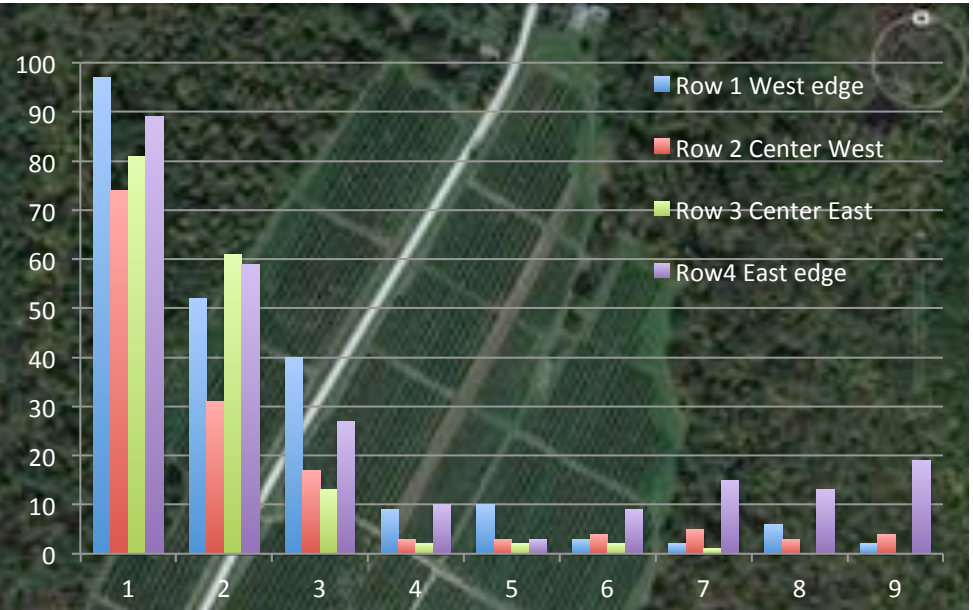
- BMSB Ecology & Biology
- Monitoring / Scouting
- Stink Bug Injury Diagnostics
- **Insecticide Efficacy** Biological Control
- Novel / Innovation Mgt. Research

Management Options

Insecticide Group	Product	Active Ingredient	% Adult BMSB Mortality[1]
Pyrethroid	Bifenture	bifenthrin	100
	Danitol	fenpropathrin	95
	Warrior II	lambda-cyhalothrin	73
Carbmate	Lannate	methomyl	92
	Vydate	oxymyl	68
Neonicotinoid	Actara	thiamethoxam	92
	Assail	acetamiprid	87
Pre-mix	Leverage 360	imidacloprid and β-cyfluthrin	95
	Endigo	lambda-cyhaloth	98
	Voliam Flexi	chlorantraniliprole and thiamethoxam	98

1. Direct contact activity of insecticides against BMSB adults in a lab setting may be very high, yet the activity of field-aged residue may, over time, quickly becomes ineffective at preventing feeding injury.

A strong edge effect observed from wooded edge toward the interior of the block in Pink Lady harvested in early November.

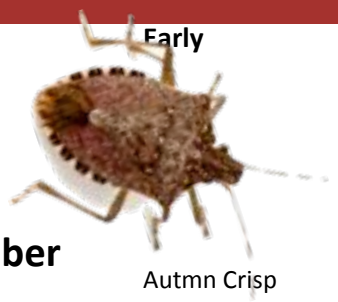


Along 30’ of border fruit 74-98% injury was assessed.

>21% injury was documented at packout.

Campbell Hall, NY
Commercial apple

NY BMSB Management Options

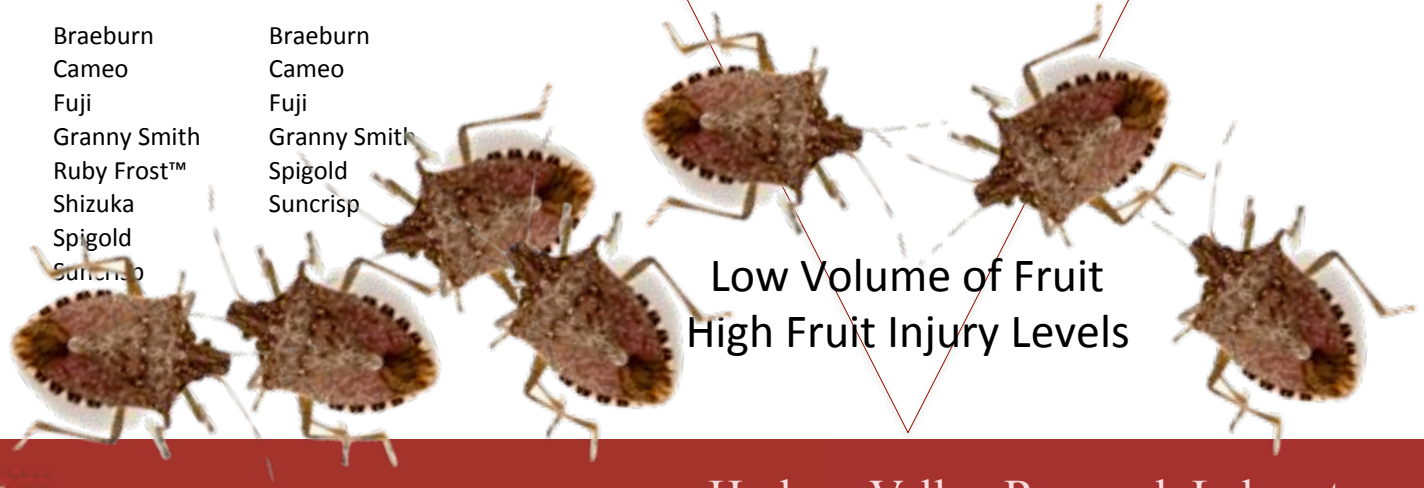


	Early	Mid	Late	
August		Blondee Sansa	Blondee Paulared Tydeman Zestar	**WHOLE ORCHARD** application early-mid August Trap Threshold + observation Egg laying in orchard possible 35-7d PHI
September	Autmn Crisp Blondee Gala Ginger Gold	Autmn Crisp Cortland Empire Honeycrisp	Ambrosia Autmn Crisp Braeburn Golden Delicious	2-4 applications beginning in early August **Perimeter Row applications** 35-7d PHI
	Golden Supreme Greening Jonamac McIntosh Twenty Ounce Tydeman	Macoun Shamrock Snow Sweet Tydeman	Jonagold Mutsu/Crispin Pinova Red Delicious Ruby Frost™ Ruby Jon Snap Dragon™ Snow Sweet	
October	Braeburn Cameo Fortune Idared Northern Spy Rome Ruby Frost™ Shizuka Snap Dragon™ Snow Sweet	Braeburn Cameo Fuji Granny Smith Ruby Frost™ Shizuka Spigold Suncrisp	Braeburn Cameo Fuji Granny Smith Spigold Suncrisp	5-8 applications beginning in early August **Perimeter Row applications** 35-7d PHI
				>6 applications beginning in early August **Perimeter Row applications** 35-7d PHI
November	Pink Lady			

NY BMSB Management Options

	Early	Mid	Late
August		Blondee Sansa	Blondee Paulared Tydeman Zestar
September	Autmn Crisp Blondee Gala Ginger Gold Golden Supreme Greening Jonamac McIntosh Twenty Ounce Tydeman	Autmn Crisp Cortland Empire Honeycrisp Macoun Shamrock Snow Sweet Tydeman	Ambrosia Autmn Crisp Braeburn Golden Delicious Jonagold Mutsu/Crispin Pinova Red Delicious Ruby Frost™ Ruby Jon Snap Dragon™ Snow Sweet
October	Braeburn Cameo Fortune Idared Northern Spy Rome Ruby Frost™ Shizuka Snap Dragon™ Snow Sweet	Braeburn Cameo Fuji Granny Smith Ruby Frost™ Shizuka Spigold Suncrisp	Braeburn Cameo Fuji Granny Smith Spigold Suncrisp
November	Pink Lady		

High Volume of Fruit
Low Injury Level



Low Volume of Fruit
High Fruit Injury Levels

NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Besiege	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
Bifenture EC	Bifenthrin	5.2-12.8 fl oz/A	12	14	++++	32 fl ozs (0.50 lbs ai)	30d
Bifenture 10DF	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Brigade WSB	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Danitol 2.4EC	Fenpropathrin	10.66-21.33 fl oz/A	24	14	+++	42.56 fl ozs (0.80 lbs ai)	10d
Endigo ZC	Thiamethoxam / Lambda-cyhalothrin	5-6 fl fl oz/A	24	35	++++	19 fl oz./A (0.172 lb ai) NY	10d
Gladiator EC	Zeta-Cyfluthrin / Avermectin B1	19.0 fl.oz./A	12	28	++	38.0 fl oz/A	21d
Lannate 2.4LV*	Methomyl	2.25 pt/A	72	14	++++	240 ozs (0.50 lbs ai)	7d
Lannate 90SP*	Methomyl	0.75 lb./A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d

* Although these materials have excellent topical ratings in lab bioassay studies, field efficacy studies have shown economic fruit injury from BMSB feeding, suggesting low residual levels.

** Post bloom applications

(+) low to (++++) high efficacy

Early-mid August

- Single Application (Thiamethoxam)
- NYS total 11.0 oz./A of Actara WDG
- 35 DTH

NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Besiege	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
Bifenture EC	Bifenthrin	5.2-12.8 fl oz/A	12	14	++++	32 fl ozs (0.50 lbs ai)	30d
Bifenture 10DF	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Brigade WSB	Bifenthrin	12.8-32.0 oz/A	12	14	++++	80 ozs (0.50 lbs ai)	30d
Danitol 2.4EC	Fenpropathrin	10.66-21.33 fl oz/A	24	14	+++	42.56 fl ozs (0.80 lbs ai)	10d
Endigo ZC	Thiamethoxam / Lambda-cyhalothrin	5-6 fl fl oz/A	24	35	++++	19 fl oz./A (0.172 lb ai) NY	10d
Gladiator EC	Zeta-Cyfluthrin / Avermectin B1	19.0 fl.oz./A	12	28	++	38.0 fl oz/A	21d
Lannate 2.4LV*	Methomyl	2.25 pt/A	72	14	++++	240 ozs (0.50 lbs ai)	7d
Lannate 90SP*	Methomyl	0.75 lb./A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
Warrior 1CS	Lambda-cyhalothrin	2.56-5.12 fl oz/A	24	21	++	20.48 fl. oz. (0.28 lb. a.i.)**	5d

* Although these materials have excellent topical ratings in lab bioassay studies, field efficacy studies have shown economic fruit injury from BMSB feeding, suggesting low residual levels.

** Post bloom applications

(+) low to (++++) high efficacy

Mid-late August

- 5-10 d application schedule
- 21 DTH

NY Management Options

Product	Active ingredient	Rate / A	REI Hrs.	PHI Days	Efficacy (USDA)	Max. per crop / season	App. Interval
Actara 25WDG	Thiamethoxam	4.5-5.5 oz/A	12	35	+++	16.5 oz./A (0.258 lb. a.i./A)	10d
Asana XL 0.66EC	Esfenvalerate	4.8-14.5 fl oz/A	12	21	++	101 fl oz/A (0.525 lb AI/A).	NA
Baythroid XL 1EC	Beta-Cyfluthrin	1.4-2.8 fl oz/A	12	7	++	2.8 fl oz/A (0.022 lb AI/A).	14d
Besiege	Chlorantraniliprole / Lambda-cyhalothrin	6-12 fl oz/A	24	21	+++	31.0 fl oz/A	10d
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Lannate 90SP*	Methomyl	0.75 lb./A	72	14	++++	5.0 lbs	7d
Leverage 360	Beta-Cyfluthrin / Imidacloprid	2.4-2.8 fl oz/A	12	7	+++	2.8 fl oz/A	14d
Surround 95WP	Kaolin	25-50 lb/A	4	0	+	NA	0d
Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
Vydate 2L*	Oxamyl	1.5-3.0 pt/A	48	14	++	281 fl oz/A (128 oz AI/A).	7d
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** Post bloom applications

(+) low to (++++) high efficacy

Late August-Early September

- 5-10 d application schedule
- Bifenthrin (30d Re-application)
- 14 DTH

NY Management Options

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Voliam Flexi	Chlorantraniliprole/Thiamethoxam	6.0-7.0 oz/A	12	35	+++	11 fl oz./A (0.172 lb ai) NY	10d
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** Post bloom applications

(+) low to (++++) high efficacy

Mid-September

- 5-10 d application schedule
- 7 DTH

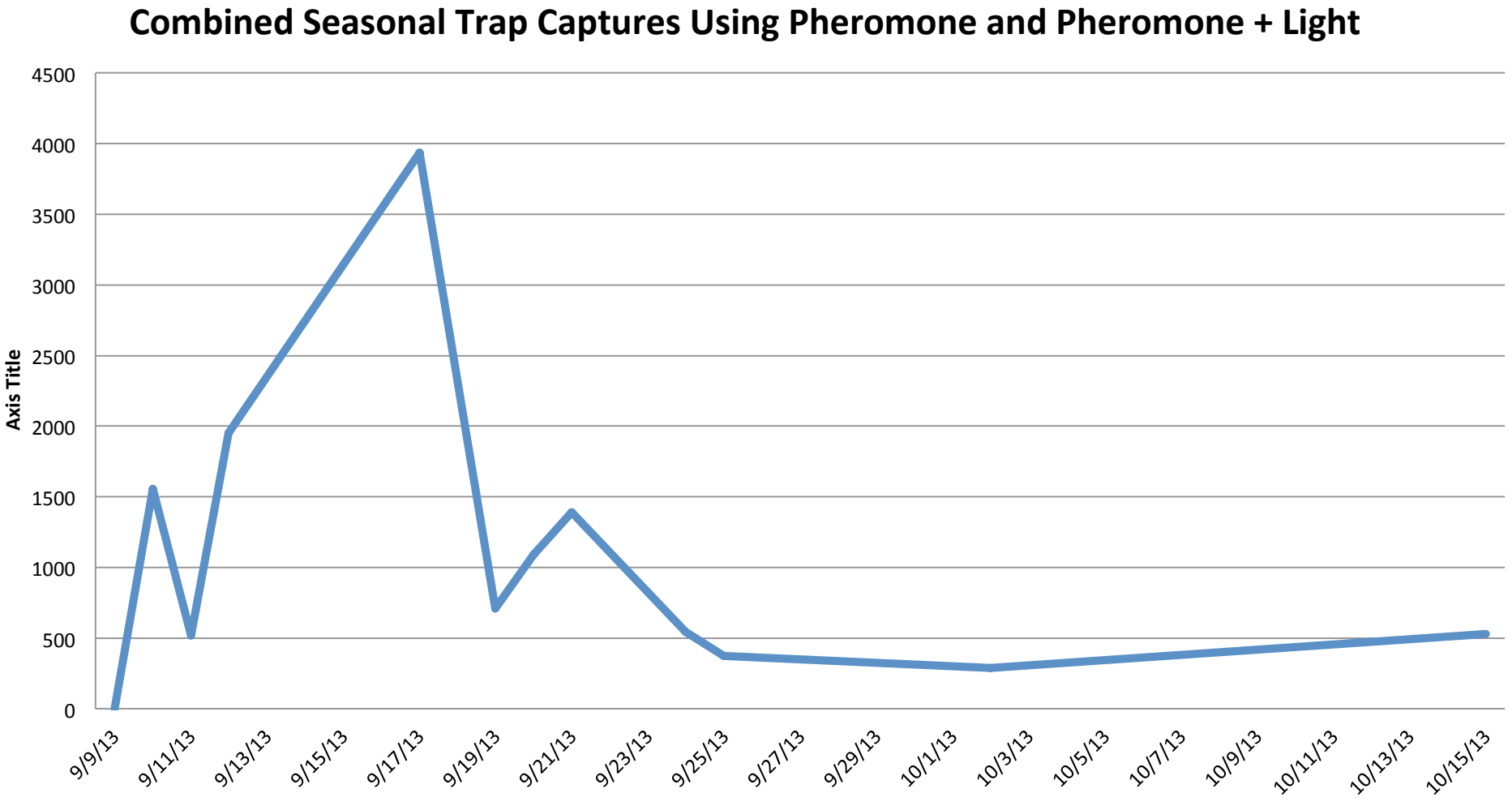
Brown Marmorated Stink Bug Management

- Aspects of BMSB Ecology & Biology
- Agricultural Monitoring / Scouting
- Defining Stink Bug Injury
- Directed Applications & Efficacy
- **Novel / Innovation (Research)**

Attract and Kill Netting in Orchard
Duel Pheromone + Insecticide

Attract and Kill Netting in Orchard
Duel Pheromone + Insecticide

Studies of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål), in New York State 2016



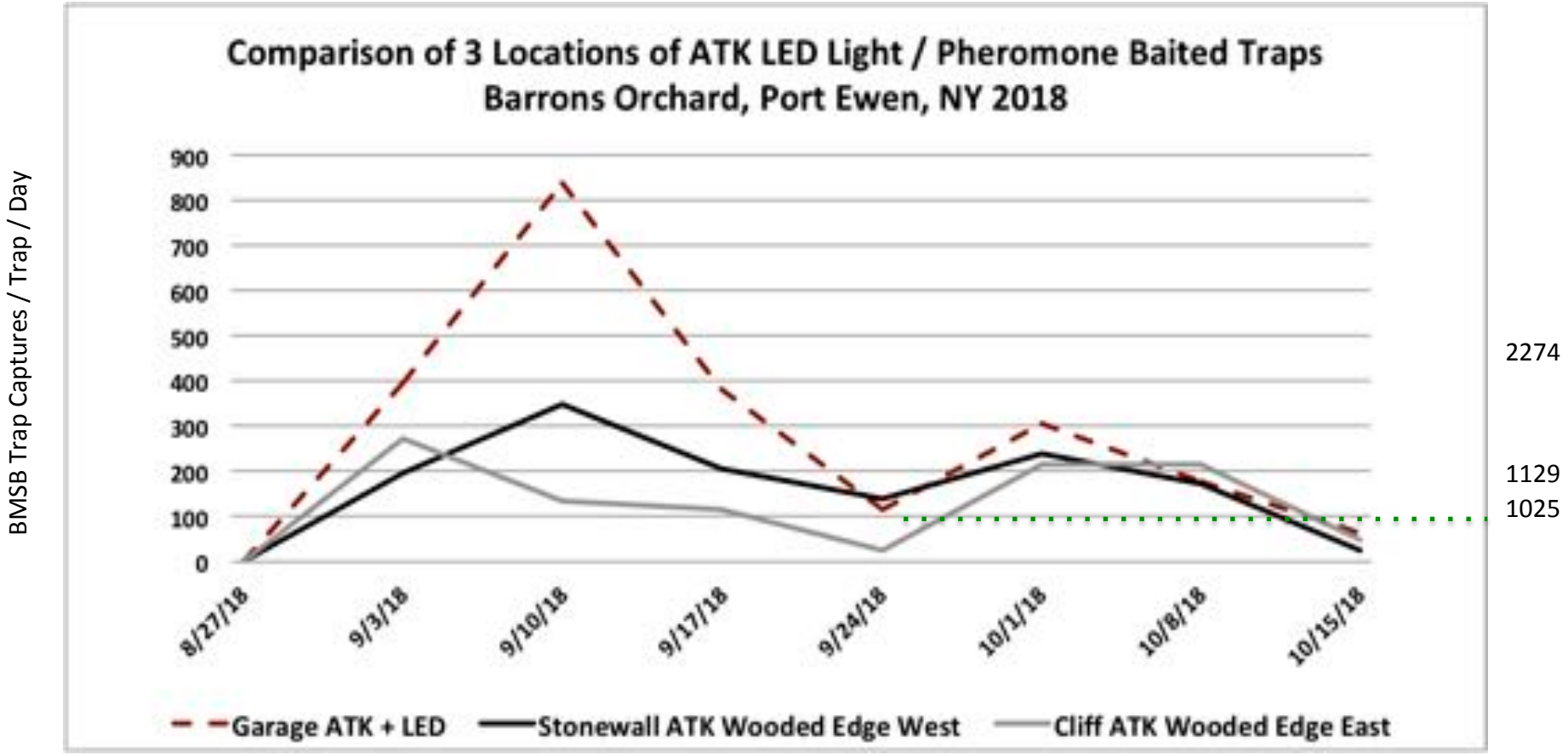
(September – 15 October: Total BMSB = 12,894

Monitoring *the* Stink Bug Complex
Using Free Standing Solar LED ATK + Phermone

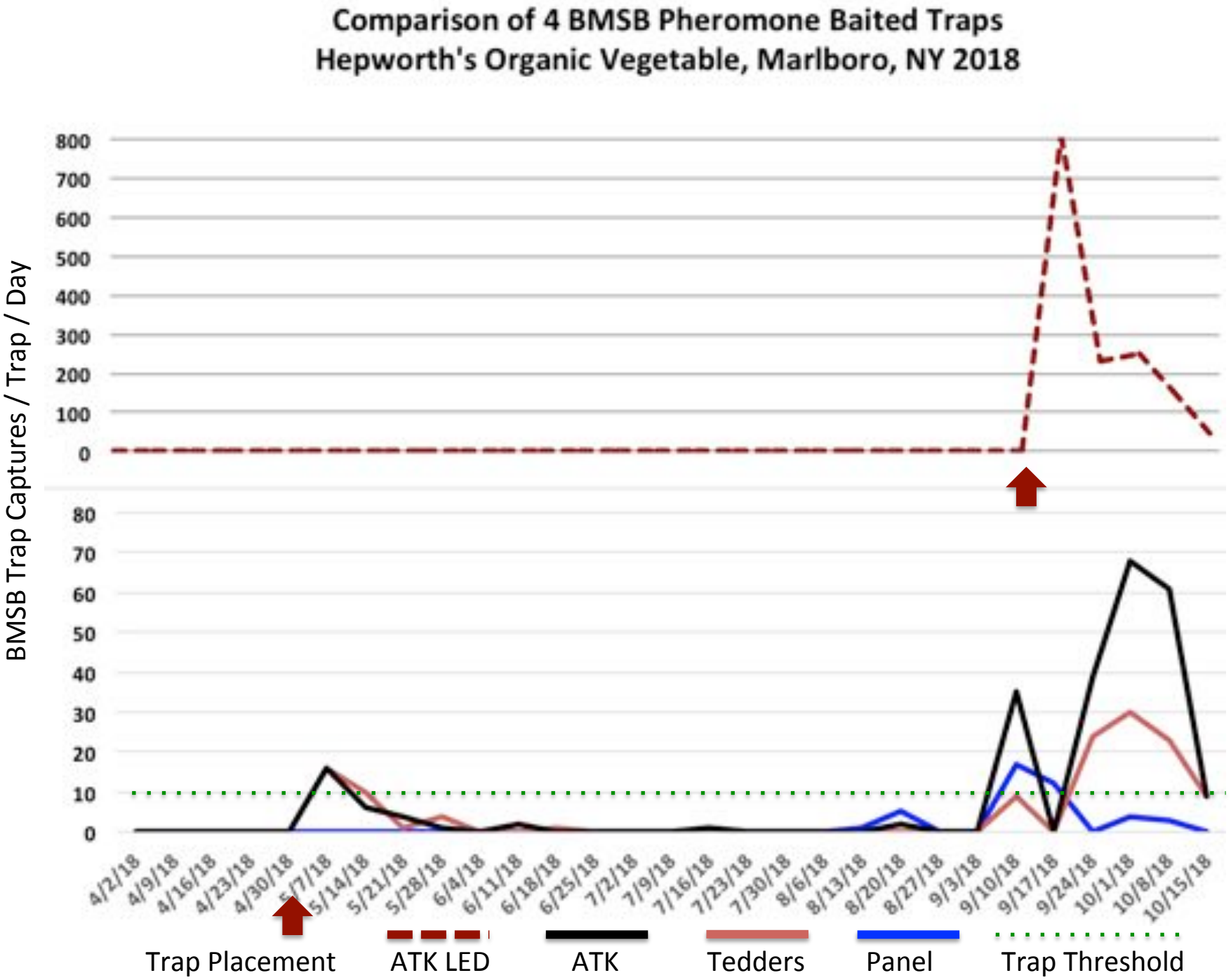
Cornell University

Hudson Valley Research Laboratory

Attract & Kill of the Stink Bug Complex
To Reduce BMSB Populations Along the Orchard Edge



Including Solar LED auto-on with ATK / pher. increases BMSB captures


Comparison of 4 BMSB Pheromone Baited Traps
Hepworth's Organic Vegetable, Marlboro, NY 2018
BMSB Trap Captures / Trap / Day
800
700
600
500
400
300
200
100
0
80
70
60
50
40
30
20
10
0
4/2/18
4/9/18
4/16/18
4/23/18
4/30/18
5/7/18
5/14/18
5/21/18
5/28/18
6/4/18
6/11/18
6/18/18
6/25/18
7/2/18
7/9/18
7/16/18
7/23/18
7/30/18
8/6/18
8/13/18
8/20/18
8/27/18
9/3/18
9/10/18
9/17/18
9/24/18
10/1/18
10/8/18
10/15/18
Trap Placement
ATK LED
ATK
Tedders
Panel
Trap Threshold

Redistribution of Samurai Wasp, Trissolcus japonicus (Ashmead) In NYS

- Samurai wasp, *Trissolcus japonicus*, is an egg parasitoid of the BMSB
- Lays 1 egg into each BMSB egg
- Wasp larva feed on BMSB nymph
- Adult wasp emerges from BMSB eggs
- Can have 5 generations / year

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Live along the wooded edge of Ag.

Resides in BMSB deciduous tree hosts

Limited exposure to insecticides

Introduction to *Trissolcus japonicus* (Samurai Wasp) For BMSB Management ?

2 mm

Trissolcus japonicus

Trissolcus japonicus
Field Recovery Sites in the US

- In 2014 **adventive** populations (wild) of *T. japonicus* were found in Beltsville, MD using sentinel BMSB eggs

(Talamas EJ, Herlihy MV, Dieckhoff C, Hoelmer KA, Buffington ML, Bon M-C, Weber DC (2015) *Trissolcus japonicus* (Ashmead) emerges in North America. Journal of Hymenoptera Research 43: 119-128. https://doi.org/10.3897/JHR.43.4661)

- In 2015 *T. japonicus* were found in Vancouver, WA, Washington DC and Winchester, VA,.

- In 2016, *T. japonicus was also found* in WV, MD, NJ and NY in the East, and OR in the West.


2017
Sentinel Egg Placement
11 NYS Sites
Orleans Co.
Monroe Co.
Wayne Co.
Ontario Co.
Columbia Co.
Ulster Co.
Dutchess Co.
Orange Co.
Kingston
Toronto
Lake Ontario
New York
Pennsylvania
Connecticut

NYS DEC Liberation of Wildlife Permit (July 2017)

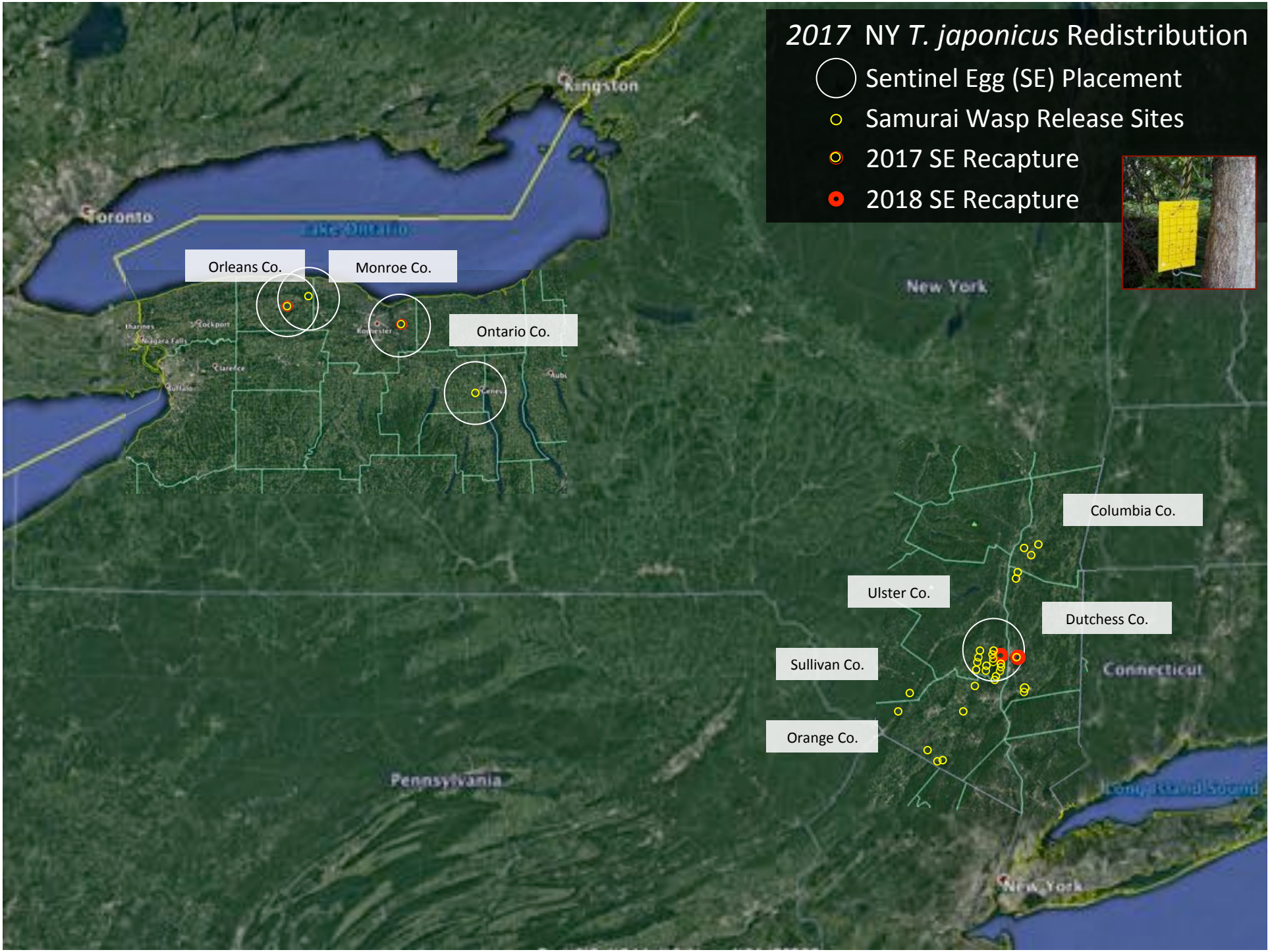
After in-depth review of applicable provisions of the Environmental Conservation Law (ECL) and Codes, Rules and Regulations of the State of New York (NYCRR), **DEC has concluded that its regulatory authority extends to the issuance of permits for the release of specifically defined species of wildlife and listed endangered, threatened, and/or invasive species.** Wildlife is defined in ECL S 1 1-0103. Endangered and threated species are identified in 6 NYCRR Part 182, and listed **invasive species are identified in 6 NYCRR Part 575.**

DEC has recently concluded that their statutory and regulatory framework around the Liberation of Wildlife Permit regulating release of biologicals such as insects does not generally apply to releasing insects into the wild, so long as the proposed release is not of an insect that is listed on either the endangered or invasive species listings.

Upon review by the DEC, the adventive *T. japonicus population does not require a* license or permit from DEC to undertake the movement and release of the Samurai wasp, as it is not listed within 6 NYCRR 575.

2017 Parasitized Egg Parasitoid Release 'Redistribution'

- Marlboro *T. japonicus* used to develop colony and parasitize -80°C BMSB eggs.
- Fixed parasitized eggs to petri dish lid added zip tie for RT mailing and emergence.
- Parasitized eggs sent to cooperators on **15th September.**
- Parasitized eggs placed on 32 sites of 25 farms in 5 NY counties.


2017 NY T. japonicus Redistribution
Sentinel Egg (SE) Placement
Samurai Wasp Release Sites
2017 SE Recapture
2018 SE Recapture
Orleans Co.
Monroe Co.
Ontario Co.
Columbia Co.
Ulster Co.
Dutchess Co.
Sullivan Co.
Orange Co.
Kingston
Toronto
Lake Ontario
New York
Pennsylvania
Connecticut
Long Island Sound
New York

Drape Net Insect Exclusion Study
Stink Bug Exclusion

Hudson Valley Research Lab

- Scab Resistant Block
- 11 Varieties on G.11
- 2018 Drape Net Study
  - Insect Exclusion

Drape Net Insect Exclusion Study
Samurai Wasp Conservation

Results of 2018 Insecticide and Acaricide Studies in Eastern New York. Jentsch et. al.

Table 1 **Management of the Apple Insect Complex Using 'Drape Net' IPM / Organic Split and Season Long IPM Management . Hudson Valley Research Laboratory, Highland, NY - 2018**

		Incidence (%) of insect damaged cluster fruit											
	Net Type Treatment / Rate	PC	EAS	TPB	Lf.Rlr	Int. Lep	Ext.Lep	CM	AM.P	AM.T	SJS	SB	Clean
1.	Black Drape Early Season IPM	3.0 a	0.6 a	4.4 a	10.9 bc	2.2 b	18.8 b	11.3b	0.6 b	0.6 b	96.3 a	0.3 b	1.3 c
2.	White Drape Early Season IPM	4.7 a	0.0 a	4.4 a	11.9 b	3.1 b	20.3 b	12.5 b	0.9 b	0.9 b	95.6 a	0.9 b	0.6 c
3.	**No Drape Early Season IPM**	**10.8 a**	**0.8 a**	**4.6 a**	**22.9 a**	**6.7 a**	**37.1 a**	**23.8 a**	**7.5 a**	**4.2a**	**83.8 b**	**3.8 a**	**1.3 c**
4.	Black Drape Season Long IPM	5.6 a	1.3 a	7.8 a	0.3 d	0.0 c	1.6 c	0.3 c	0.0 bc	0.0 b	6.6 d	0.0 b	82.5 a
5.	White Drape Season Long IPM	7.8 a	0.9 a	7.8 a	0.3 d	0.0 c	0.6 c	0.0 c	0.3 b c	0.3 b	20.0 c	0.0 b	65.9 b
6.	**No Drape Season Long IPM**	**5.6 a**	**0.9 a**	**5.0 a**	**0.6 cd**	**0.3 c**	**1.3 c**	**0.0 c**	**0.6 b c**	**0.3 b**	**6.3 d**	**0.9 b**	**81.3 a**
P value		0.2062	0.6565	0.5998	0.0001	0.0001	0.0001	0.0001	0.0001	0.0135	0.0001	0.0154	0.0001

* Evaluation made on 'Crimson Crisp, Honey Crisp & Gold Rush cultivars harvested on 29 September. Data were transformed using arcsine(sqrt(x)) prior to ANOVA (P ≤0.05). Means separation by Fisher Protected (P ≤0.05); treatment means followed by the same letter are not significantly different. Arithmetic means reported.

Spotted Wing Drosophila Tsunami: SWD Management

A Spotted Wing Drosophila Tsunami: SWD Management in NYS in 2017

- Spotted Wing Drosophila (SWD) is an invasive Southeast Asian species of vinegar fly, first reported in 1939 Japanese literature.
- Female SWD damages unripened & healthy fruit while depositing eggs into fruit.
- Wounded fruit have been found to contain microbial organisms, often leading to increased rot.

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

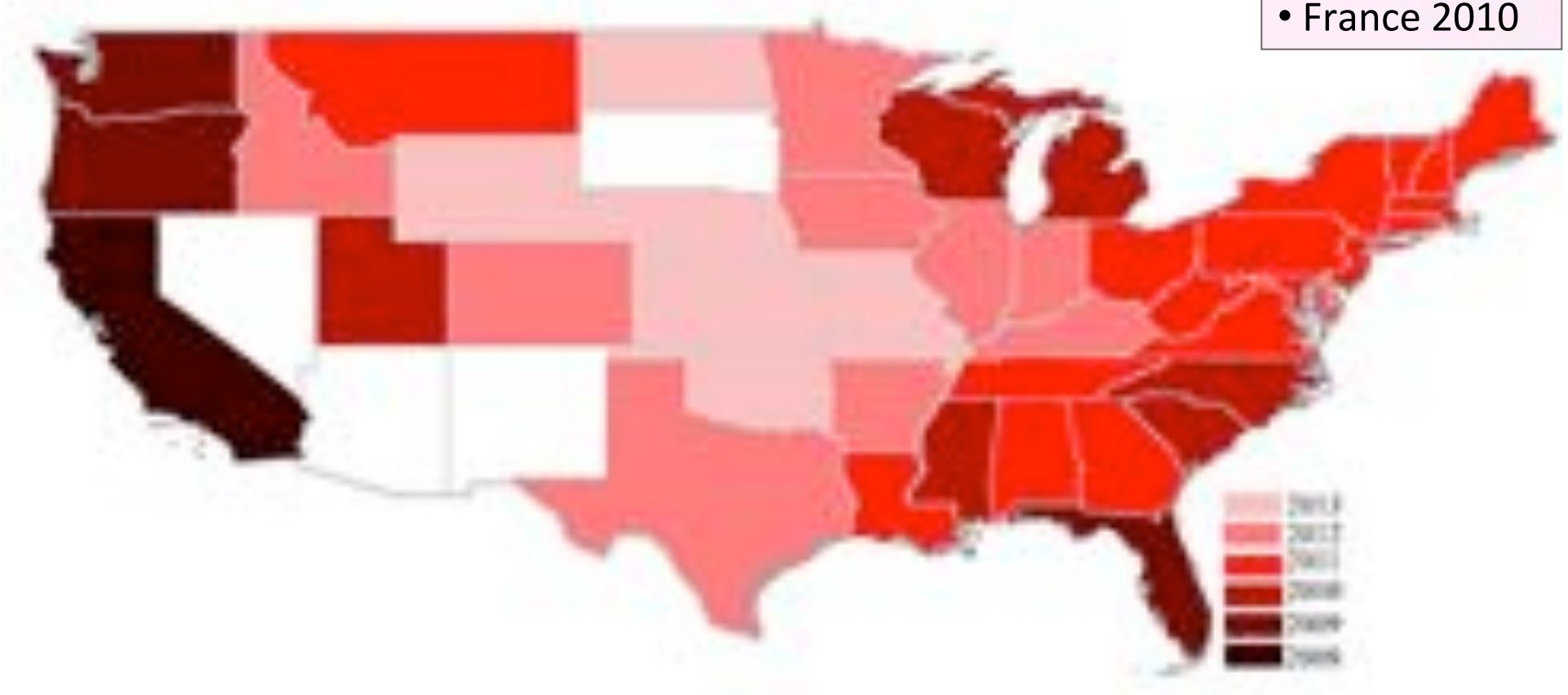
Leading edge of wing has dark spot

Unbroken abdominal bands

SWD Spread from 2008 – 2013 in the US

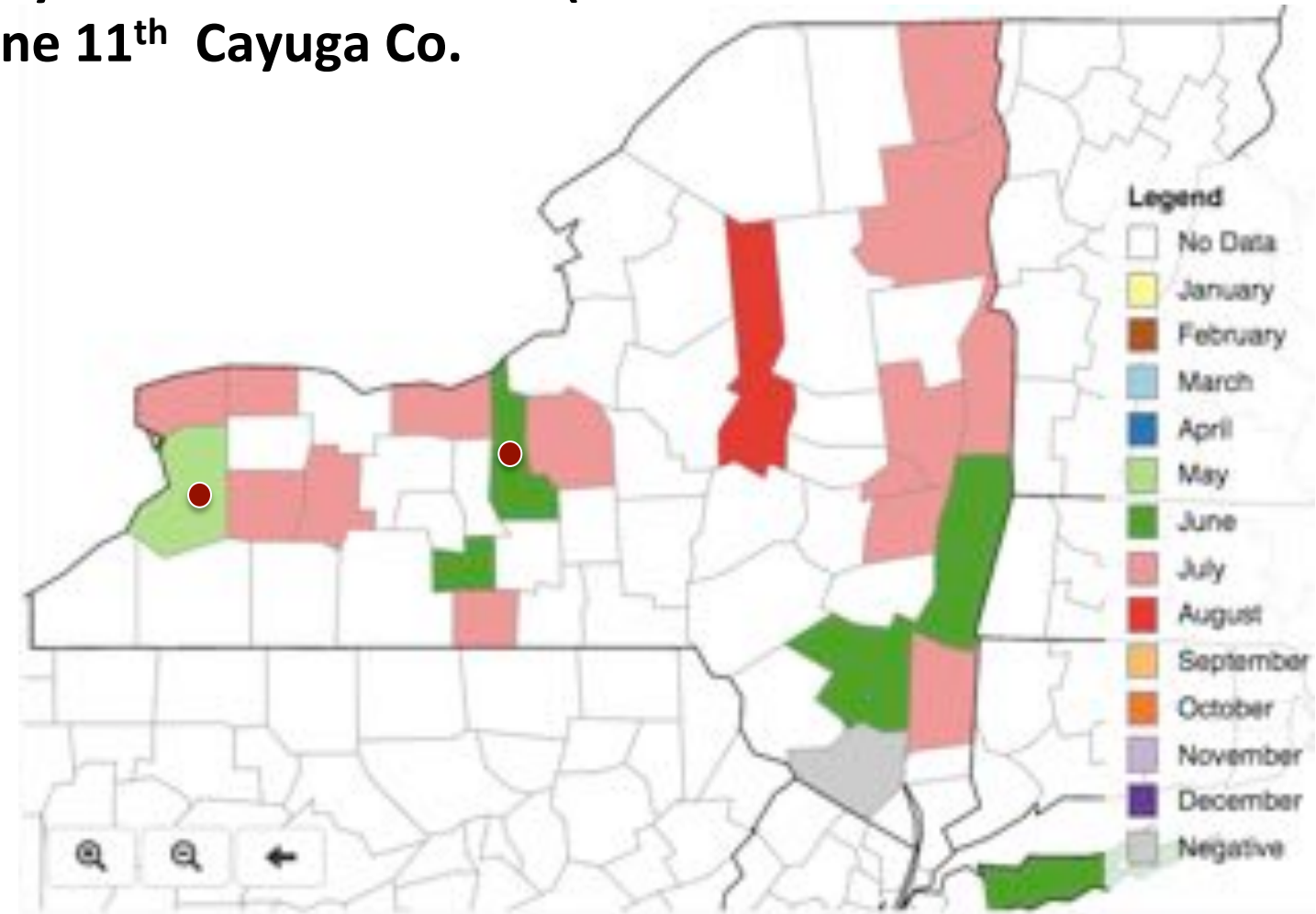
Hawaii 1980

- Italy 2009
- Russia 2009
- Spain 2009
- France 2010



SWD in New England - 2018

May 31st Orleans Co. NY (first detection: earliest on record)
June 11th Cayuga Co.



Life Cycle of the Spotted Wing Drosophila
Drosophila Suzukii (Matsumurai)

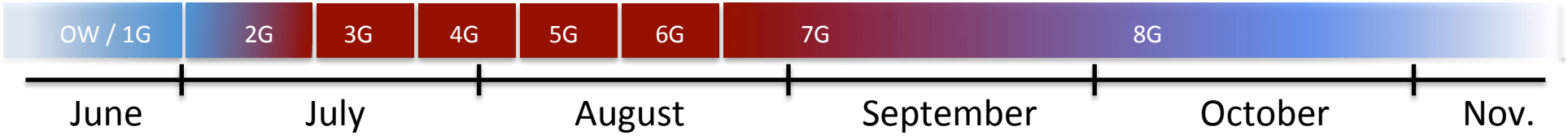
Yearly First Trap Captures

New York	Michigan
2011 – Sept. 11 (Columbia/Suffolk)	2011 – August 7
2012 – July 20 (Ulster)	2012 – June 3
2013 – June 11 (Ontario)	2013 – May 26
2014 – July 22 (Orleans)	2014 – June 15
2015 – June 22 (Orange)	2015 – June 28
2016 – July 7 (Dutchess)	2016 – June 19
2017 – May 31 (Orleans)	**2017 – May 19**
June 27 (Dutchess)	
2018 – May 22nd (Erie)	**2018 – May 19**

Life Cycle of the Spotted Wing Drosophila
Drosophila suzukii (Matsumurai)

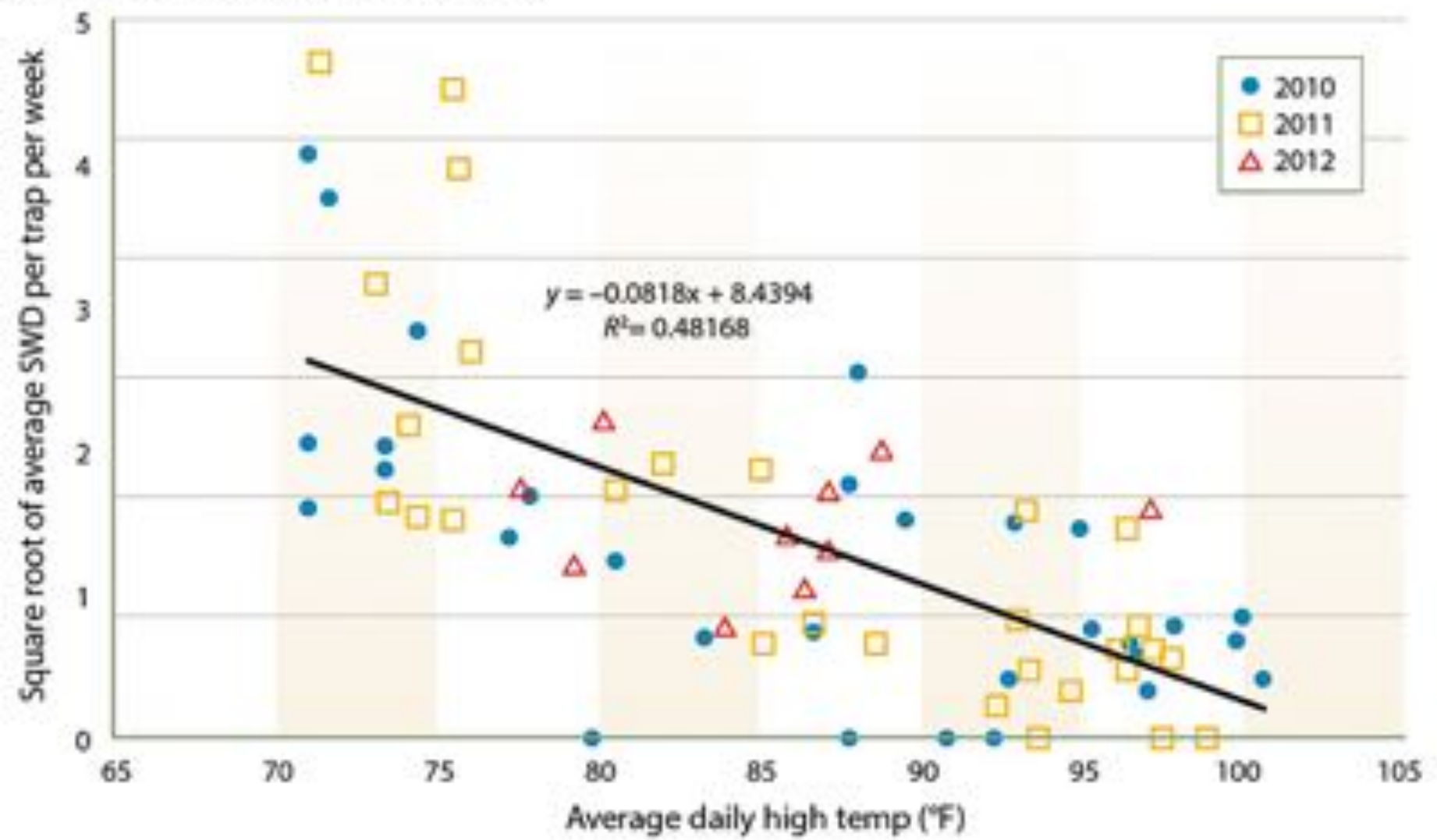
- **Earliest 1st emergence & trap capture on 31st May (Orleans), 27th June (Dutchess), 2017**
- **≥6 Generations / year**
- **350 eggs per female**
- **Majority of the population at any time exist in the immature life stage**
- **Insecticides primarily target the adult stage with some activity against the egg and developing larva**

	egg	larvae	pupae	adult	egg to adult
Spring	72 hrs	7 days	15 days	30 days	25.0 days
Summer	12 hrs	5 days	4 days	20-30 days	9.5 days



Generational Intervals

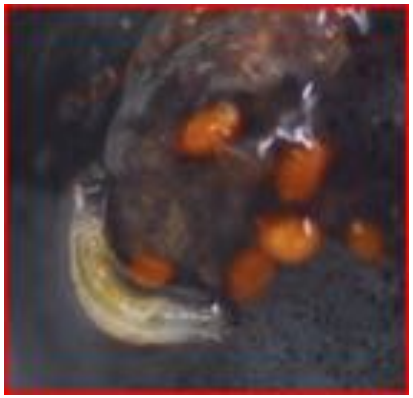
Life Cycle of the Spotted Wing Drosophila
Drosophila suzukii (Matsumurai)



Haverland, D.R. et. al. Phenology of spotted wing drosophila in the San Joaquin Valley varies by season, crop and nearby vegetation. *California Agriculture* 70(1):24-31. https://doi.org/10.3733/ca.v070n01p24 January 01, 2016

Fruit Affected by SWD

Highest risk	Moderate risk	Alternate hosts
Strawberries	Peaches	Wild plants with berries, such as…
Raspberries	**Grapes**	**Tartarian Honeysuckle**
Cherries (Tart pref.)	Pears	Snowberry
Nectarines	Apples	Elderberry
Blueberries	Tomato	Pokeweed
Blackberries		Dogwood

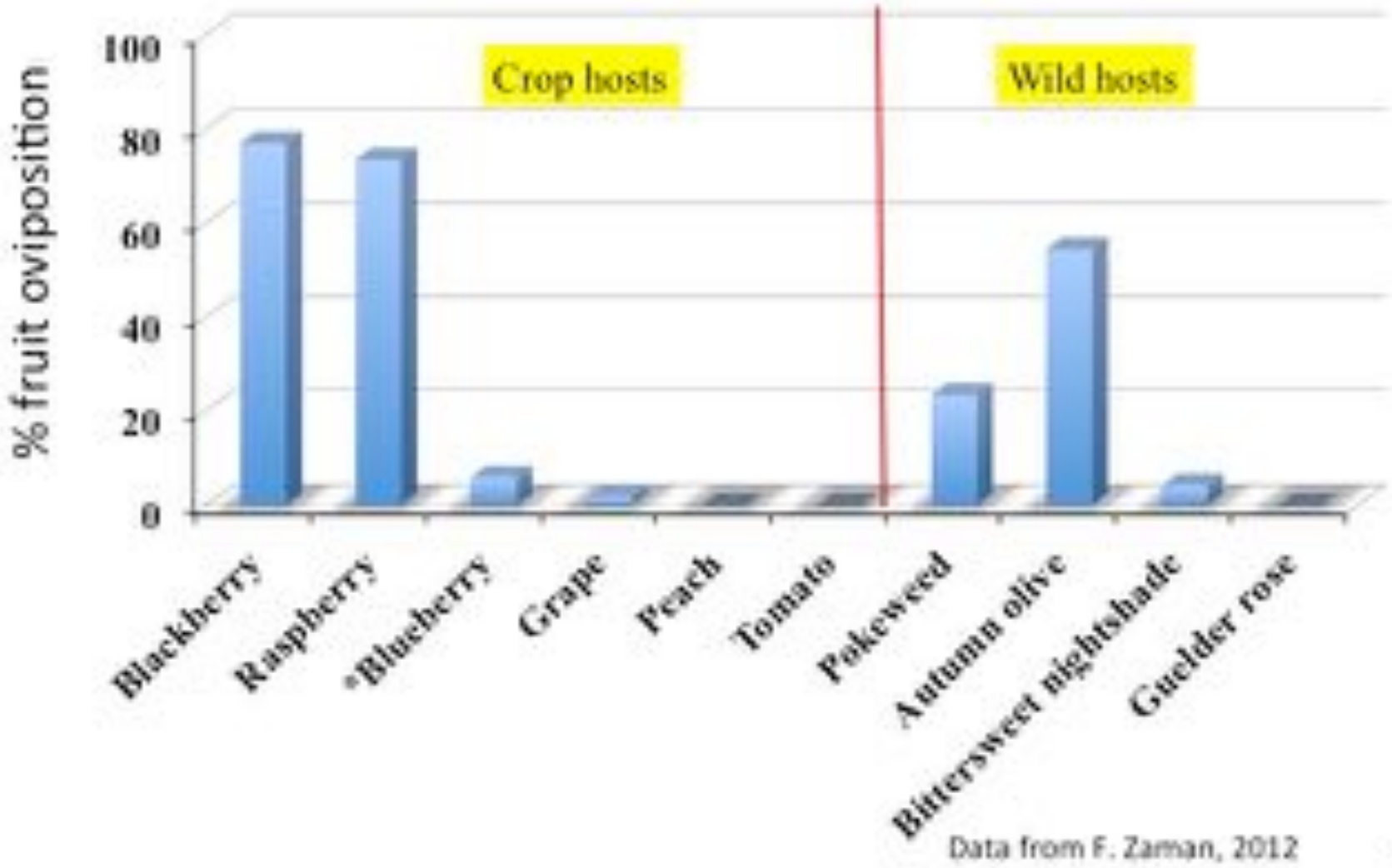
SWD Attract and Kill Management 2015

Honeysuckle is a primary host for SWD; *L. tartarica* fruit favored over raspberry in June-August.

Begin to build in high numbers then move from alternate host to crops.

Potential for use as management sites using biological control and attract and kill for SWD in alternate hosts.

Fruit and wild berries oviposited or egg laid by SWD -2012



Data from F. Zaman, 2012

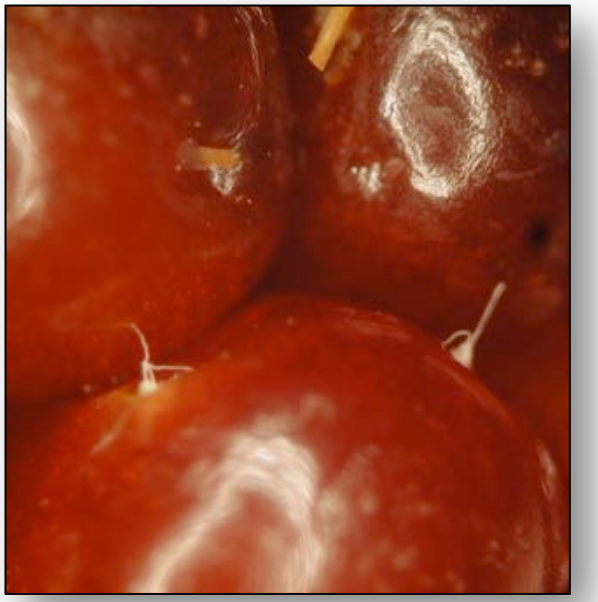
Sampling and Monitoring Protocols

Monitoring: Set traps in late May along wooded / hedgerow edge of crop
Check traps weekly for adult fly. (Scentry SWD trap and lure; $15.00 ea.)

Extension Outreach: EDDMaps for first trap capture

Sampling: Salt foltation
Sample 25 fruit from each of 4 edge plants to observe 1st eggs in fruit

Application: Begin at 1st observation of egg laying.



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

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

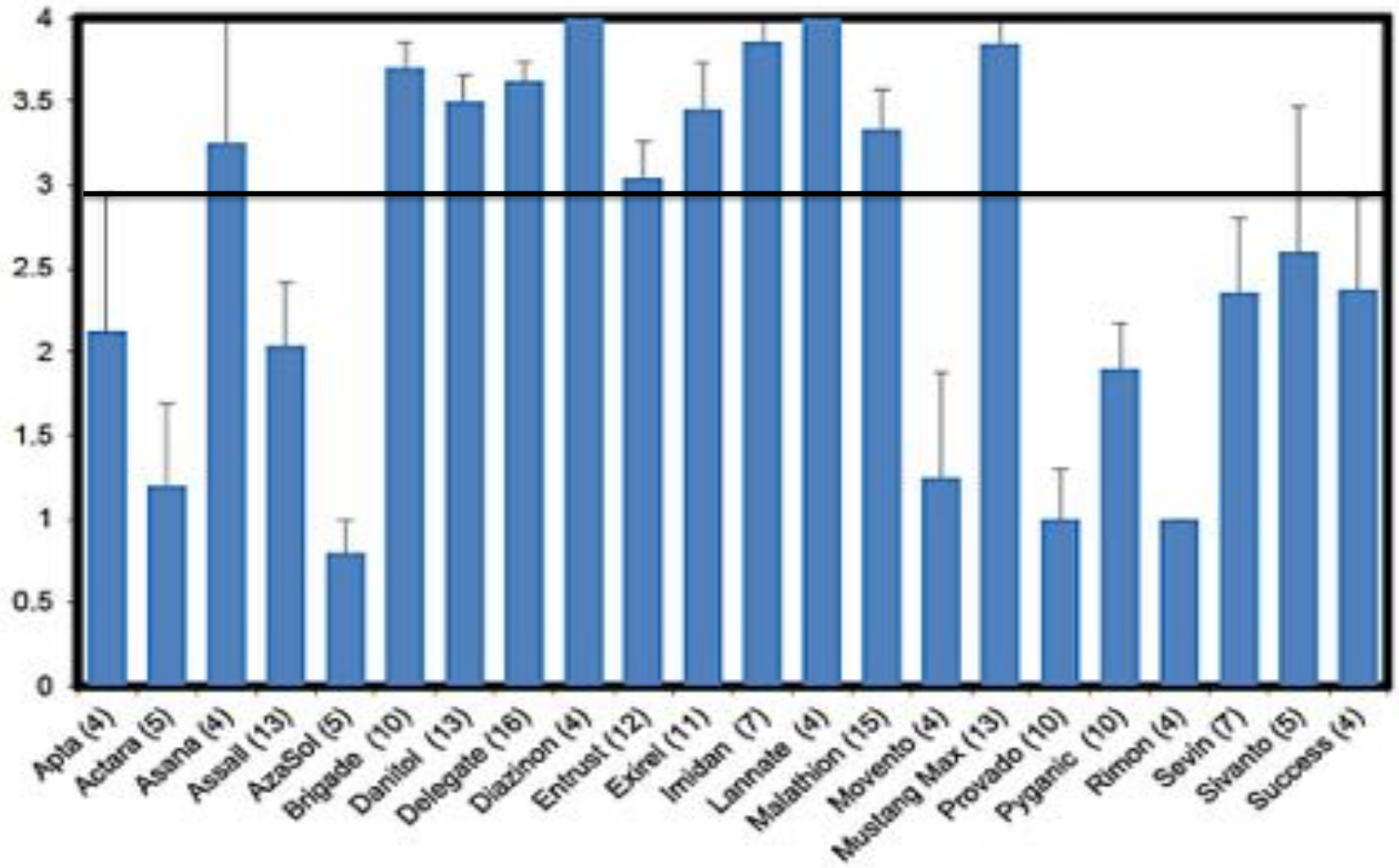


Figure 1. Average ± S.E. efficacy rankings for 22 insecticides that have been tested against SWD in various fruit crops. Insecticides were ranked as not effective (score = 0), weakly active (1), fair (2), good (3), or excellent (4). Only insecticides that had 4 or more submitted are included in the figure,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

Larry Gut, Feb. 8th, 2018 Horticultural Days - Southwest Michigan Lake Michigan College, Mendel Center, Benton Harbor, MI

Success and Failure in West Central Michigan 2017 Cherry Production

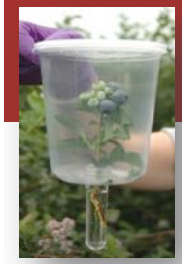
- **Successful control of SWD:** Applications began about three weeks before predicted harvest, keeping tight intervals (six to eight days) using excellent rated insecticides. Consideration for re-application of insecticide shortly after rain events.

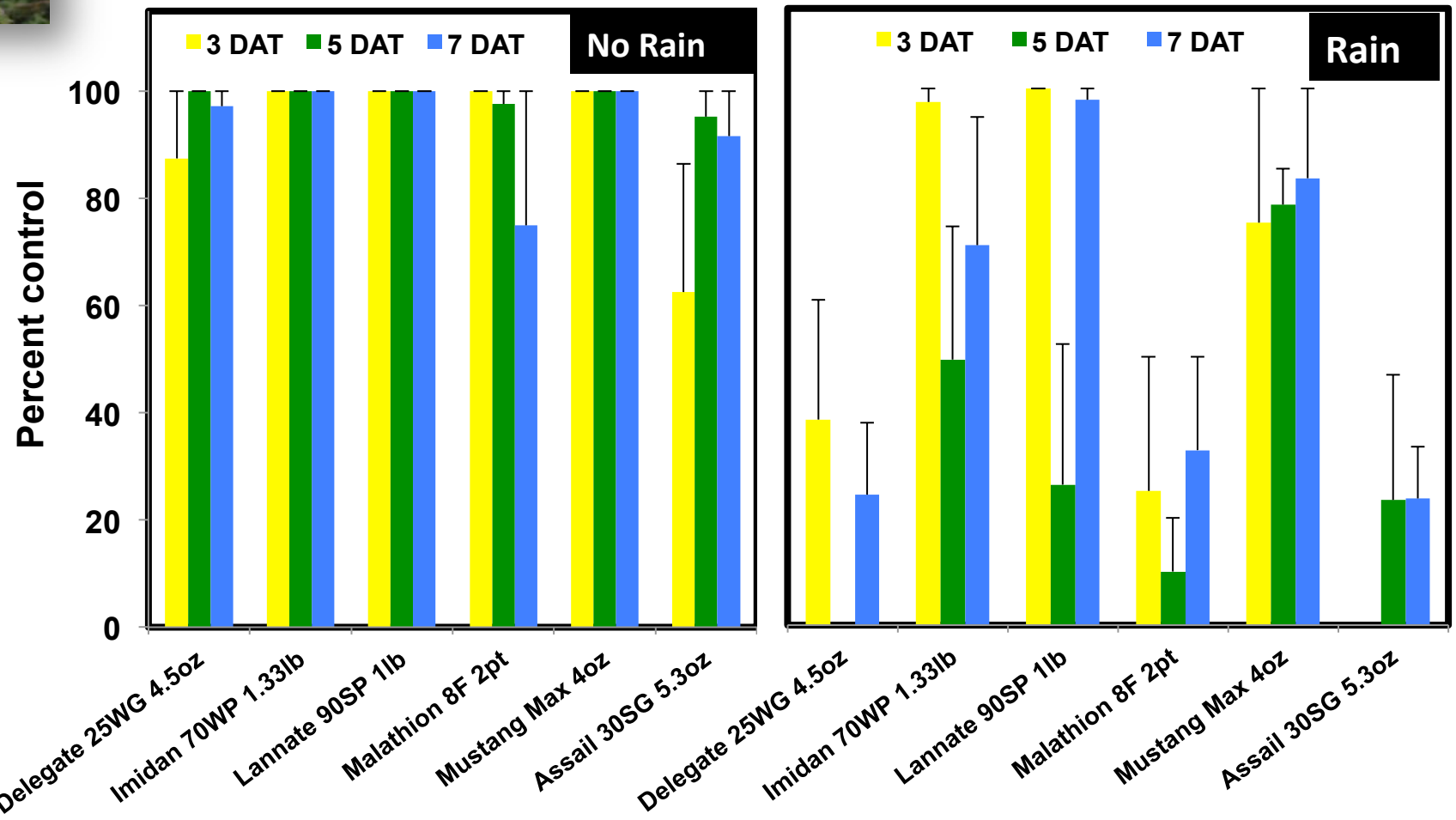
- **Failure: Growers beginning 'early',** four weeks from harvest and trying to stretch the same number of sprays further to keep costs down, suffered SWD larval contamination.

Larry Gut, Feb. 8th, 2018 Horticultural Days - Southwest Michigan Lake Michigan College, Mendel Center, Benton Harbor, MI

Effect of Rain on Some Common Insecticides in Blueberry

From Rufus Isaacs, MSU

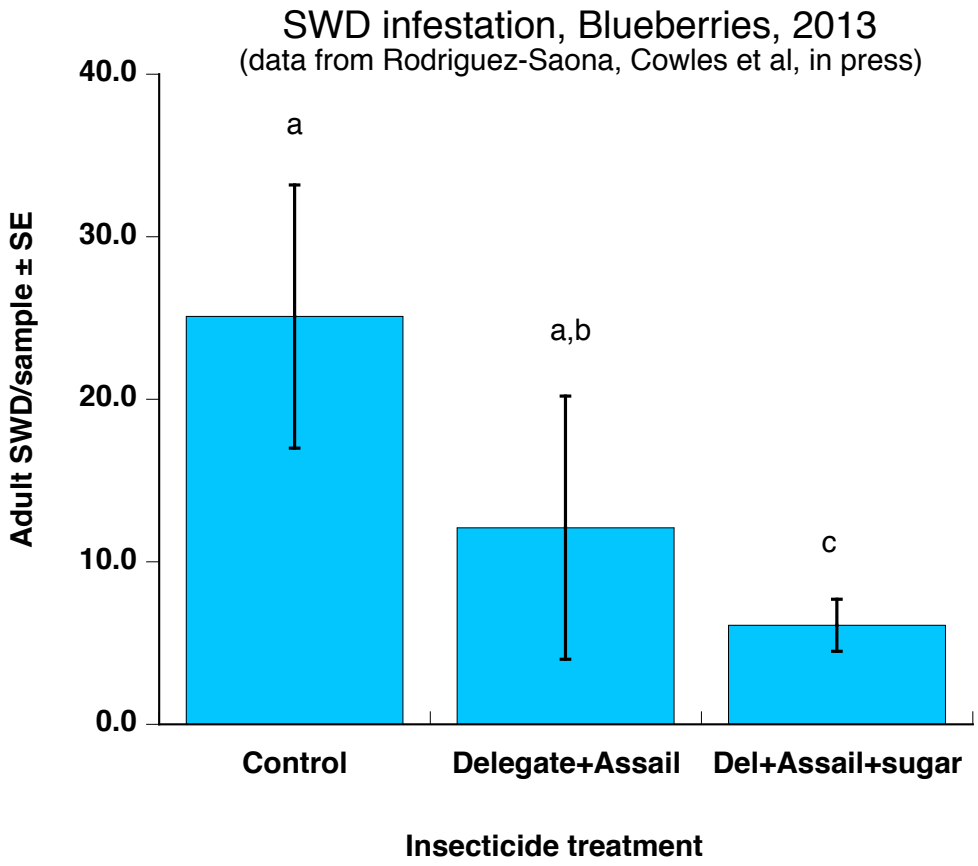




0.8 inches of rain on treated bushes
1 day after application

MICHIGAN STATE UNIVERSITY

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
- 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

Thanks to the staff at the HVRL for all their support:

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Research Assistant	Lucas Canino
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Administrative Assistant	Erica Kane
Administrative Assistant	Christine Kane
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