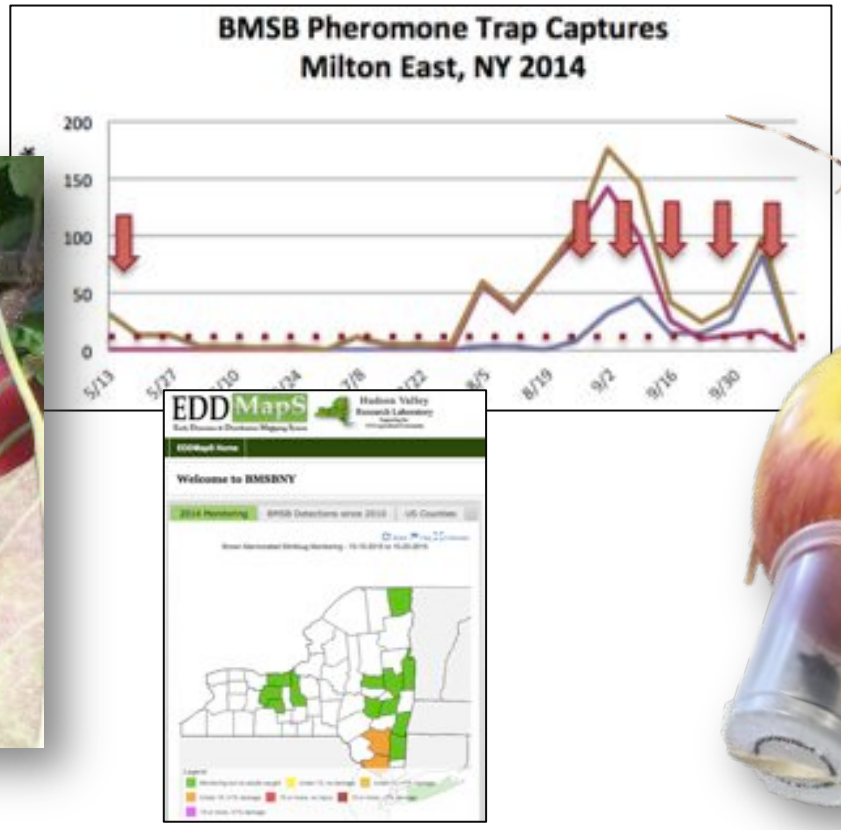
Monitoring and Management of the Stink Bug Complex In the Northeast



Peter J. Jentsch

Red Tomato Annual Growers Meeting

February 28th , 2018

Henry A. Wallace Center, FDR Presidential Library

Hyde Park, NY

BMSB Spread: New Zealand

New Zealand: 4.5 million people
Apple Production:

2012: 16.0 million cartons

2016: 19.5 million cartons

2017: 21.5 million cartons ($800 million)
(carton approx. bushel (40.7 lbs.)

Ideallic production conditions
Low disease and insect pressure

'Our apples have the highest food safety profile of any fruit or vegetable, earning us exclusive market access…consistently delivering the most sustainable, safe, high quality, and exclusive apples and pears'

BMSB Spread: New Zealand

Brown Marmorated Stink Bug Management

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

Stink Bug Biology

- **Population Dynamics:** Overwintering Success, # of generations per yr.
- **Environmental conditions:** Temperature Extreames, Drought, Crop Irrigation
- **Ecology:** Plant Host Suitability (bi-annual seed availability)
- **Biological Control Availability:** Predator/Prey dynamics; Parasitoid host finding

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

Stink Bug Biology

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

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).

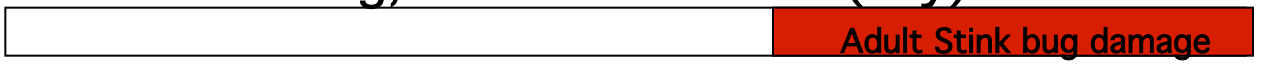
- Native to North America
- Arborial dwelling, feed on seed, stems and foliage
- Moves to apple borders during periods of drought

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

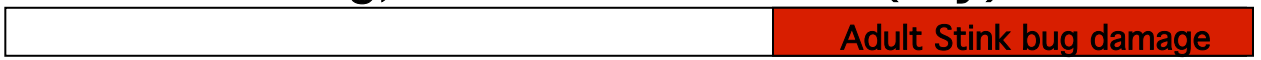
Brown Stink Bug, *Euschistus servus* (Say)



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).



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)

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

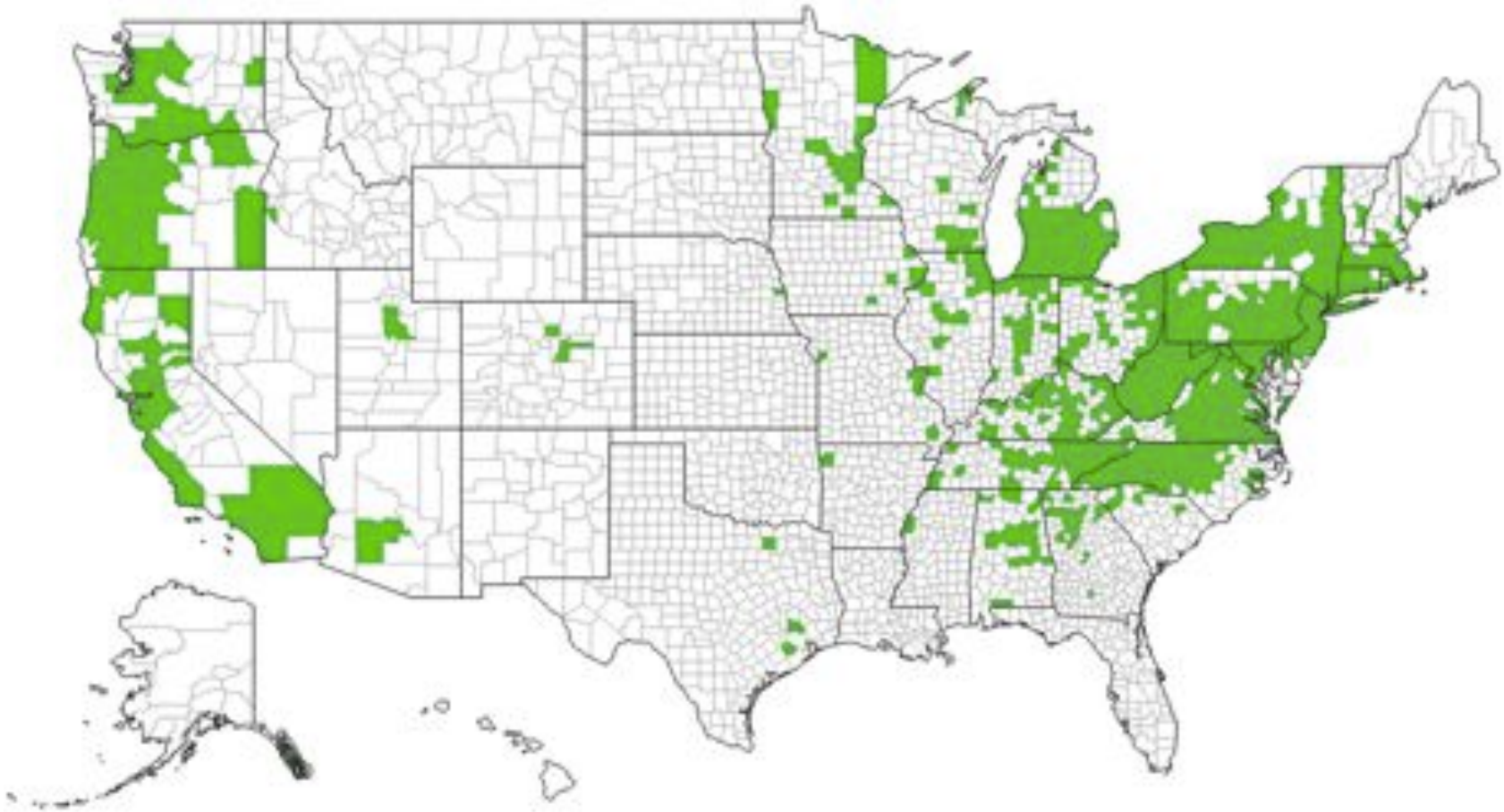
21 March 21 April 27 April 1 May 14 May 28 May 10 June 25 June 5 July 15 July 1 Aug. 15 Aug. 1 Sept.

EDDMapS

brown marmorated stink bug
Halyomorpha halys (Stal)

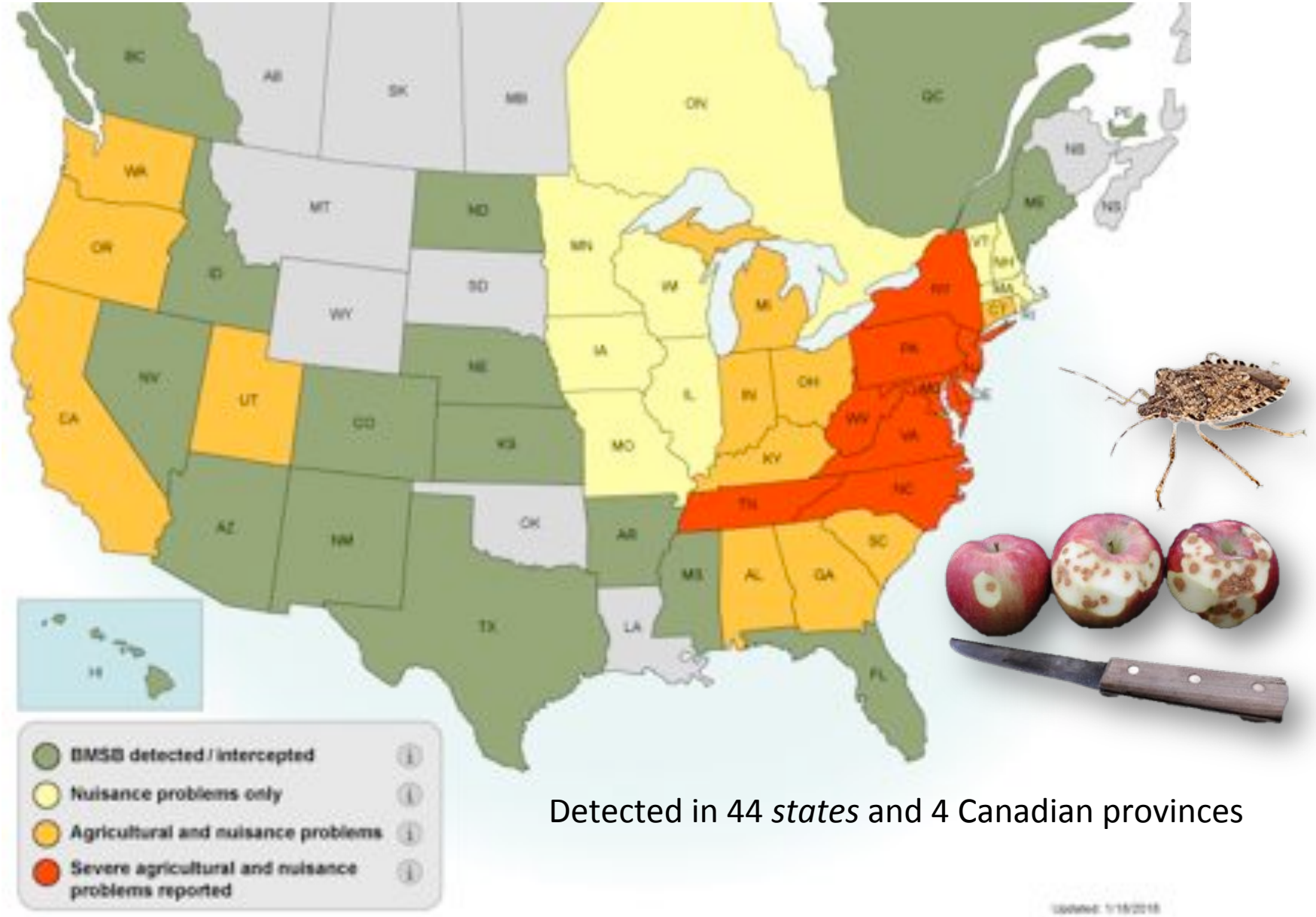
States | Counties | Points | List

Citizen Science Project Participation (Homeowners)
BMSB has been detected in all but 6 of 62 counties in NYS



Legend
No Data
Species Reported

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



Detected in 44 *states* and 4 Canadian provinces

Factors for BMSB Success: Overwintering

Overwintering habitat

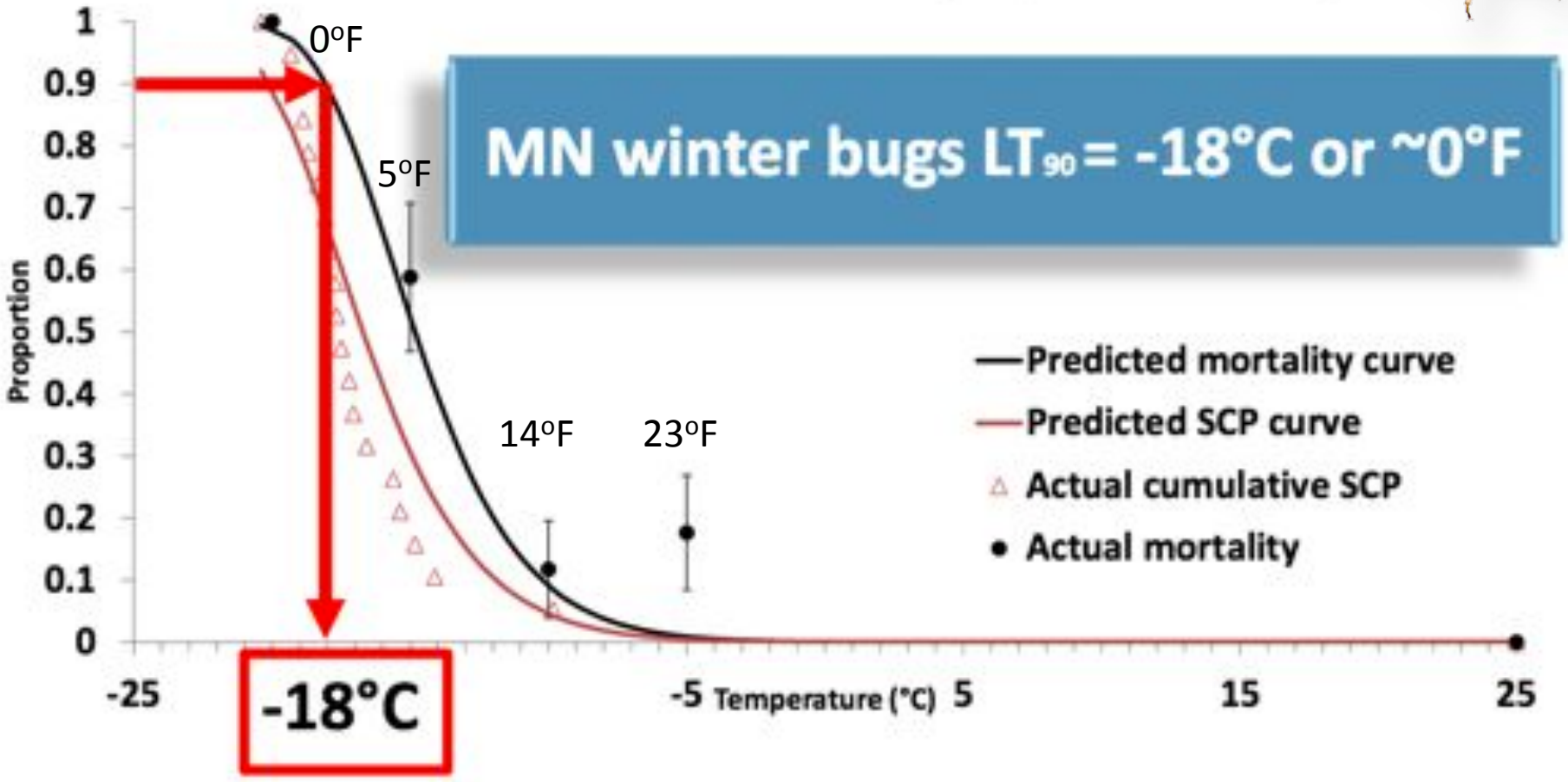
- A smaller percent of the population will aggregate in buildings where temperature extremes allow for survival in northern climates, **potentially creating localized cluster points for Ag. infestations.**

- 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)

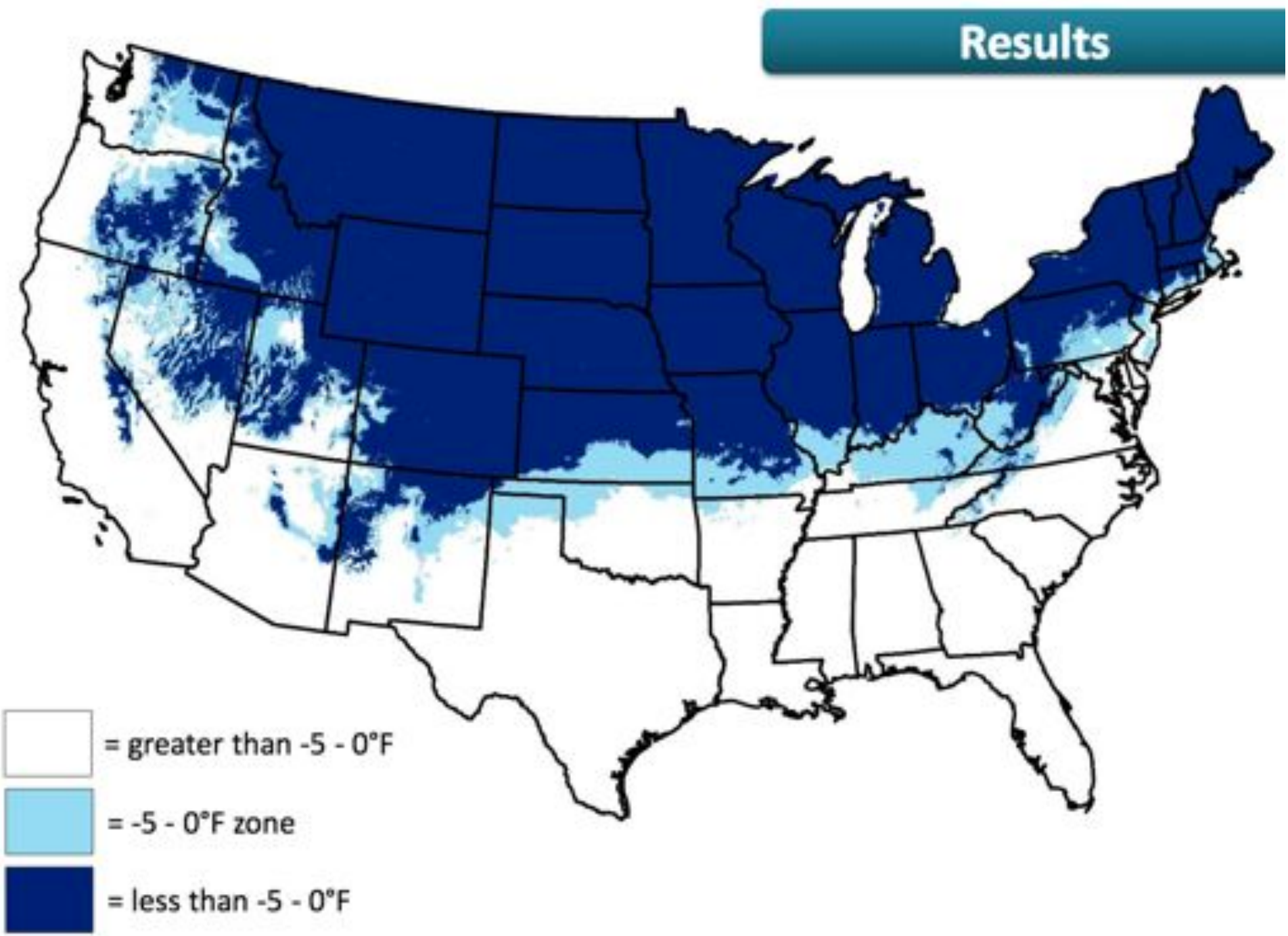
Factors for BMSB Success: Overwintering

Predicted and observed BMSB: Cumulative SCP & proportion mortality



SCP: n=19 bugs
Mortality: n=17 bugs/each temp (mean ± 95% confidence interval)
Regression curves fitted with a Weibull distribution

Results

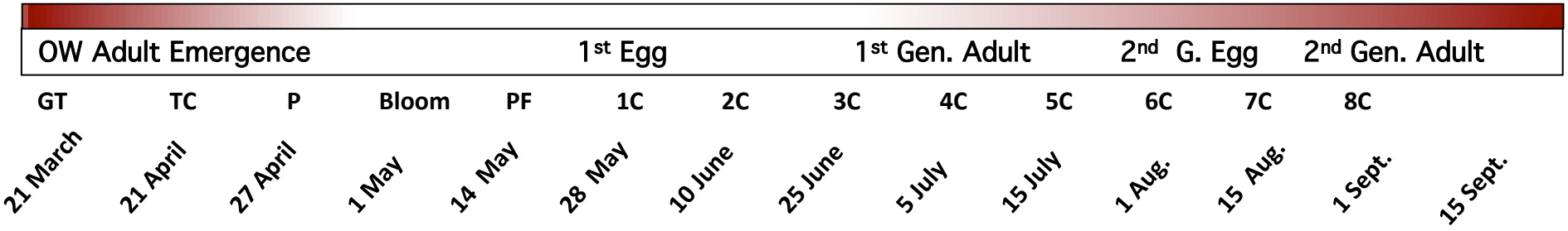


Factors for BMSB Success: # of Generations

- **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:

- clip holding 1 #10 & 1 MDT lure

Cone base

Killing strip of Vapona; bungi cord straps

Plywood /plastic triangle black base to mimmic tree trunk

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

NOT placed in the orchard but along decidious woodland

AgBio-inc.com

Trap, lures, kill strip

Green & Brown Marmorated Stink Bug: Monitoring

Tedders Trap
+ duel pheromone

Sticky Card Trap
+ duel pheromone

AtK Trap (Vesteegard)
+ duel pheromone

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
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- **Stink Bug Injury Diagnostics**
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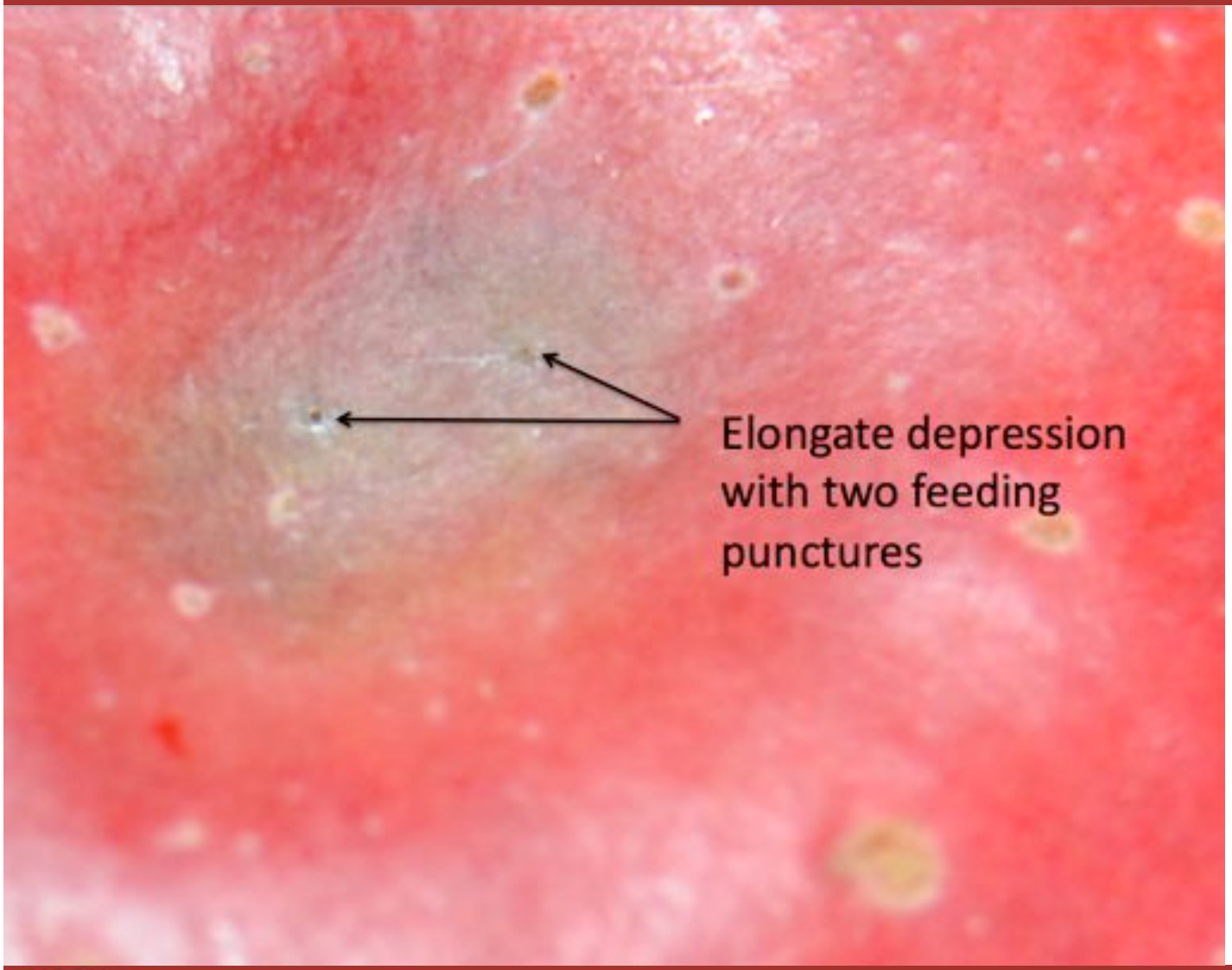
BMSB: Defining Injury
Stink Bug, Hail, Bitter Pit, Maggot



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
- Discoloratio
- No corking
- Oxidized tunneling or trails

Brown Marmorated Stink Bug Management

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

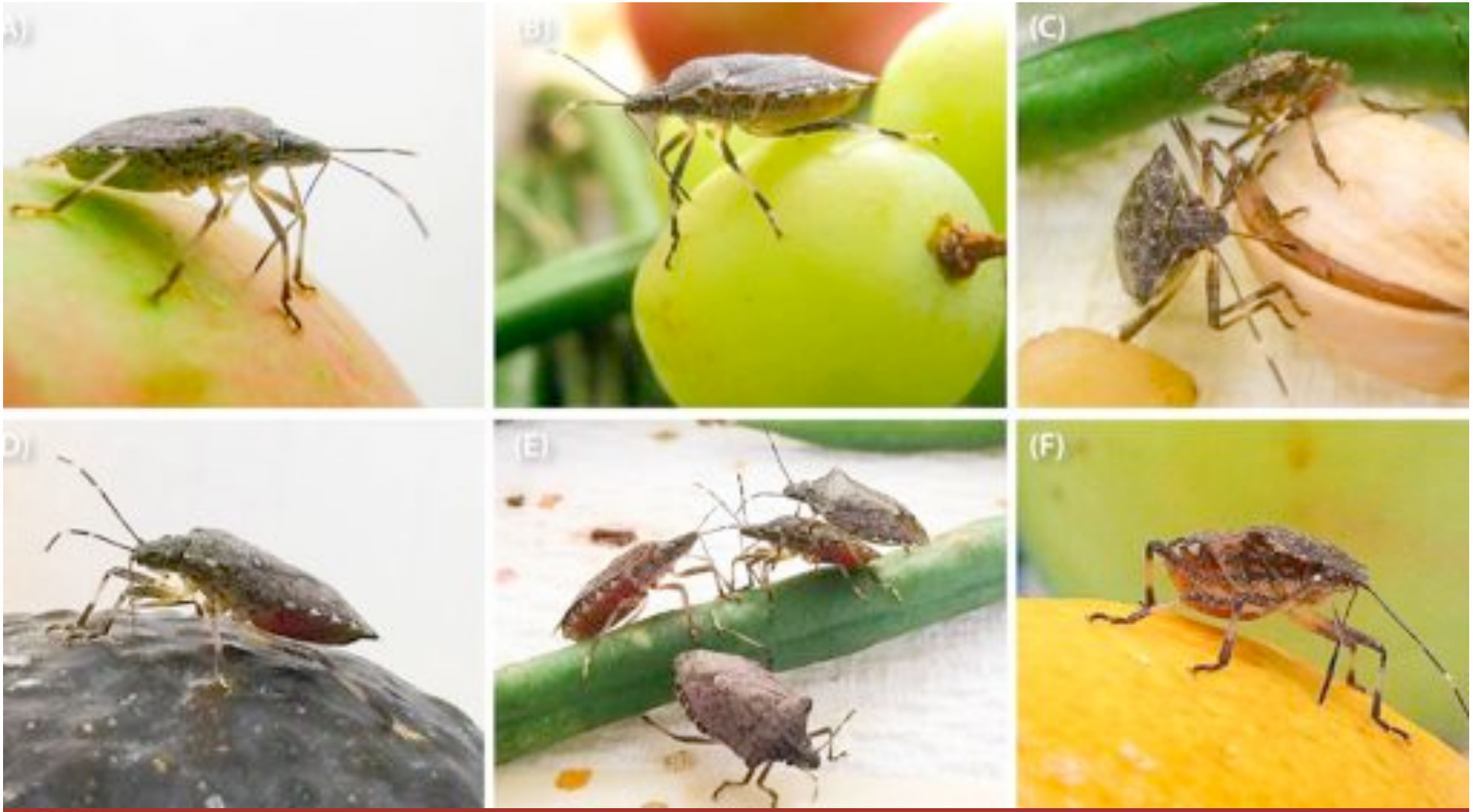
BMSB: Body Mass

Increased Rates of A.I. Needed to Induce Mortality Relative to Plum Curcilio

Plum Curculio

BMSB

BMSB: Residual Efficacy
Feeding Sheath & Limited Abdominal Contact with Fruit



BMSB mortality based on direct contact bioassays – organophosphates, IRAC 1B

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	% DIRECT MORTALITY**			RESIDUAL: LETHALITY INDEX[1]
				24 h	72 h	120 h	
Acephate 97UP	acephate	4 oz	Nonbearing/border	13	42	63	88
Acephate 97UP	acephate	1 lb	Nonbearing/border	10	45	73	88
Diazinon 50W	diazinon	3 lb	PF, SF	0	3	7	20
Guthion	azinphos-methyl	2 lb	PF	3	13	27	71
Imidan	phosmet	4 lb	PF, SF	2	20	35	20
Lorsban Adv.	chlorpyrifos	3 pt	Before bloom	42	73	82	89
Penncap-M	methyl parathion	6 pt	Not registered	65	82	87	93
Thionex 50W	endosulfan	2 lb	PF, SF	52	98	100	90
Thionex 50W	endosulfan	4 lb	PF, SF	33	98	100	90

[1] – based on dry residual bioassays T. Leskey, USDA ARS

**PF- Pom Fruits, SF- Stone Fruits, G- Grapes*

*** Mortality includes dead plus moribund*

BMSB mortality based on direct contact bioassays – pyrethroids, IRAC 3

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL: LETHALITY INDEX[1]
				24 h	72 h	120 h	
Asana XL	esfenvalerate	14 oz	Apple, Pear, SF	15	27	48	43
Baythroid XL	beta-cyfluthrin	2 oz	PF, SF, G	7	13	37	55
Baythroid XL	beta-cyfluthrin	2.8 oz	PF, SF, G	42	30	53	55
Bifenture EC	bifenthrin	12.8 oz	G, Pears	98	100	100	92
Brigade 2EC	bifenthrin	10 oz	G, Pears	100	100	95	92
Danitol 2.4EC	fenpropathrin	12 oz	PF, SF, G	87	65	60	67
Danitol 2.4 EC	fenpropathrin	16 oz	PF, SF, G	95	82	82	67
Hero	bifenthrin zeta-cypermethrin	10 oz	Not registered	93	87	82	92 52
Lambda-Cy EC	lambda-cyhalothrin	4.4 fl oz	Not registered	52	40	35	53
Mustang Max	zeta-cypermethrin	4 oz	PF, SF, G	67	37	30	52
Pounce 25 WP	permethrin	16 oz	PF, SF	45	42	35	77
Warrior II	lambda-cyhalothrin	2 oz	PF, SF	73	72	77	53
Warrior II	lambda-cyhalothrin	2.5 oz	PF, SF	52	51	53	53

**PF- Pome Fruits, SF- Stone Fruits, G- Grapes*

*** Mortality includes dead plus moribund*

[1] – based on dry residual bioassays T. Leskey, USDA ARS

BMSB mortality based on direct contact bioassays – carbamates (IRAC 1A)

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL LETHALITY INDEX[1]
				24 h	72 h	120 h	
Carzol SP	formetanate	1 lb	PF, SF	58	68	68	64
Lannate LV	methomyl	2 pt	Apple, Peach, G	88	90	90	90
Lannate LV	methomyl	3 pt	Apple, Peach, G	87	92	92	90
Lannate SP	methomyl	6 oz	Apple, Peach, Nectarine	52	55	60	90
Lannate SP	methomyl	9 oz	Apple, Peach, Nectarine	88	92	92	90
Lannate SP	methomyl	12 oz	Apple, Peach, Nectarine	85	87	87	90
Lannate SP	methomyl	16 oz	Apple, Peach, Nectarine	92	98	98	90
Sevin XLR Plus	carbaryl	3 pt	PF, SF	3	12	8	9
Vydate L	oxamyl	4 pt	Apple, Pear	52	58	63	34
Vydate L	oxamyl	6 pt	Apple, Pear	68	73	82	34

**PF- Pome Fruits, SF- Stone Fruits, G- Grapes*

*** Mortality includes dead plus moribund*

[1] – *based on dry residual bioassays T. Leskey, USDA ARS*

BMSB mortality based on direct contact bioassays – neonicotinoids, IRAC 4A

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	Fruit REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL LETHALITY INDEX[1]
				24 h	72 h	120 h	
Actara	thiamethoxam	4 oz	PF, SF, G	92	95	97	56
Actara	thiamethoxam	5 oz	PF, SF, G	77	95	98	56
Admire Pro	imidacloprid	7 oz	PF, G	82	87	88	40
Assail 30SG	acetamiprid	6 oz	PF, SF, G	87	87	63	19
Assail 30SG	acetamiprid	8 oz	PF, SF, G	83	83	95	19
Assail 70WP	acetamiprid	3.4 oz	PF, SF, G	78	83	75	19
Belay	clothianidin	6 oz	PF, Peach, G	100	100	100	56
Calypso 4F	thiacloprid	8 fl oz	PF	58	52	53	18
Endigo ZC	lambda-cyhalothrin thiamethoxam	3 oz	PF, SF	93	95	87	53 56
Endigo ZC	lambda-cyhalothrin thiamethoxam	5 oz	PF, SF	98	100	98	53 56
Leverage 360	imidacloprid beta-cyfluthrin	2.8 oz	PF, SF, G	95	93	88	40 55
Scorpion 35SL	dinotefuran	5 oz	G	97	98	97	67
Venom	dinotefuran	3 oz	G	93	98	98	67

*PF- Pom Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

BMSB mortality based on direct contact bioassays – mixes (IRAC various)

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL LETHALITY INDEX[1]
				24 h	72 h	120 h	
Endigo ZC	lambda-cyhalothrin thiamethoxam	3 oz	PF, SF	93	95	87	53 56
Endigo ZC	lambda-cyhalothrin thiamethoxam	5 oz	PF, SF	98	100	98	53 56
Hero	bifenthrin zeta-cypermethrin	10 oz	Not registered	93	87	82	92 52
Leverage 360	imidacloprid beta-cyfluthrin	2.8 oz	PF, SF, G	95	93	88	40 55
Voliam Xpress	lambda-cyhalothrin chlorantraniliprole	10 fl oz	PF, SF	40	40	38	53 N/A
Voliam Flexi	thiamethoxam chlorantraniliprole	6 oz	PF, SF, G	100	100	100	56 N/A

*PF- Pom Fruits, SF- Stone Fruits, G- Grapes
** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

BMSB mortality based on direct contact bioassays – Various IRAC Groups

G. Krawczyk, PSU FREC 2011.

PRODUCT	ACTIVE INGREDIENT	FIELD RATE tested	FRUIT REGISTRATION*	Percent DIRECT MORTALITY**			RESIDUAL LETHALITY INDEX[1]
				24 h	72 h	120 h	
Agri-Mek 0.15EC	abamectin	15 oz	Apple, Pear, SF, G	2	7	8	16
Altacor	chlorantraniliprole	3 oz	PF, SF, G	3	7	12	N/A
Avaunt	indoxacarb	6 oz	PF, SF, G	0	5	13	11
Beleaf 50SG	flonicamid	2.8 oz	PF, SF	5	10	15	8
cyazypyr		100 ppm	Not registered	5	3	5	
Delegate WG	spinetoram	7 oz	PF, SF, G	0	3	15	N/A
Esteem 0.86EC	pyriproxyfen	5 oz	PF, SF	0	5	8	N/A
M-Pede	insecticidal soap	2%	PF, SF, G	0	2	5	N/A
M-Pede Spray	insecticid soap	2%	PF, SF, G	10	15	15	N/A
Neemix 4.5	azadirachtin	16 oz	PF, SF, G	0	2	8	N/A
Rimon 0.83EC	novaluron	30 oz	PF, SF	0	2	2	N/A
Stylet Oil	mineral oil	2%		2	2	5	
Besiege	lambda-cyhalothrin chlorantraniliprole	12 fl.ox.	PF, SF	40	40	38	53 N/A
Voliam Flexi	thiamethoxam chlorantraniliprole	6 oz	PF, SF, G	100	100	100	56 N/A

*PF- Pome Fruits, SF- Stone Fruits, G- Grapes

** Mortality includes dead plus moribund

[1] – based on dry residual bioassays T. Leskey, USDA ARS

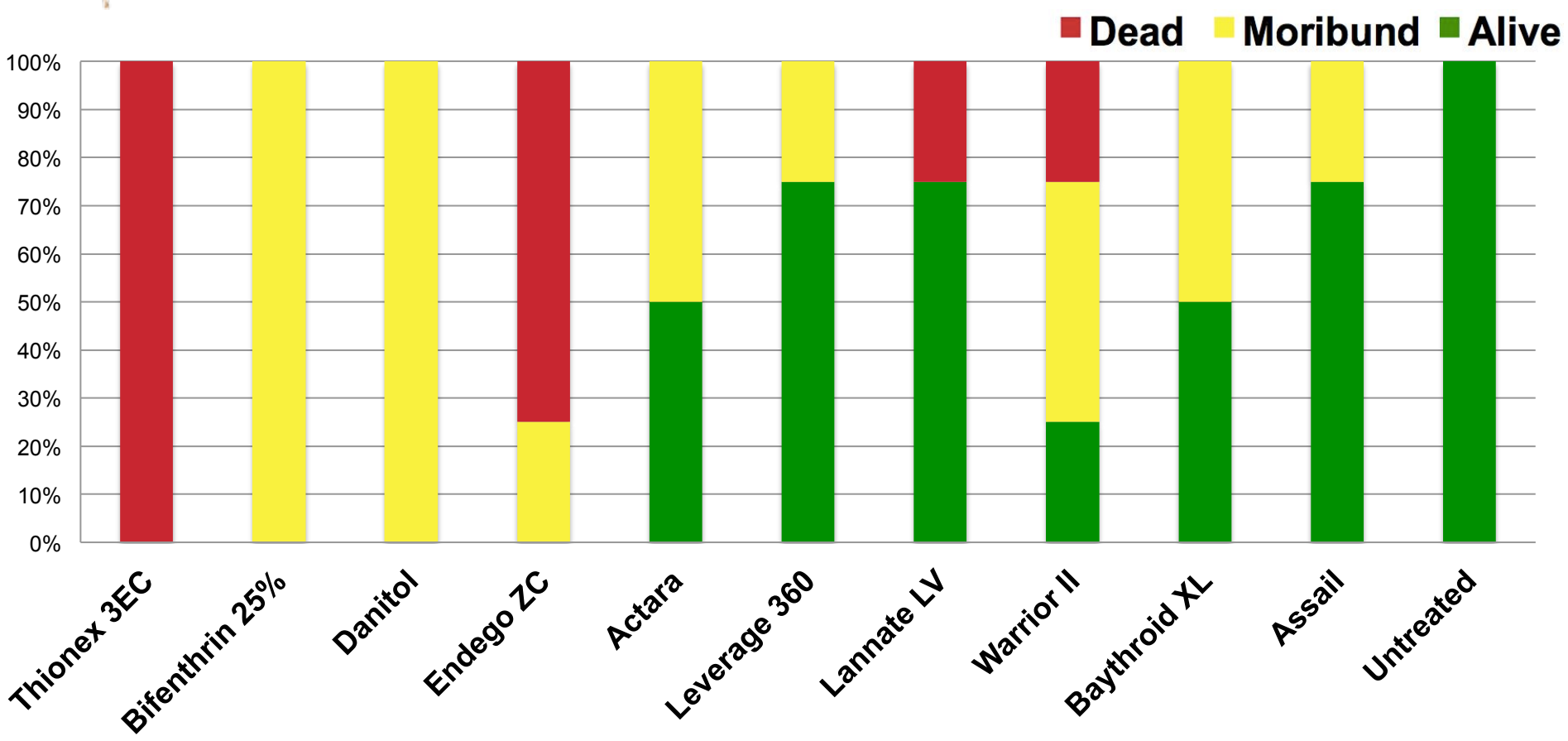
Management Options

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-cyhalothrin and thiamethoxam	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.

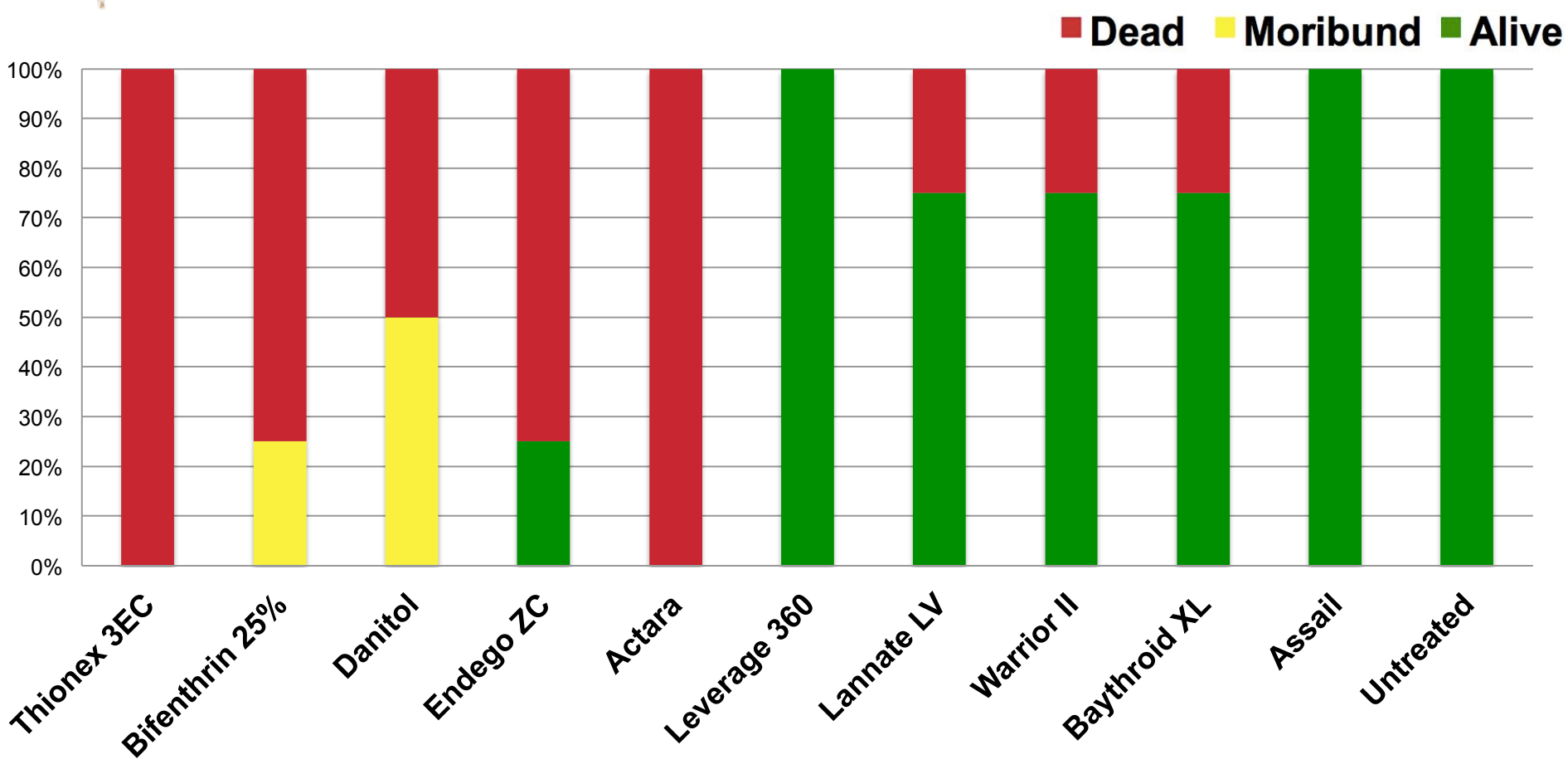
Management Options

BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 1 d

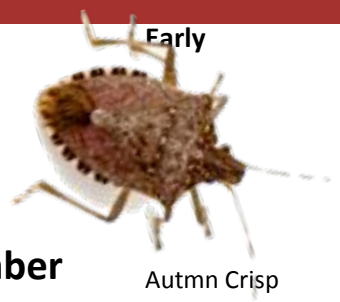


Management Options

BMSB Adult Exposure to Insecticide Residue of Apple Foliage
24h Old Residue @ 3 d



NY BMSB Management Options

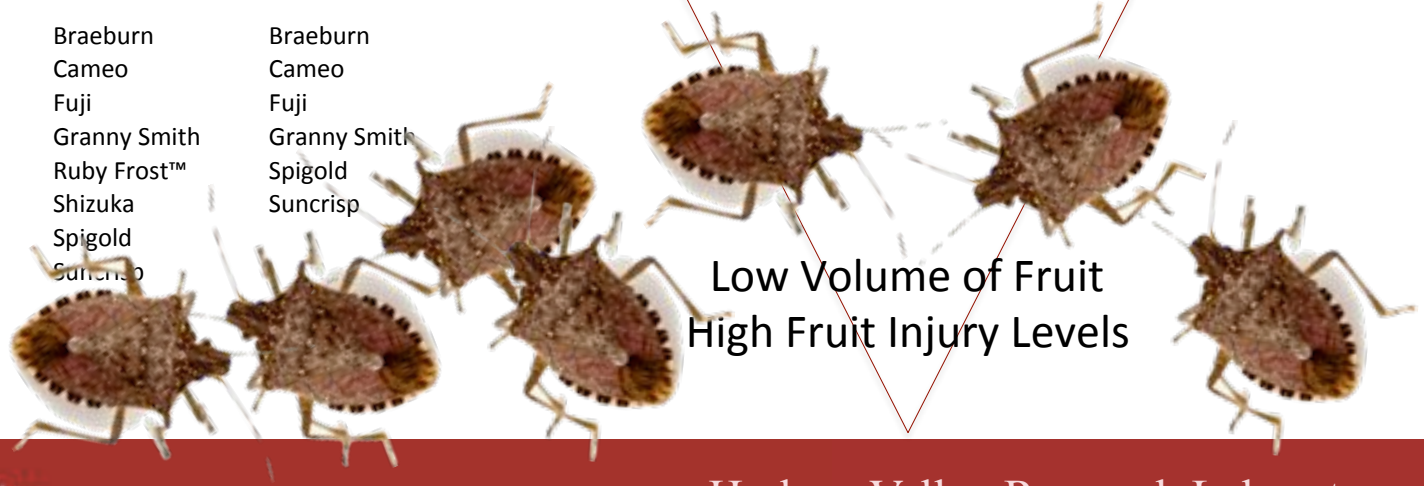


	Early	Mid	Late	
August		Blondee Sansa	Blondee Paulared Tydeman Zestar	Single application in early August 14-7d PHI
September	Autmn Crisp Blondee Gala Ginger Gold	Autmn Crisp Cortland Empire Honeycrisp	Ambrosia Autmn Crisp Braeburn Golden Delicious	2-4 applications beginning in early August 35-7d PHI
	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 35-7d PHI
				>6 applications beginning in early August 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 of Product Containing Thiamethoxam

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

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
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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

Late August-Early September

- 5-10 d application schedule

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
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* 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-September

- 5-10 d application schedule

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

Proceedures Con't

- Generator + 500W Halogen light directed toward the field population of BMSB.
- Plastic sheets to define location and number of BMSB trap and kill data.
- Study was designed to:
    1. Determine the attractiveness of lights with net relative to net alone
    2. Determine the number of BMSB observed coming from field versus forest sides of trap

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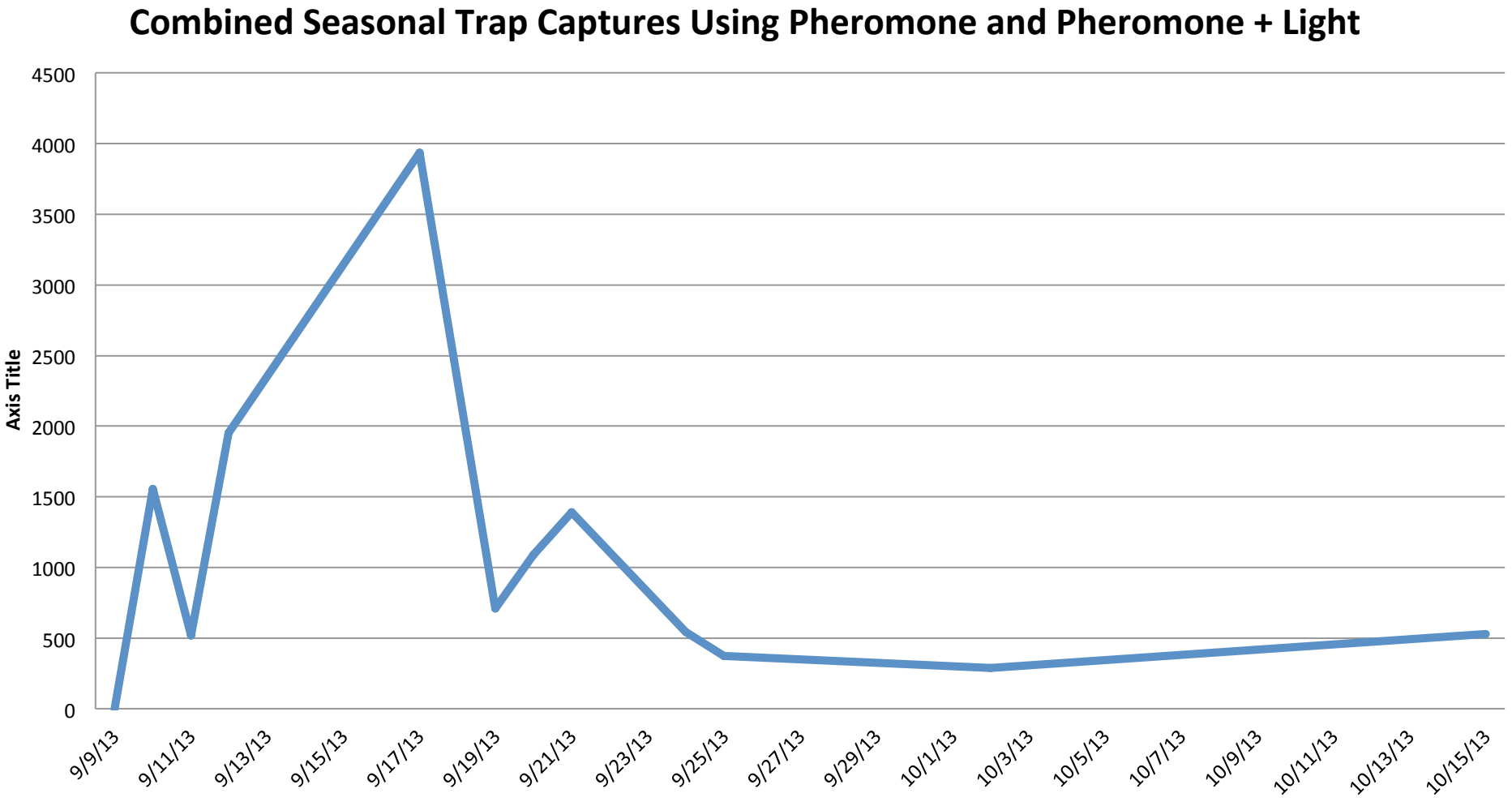
Studies of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål), in New York State



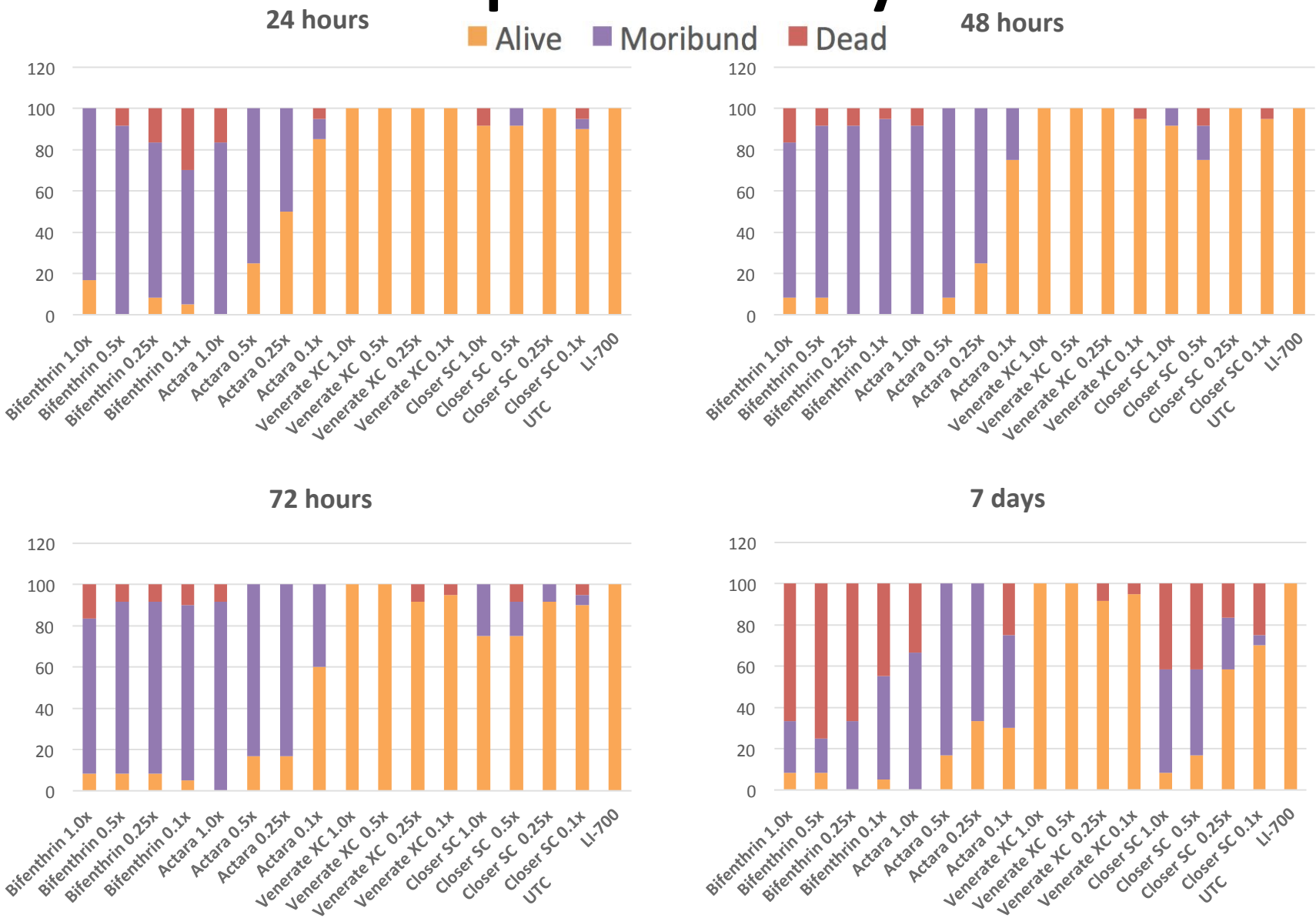
(September – 15 October: Total BMSB = 12,894

BMSB Feeding and Mortality Comparison Using Actara, Bifenthure, Closer, Venerate Topical Bioassay and Residual Treated Apple.

Topical Bioassays

- Stink bug were separated into individual cups for male and female
- Individuals received 2 uL of distilled water, 0.25% LI700, individual insecticide to the dorsal thoractic plate.
  - Treatments: **Actara, Bifenthure, Closer, Venerate, UTC**
  - Doses: 1, 0.5, 0.25, and 0.1 times the top label rate
- Status (alive, moribund, dead) was recorded at 24, 48, 72 hours and at 7d post treatment.

Topical Bioassays



2017 Field Application

Applications using tractor mounted sprayer on 20th Sept. 300 psi. using dilute handgun applications:

- Closure SC 5.75 fl.oz./A
- Bifrenthrin SC 32.0 fl.oz./A
- Actara 25 WDG 5.5 oz./A
- Venerate XC 128.0 fl.oz./A
- BMSB adults placement beginning on 20th Sept.
  - 24h; 48hr; 72hr placement. Collection made after 7d of placement.
  - Insects placed inside portion cups with screened bottoms, rubber band onto the north side of the tree and the north side of those apples to reduce sun exposure.
  - BMSB adults placed into growth chamber supplied green beans
  - Observations made 2x/wk
  - Fruit harvested on 12 Oct. for fruit feeding evaluations

Field Application: Fruit Residue

BMBS placed on apples 24 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.1a	0.1a	0.1a	90a	0a
Bifenthrin	0a	0a	0a	100a	0a
Actara	0a	0a	0a	100a	0a
Venerate	0a	0a	0a	100a	20a
UTC	0.7a	0a	0a	50a	20a
Kruskal-Walis Test, Prob>ChiSq	0.0115	0.8123	0.8123	0.0136	0.3071

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

Field Application: Fruit Residue

BMBS placed on apples 48 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.1b	0.1a	0.1a	90a	0a
Bifenthrin	0b	0a	0a	100a	10a
Actara	0.1b	0.1a	0.1a	90a	0a
Venerate	0.2ab	0a	0a	80ab	40a
UTC	1.2a	0.4a	0.4a	20b	0a
Kruskal-Walis Test, Prob>ChiSq	0.0001	0.4313	0.4313	0.0002	0.0873

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

Field Application: Fruit Residue

BMBS placed on apples 72 hours after pesticide application on Sep.20, 2017.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.2a	0.2a	0.2a	90a	80a
Bifenthrin	0.2a	0.2a	0.2a	90a	10b
Actara	0.2a	0.2a	0.2a	90a	100a
Venerate	0.1a	0a	0a	90a	70a
UTC	1.2a	0.1a	0.1a	40a	30ab
Kruskal-Walis Test, Prob>ChiSq	0.0687	0.9254	0.9254	0.0795	0.0006

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

BMSB Adult Topical Treatment

- Applications were made topically to BMSB adults on 28th Sept. placed on the tree in 10 replicates for each treatment
  - Insects were placed inside portion cups with screened bottoms with a rubber band on the north side of the tree and the north side of those apples to reduce sun exposure as much as possible
- Fruit was collected on 12th October for fruit feeding evaluations

BMSB Adult Topical Treatment

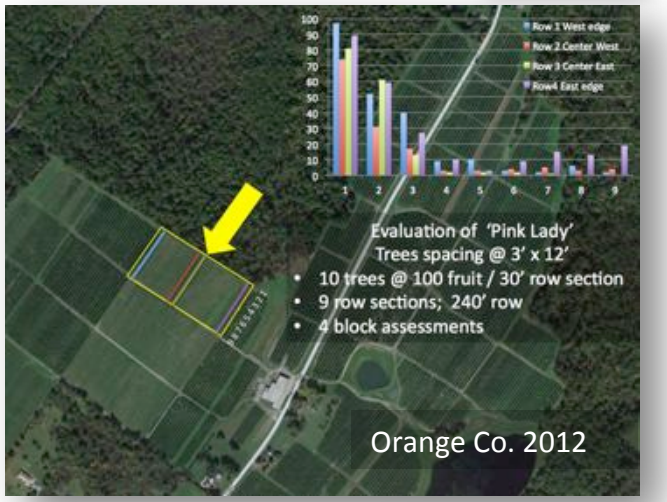
BMSB treated topically on Sep.28, 2017 and placed on apples for 7 days.

	Number of feeding sites per fruit	Dimpling per fruit	Corking per fruit	Clean fruit (%)	Survival (%)
Closer SC	0.3a	0.2a	0.2a	90a	30b
Bifenthrin	0.1a	0a	0a	90a	0b
Actara	0a	0a	0a	100a	10b
Venerate	0a	0a	0a	100a	100a
UTC	0.9a	0a	0a	60a	90a
Kruskal-Walis Test, Prob>ChiSq	0.1288	0.5348	0.5348	0.1093	<.0001

Means followed by the same letter are not significantly different by Steel-Dwass Method at α=0.05 Apples were rated on Oct.12, 2017. BMSB survival were recorded 7 days after exposure to the fruit.

A Behaviorally Based Approach To Managing The Invasive Brown Marmorated Stink Bug (BMSB), *Halyomorpha Halys*

- BMSB has 1-2 gen. in NYS each year, documented to have caused over 10% crop injury in pepper, stone and pome fruit. The native green stink bug, Chinavia halaris (Say), contributes to fruit injury.
- In 2012 commercial orchards in Orange Co. demonstrated BMSB migration from arboreal hosts to tree fruit. Highest injury assessed along the agricultural woodland interface.
- In 2016, a 10 adult BMSB / week threshold occurred in late August in Highland, NY.
- A single perimeter orchard application made along the SE wooded edge in one of two, 5-acre orchard blocks, using 12.8 fl. oz. of Bifenture EC,/A. Both blocks received three applications of Assail 30SG in 14d intervals at 6.0 oz./A. 100 Red Delicious fruit samples were harvested and assessed from 5 trees fruit in four quadrants.
- **Border management was shown to be highly effective in reducing both insecticide use and SB injury.**

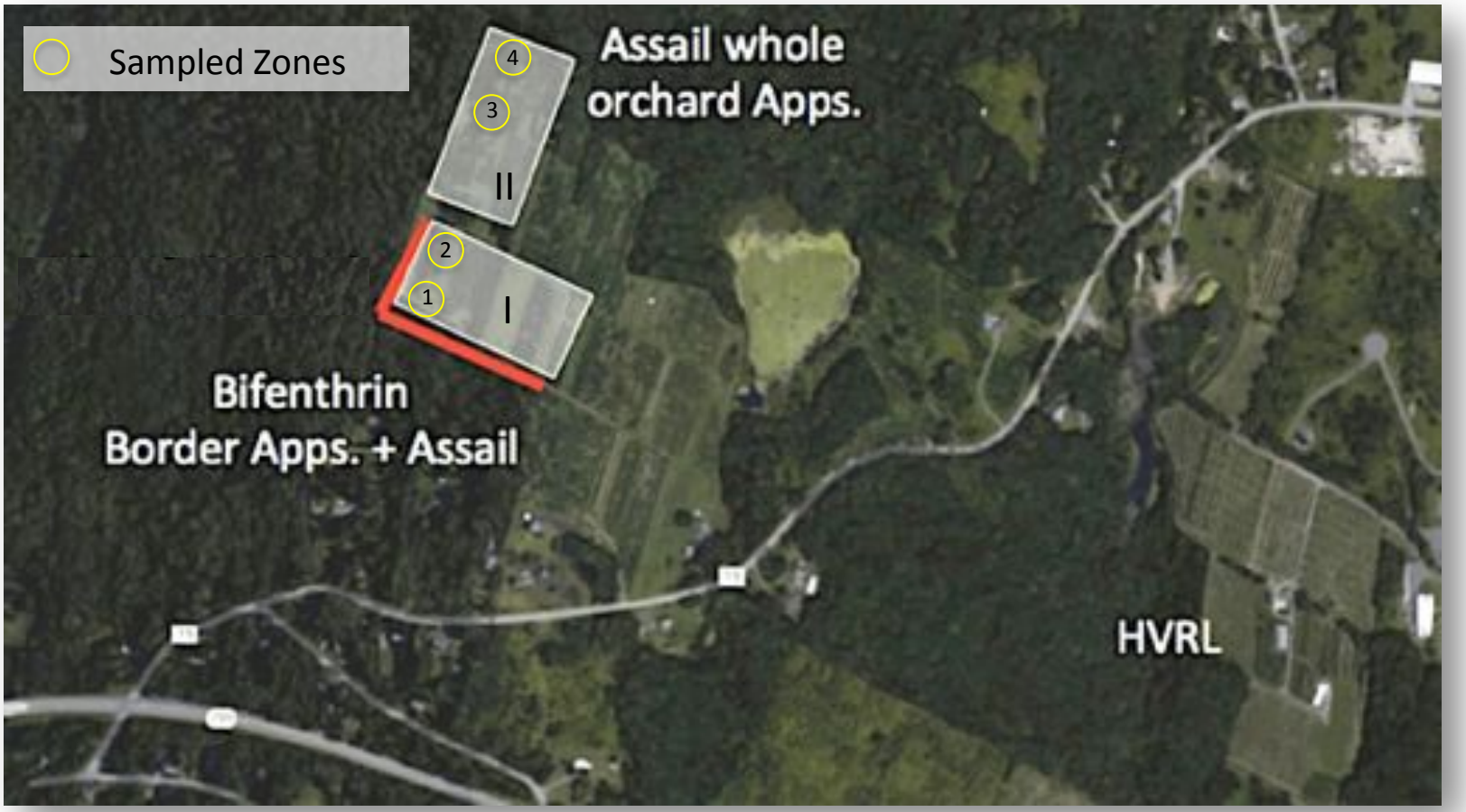


Cornell University
College of Agriculture and Life Sciences

Peter Jentsch
Senior Extension Associate
Dept. of Entomology

Hudson Valley Research Laboratory

A Behaviorally Based Approach To Managing The Invasive Brown Marmorated Stink Bug, *Halyomorpha Halys*



Liberty Orchard, Highland, NY, 2016

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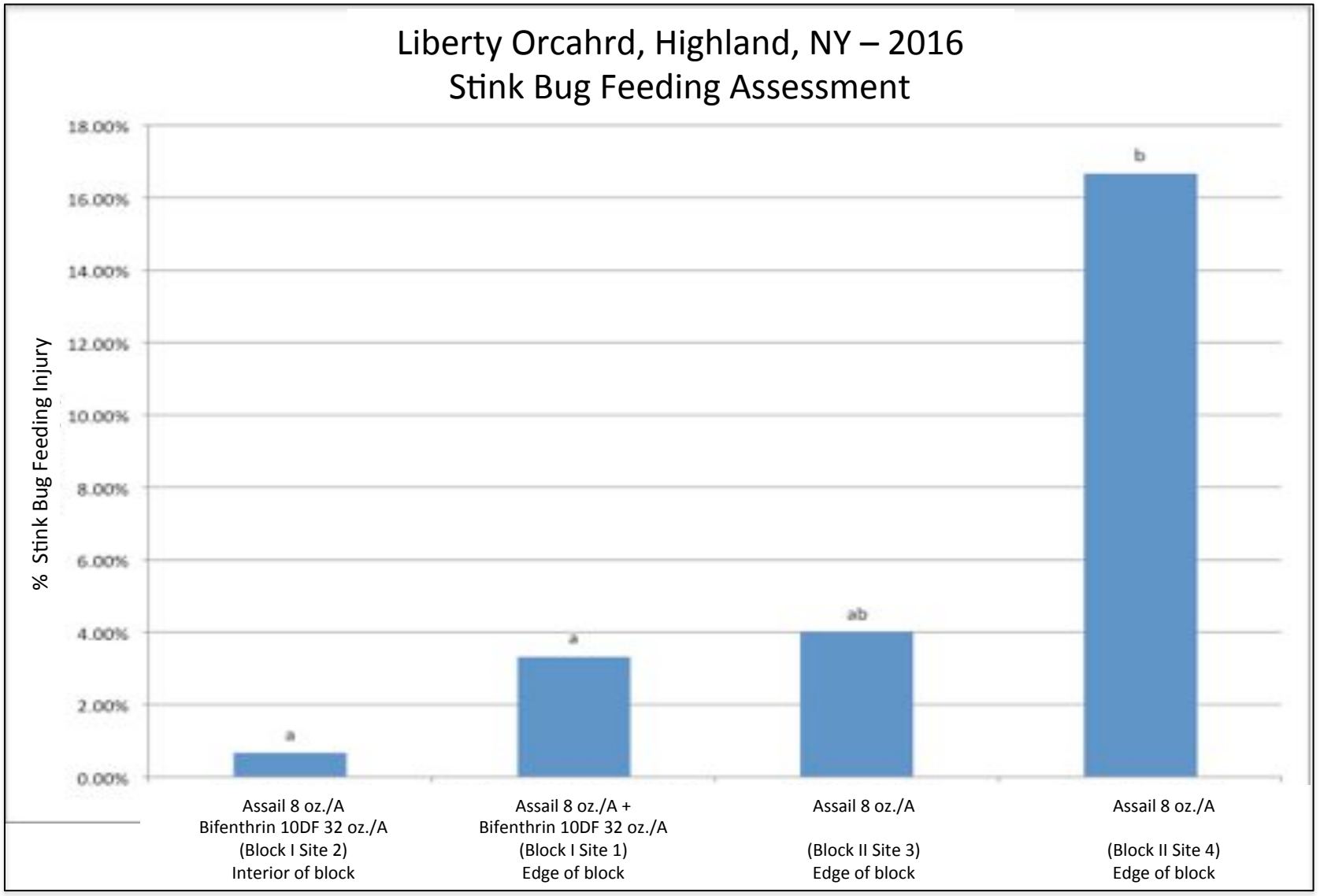

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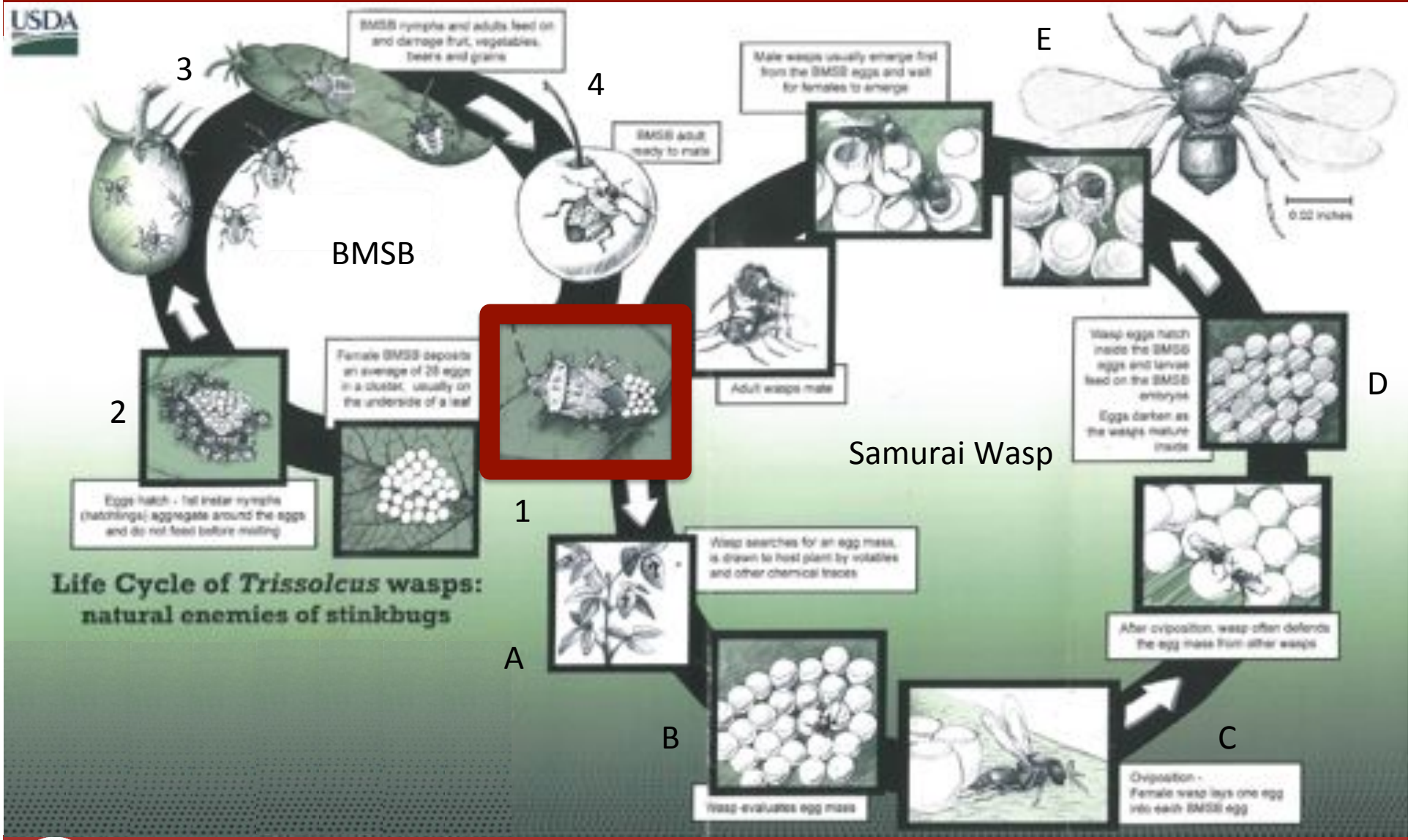
Introduction to *Trissolcus japonicus* (Samurai Wasp) For BMSB Management ?

Why Use *Trissolcus japonicus* (Samurai Wasp)

2 mm
Trissolcus japonicus

Female Samurai Wasp
'Parasitoid'
*Lays Its Own Egg Into the eggs of BMSB
*Wasp larva feeds on BMSB nymph
*Adult wasp emerges from BMSB eggs

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



Trissolcus japonicus, (Hymenoptera: Scelionidae)

Trissolcus japonicus

Background:

- Kim Hoelmer, USDA-ARS, Newark DE, Beneficial Insects Introduction Research. In 2007 he surveyed natural enemies of BMSB in Asia, returning with live parasitoid specimens, held in U.S. quarantine facilities.

- ***Trissolcus japonicus*** *(Samurai Wasp) was* found to be a highly successful parasitoid. Parasitism rates of *H. halys* eggs reported to be as high as 80% in China (Talamas et al. 2013).

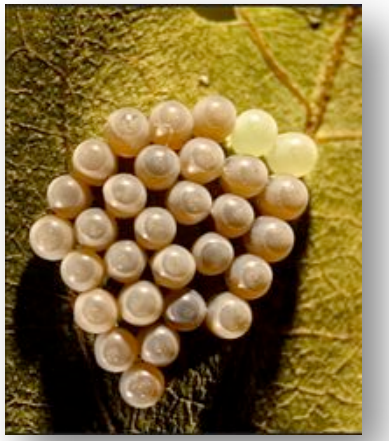
Host Specificity of the parasitoid wasp, *Trissolcus japonicus*, (Hymenoptera: Scelionidae)

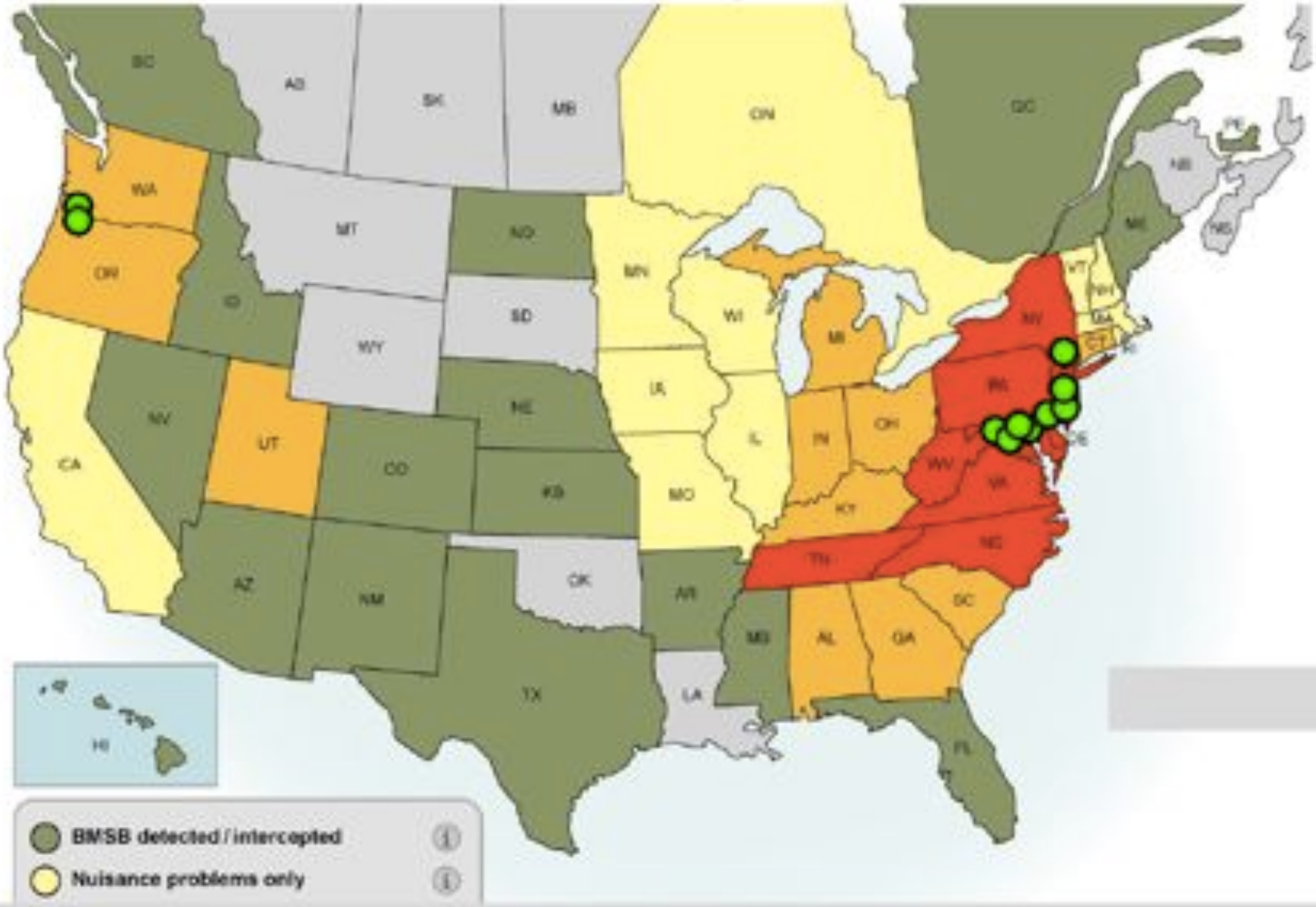
- In choice and non-choice tests of parasitoid wasps species found *Trissolcus japonicus to be* **highly effective,** parasitizing 60-100% of the eggs in BMSB clusters.

- *T. japonicus is* **highly specific** in choice tests, choosing BMSB over other pentitomiid eggs. However, in *non-choice* tests *T. japonicus* will oviposit into the eggs of the preditory spined soldier bug, *Podisus maculiventris* (Say).

Trissolcus japonicus
Field Recovery Survey Sites in the US

- In 2014 **adventive** populations (wild) of *T. japonicus* were found in Beltsville, MD.
- In 2015 *T. japonicus* were found in Washington, DC and Winchester, VA,.
- In 2016, *T. japonicus was also found* in VA, WV, MD, DE NJ and NY in the East, and WA and OR in the West.





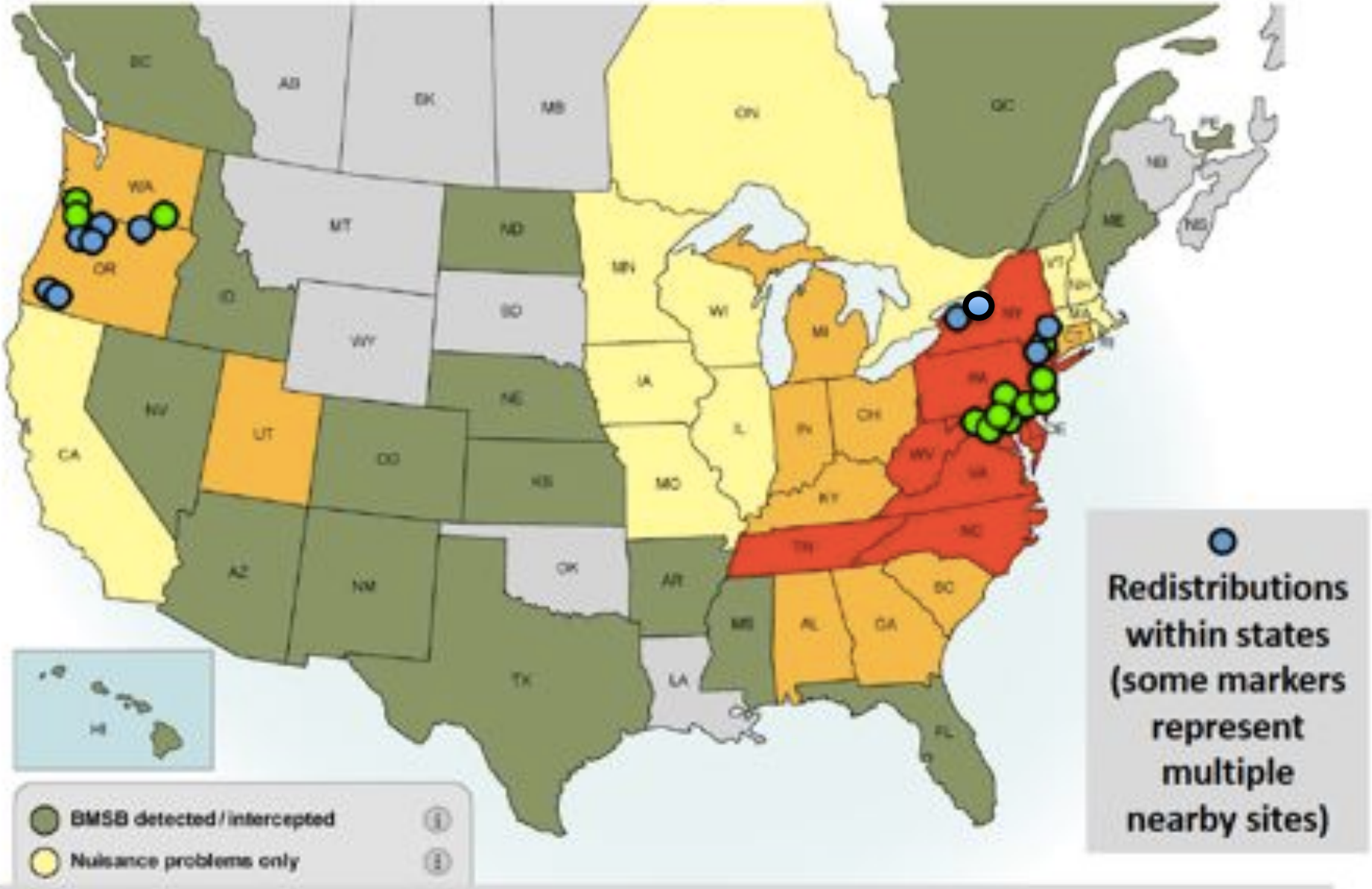
Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, NJ, NY, OR, WA (as of Dec. 2016)

New state record in 2017: PA

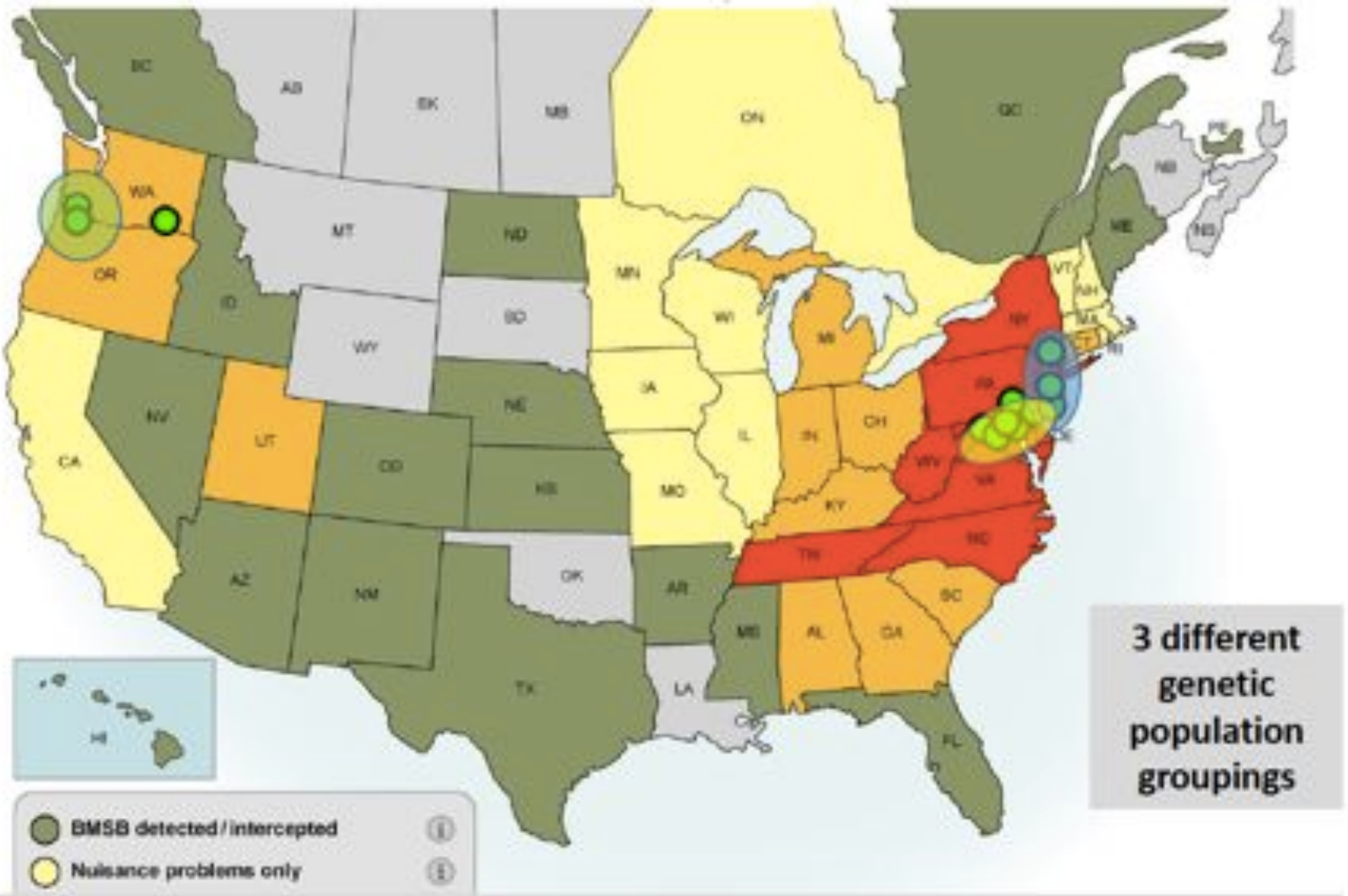
Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)



Field recoveries of *Trissolcus japonicus*

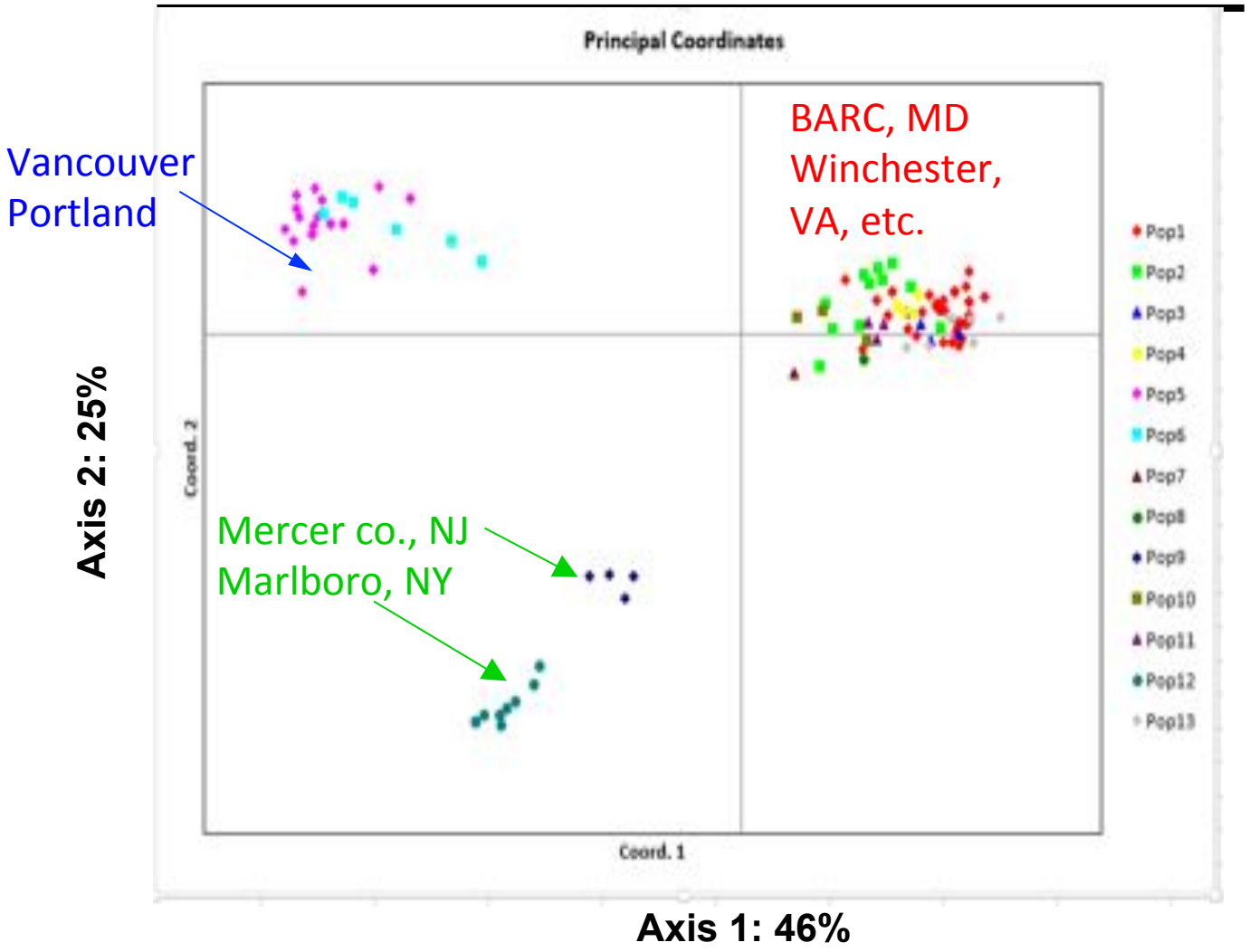
DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)



Field recoveries of *Trissolcus japonicus*

DC, MD, VA, WV, DE, PA, NJ, NY, OR, WA (as of Dec. 2017)

Principale Coordinate Analysis (PCoA)- 115 spécimens recovered in US génotype



Axis 1: Split between Western and 2 Eastern populations and all the others

Axis 2: Split between Western and the 2 Eastern populations

Dr. Marie-Claude Bon at the USDA-ARS European Biological Control Laboratory (Montpellier, France) DNA specimen extractions employing 23 microsatellite gene markers to differentiate genotypes .

Trissolcus japonicus
Field Recovery Sites in the US

* Adventive specimens of *T. japonicus* from the US were sent to Marie-Claude Bon in USDA-ARS European Biological Control Laboratory (Montpellier, France)

* DNA from submitted *T. japonicus* specimens was extracted and characterized using 23 microsatellite gene markers from thirteen different Asian *T. japonicus* populations, including those in quarantine in the U.S. and others collected in Asia in 2012-2013 by Kim Hoelmer's team at the USDA-ARS Beneficial Insects Introduction Research Laboratory (Newark, DE).

* It was **determined none of the adventive finds originated from the populations held in quarantine** (unpubl.), and **thus represented independent introductions of *T. japonicus.***

(E. Beers. PROC. ENTOMOL. SOC. WASH. 118(3), 2016, pp. 466–470)

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NYS DEC Liberation of Wildlife Permit

In January of 2017 HVRL was requested to submmit a 'Liberation of Wildlife' permit for trnsport of *T. japonicus* in NYS. 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 determined 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.

Expanding the Range of the Parasitoid Wasp, *Trissolcus japonicus*, (Hymenoptera: Scelionidae) in NYS.

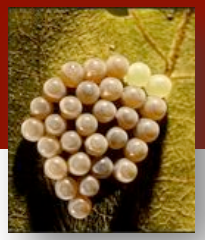
1. Monitored BMSB to determine agricultural presence. (2010)
   Established BMSB colony adult and nymphs for bioassay studies.
   Employ BMSB eggs lain on Jalapeno leaves as sentinel eggs (2016)

2. Survey the native and adventive parasitoid complex using sentinel eggs to attract *Trissolcus japonicus* in NYS. (frozen -80C, 4min.) (2016)

3. Developed *T. japonicus* colony, began establishing release sites. Art Agnello (CALS – NYSAES), Tessa Grasswitz, CCE-LOFT, Debbie Breth, CCE-LOFT Ret. (2017)

4. Determine *T. japonicus* establishment in release sites (2017)

H. halys Sentinel Egg Production and Deployment



Sentinel Egg Survey: Field Deployment

- **July 28th – Oct 1st :** Weekly placement of eggs
- 7 WNY sentinel sites and 2 ENY sites were selected to survey for parasitoids (2017).
- Sentinel eggs fixed onto known BMSB host foliage (7 host plants). 2-3 clusters/site/wk.
- Sentinel eggs sent to cooperators in overnight shipping
- Placement in Wayne, Orleans, Ontario, Columbia, Ulster & Dutchess counties
- Recollection of eggs sent and reared at the HVRL, placed in petri dishes and held in a controlled environment chamber at 25 ° C. for 5-7d,
- Monitored for emergence of parasitoids, identified by E. Talamas (U.of Fl. Gainesville).
- Adults parasitoids reared from sentinel egg masses were provided 90% honey-water solution in 1uL droplets on dish for survival and reproduction.

Establish Baseline Survey of Native and Invasive Parasitoids in New York State

Sentinel Egg Staple Attachment

Paper Clip Attachment

Baseline Sentinel *H. halys* Egg Survey Placement Sites in NYS
(N=10 Farms, 3-24 clusters/site/wk. N=2700 sentinel eggs)

Farm	Town	County	Plant Host Plant	Latitude	Longitude
Schutt Orchard	Webster	Monroe	Acer saccharum (*sugar maple)*	43°11'3.78"N	77° 26’ 56.76"W
Windmill Orchard	Ontario	Ontario	Acer saccharum (*sugar maple)*	43°15'50.27"N	77° 22’ 35.32"W
KM Davies	Williamson	Wayne	Acer saccharum (*sugar maple)*	43°14'10.54"N	77 °11’ 23.63"W
Wooded	Holley	Orleans	Juglans nigra (black walnut)	43° 13' 59.52"N	78° 18' 7.27"W
Wooded	Lyndonville	Orleans	Malus sp. (crab apple)	43° 19' 38.28"N	-78° 19' 33.96"W
Wooded	Medina	Orleans	Ailanthus altissima (tree of heaven)	43°12'1.79"N	78° 23’ 36.81"W
Hepworth Farms	Marlboro	Ulster	Robinia pseudoacacia (black locust)	41°40'14.72"N	74° 5’ 11.21"W
Hepworth Farms	Marlboro	Ulster	Ailanthus altissima (tree of heaven)	41°40'14.72"N	74° 5’ 11.21"W
Crist Orchard	Walden	Orange	Ailanthus altissima (tree of heaven)	41°33'2.64"N	74° 9’ 50.72"W
Minard Orchard	New Paltz	Ulster	Vitis sp. (wild grape)	41°42'1.47"N	74° 4’ 24.13"W

Baseline Sentinel *H. halys* Egg Survey Placement Sites in New York State

2017 Sentinel Egg Emergence

Native

Trissolcus euschisti (6/23) (N=1)

Telenomus podisi (6/30) (N=3)

Asian Invasive

Trissolcus japonicus (7/7)

Marlboro, Ulster Co. (N=96)

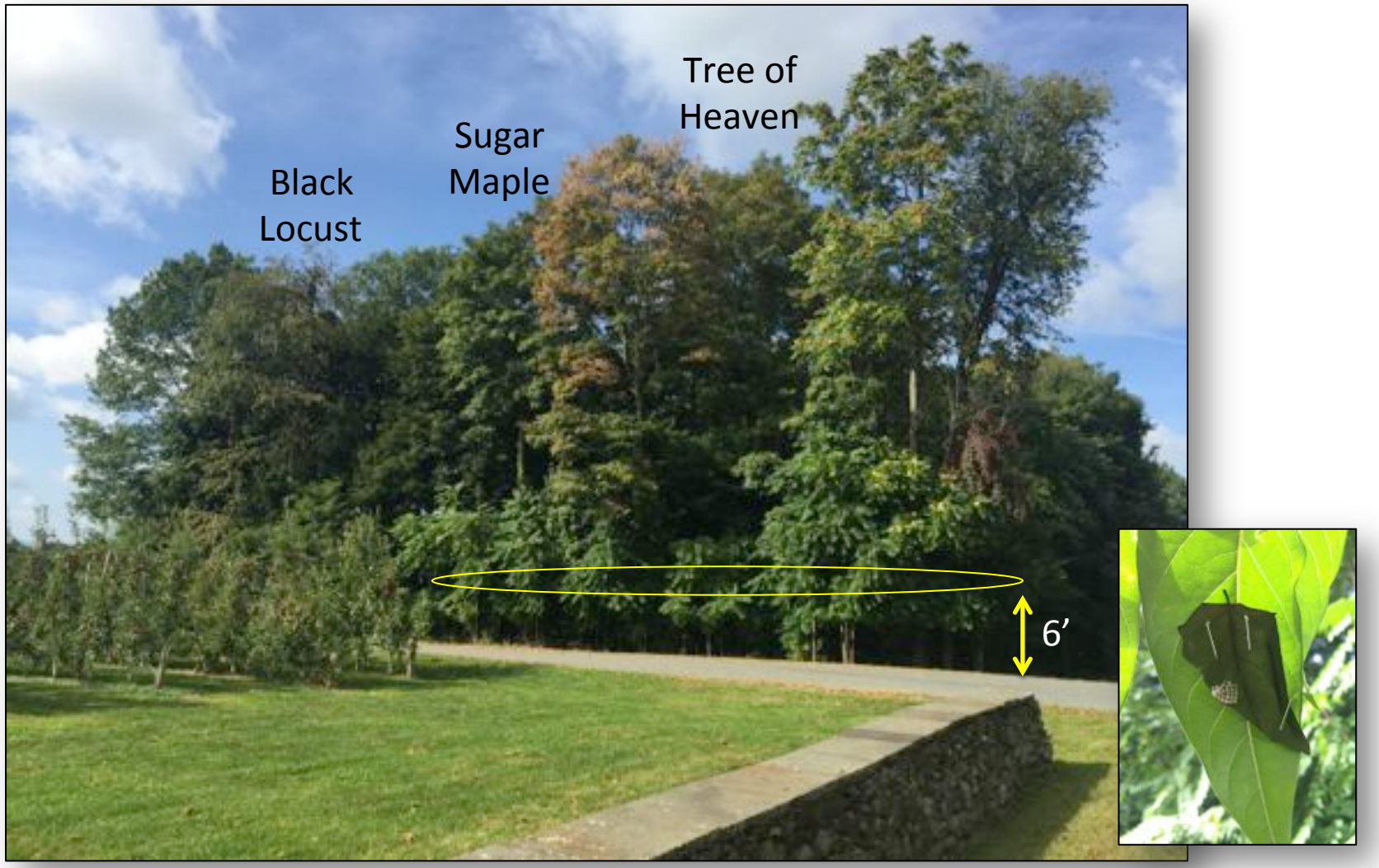
Trissolcus japonicus Release Sites in New York State

Phase II – 2017
Parasitized Egg Parasitoid Release
'Redistribution'

T. Japonicus Egg Placement

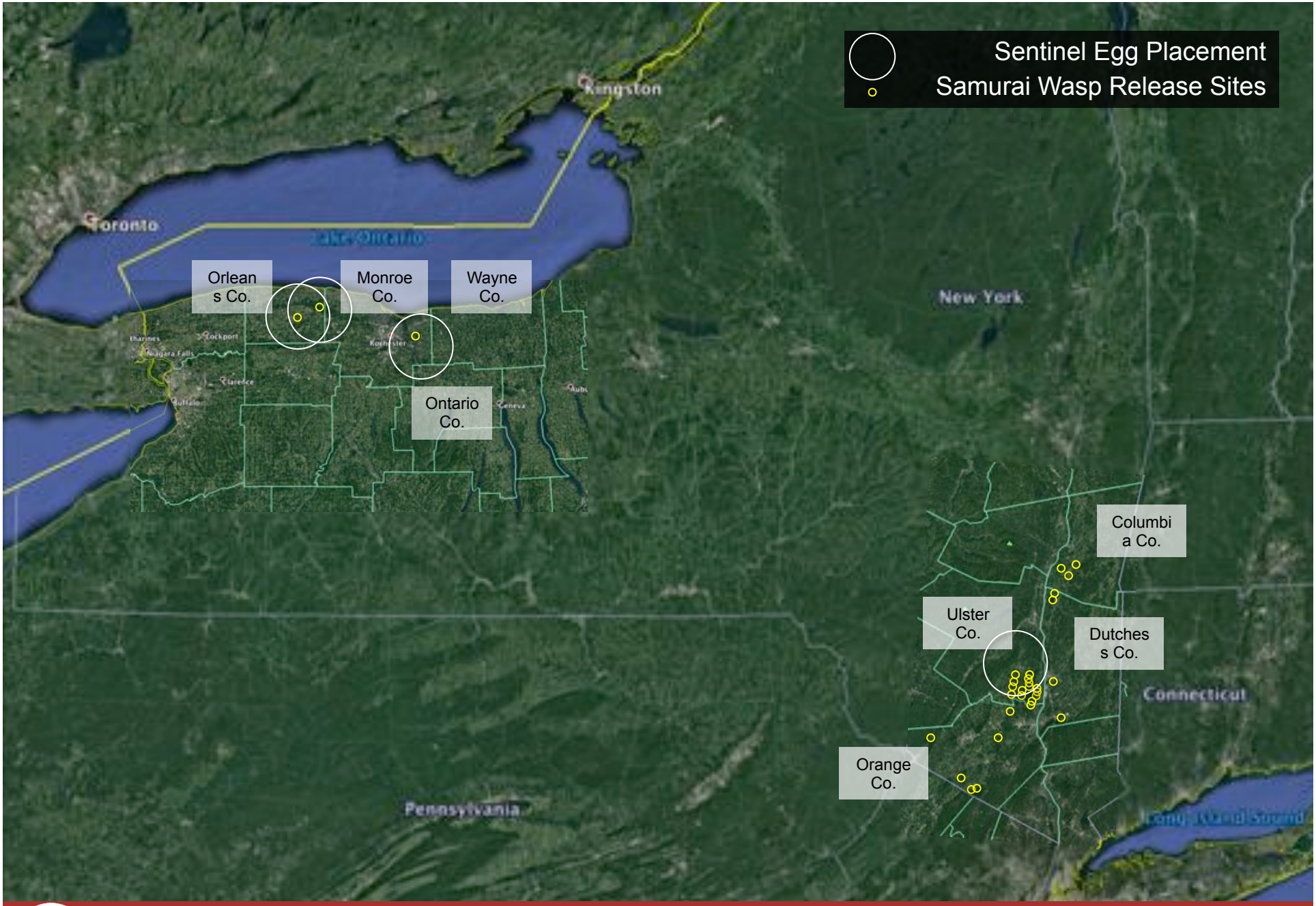
- **Captured adventive *T. japonicus* from Hepworth Farms in Marlboro, NY on July 7th 2017.**
- Wasps reared and used to parasitize frozen BMSB eggs.
- 1st parasitized eggs sent to cooperators beginning on 15th September.
- Parasitized eggs placed onto 32 sites, on 25 farms in 5 NY counties.

Trissolcus japonicus Release Sites in New York State



Placement Sites of *T. Japonicus parasitized eggs* in NYS
(N=24 Farms, 6 NY counties on 32 sites using ≈ 2300 eggs onto 7 host plant *sp.*)

Site	Town	County	Date	Clusters	Eggs	Placement / Host Plant	Latitude	Longitude
1	Webster	Monroe	15-Sep	3	78	Acer saccharum (*sugar maple)*	43°11'3.78"N	77°26'56.76"W
2	Holley	Orleans	22-Sep	3	84	Black Walnut	43°14'0.42"N	78° 1'10.46"W
3	Modena	Ulster	22-Sep	3	89	Vitis riparia (Native grape)	41°41'25.15"N	74° 4'3.51"W
4	New Paltz	Ulster	22-Sep	3	76	Vitis riparia (Native grape)	41°42'1.57"N	74° 4'24.22"W
5	Clintondale	Ulster	22-Sep	3	72	Acer saccharum (*sugar maple)*	41°41'32.91"N	74° 3'18.67"W
6	Walden	Orange	22-Sep	2	54	A. altissima (Tree of Heaven)	41°33'1.34"N	74° 9'36.77"W
7	Gardener	Ulster	23-Sep	3	74	Robinia pseudoacacia (Black Locust)	41°40'14.72"N	74° 5'11.21"W
8	Warwick	Orange	23-Sep	2	56	A. altissima (Tree of Heaven)	41°13'55.83"N	74°22'0.66"W
9	Warwick	Orange	23-Sep	2	56	A. altissima (Tree of Heaven)	41°13'52.59"N	74°23'11.62"W
10	Fishkill	Dutchess	24-Sep	3	73	Robinia pseudoacacia (Black Locust)	41°31'12.02"N	73°49'40.04"W
11	Hudson	Columbia	24-Sep	2	56	Vitis riparia (Native grape)	42°11'6.33"N	73°49'47.25"W
12	Hudson	Columbia	24-Sep	2	54	A. altissima (Tree of Heaven)	42°11'16.36"N	73°49'58.86"W
13	Marlboro	Ulster	24-Sep	2	56	Rhus sp. (Sumac)	41°38'13.67"N	74° 0'24.57"W
14	Milton	Ulster	24-Sep	3	78	A. altissima (Tree of Heaven)	41°39'4.29"N	73°59'33.93"W
15	Milton	Ulster	24-Sep	3	74	Robinia pseudoacacia (Black Locust)	41°38'43.94"N	73°59'24.84"W
16	Modena	Ulster	24-Sep	2	59	A. altissima (Tree of Heaven)	41°40'1.19"N	74° 7'44.19"W
17	Red Hook	Dutchess	24-Sep	3	73	A. altissima (Tree of Heaven)	42° 3'14.98"N	73°50'55.49"W
18	Tivoli	Dutchess	24-Sep	3	72	Robinia pseudoacacia	42° 2'56.09"N	73°52'59.69"W
19	Valatia	Columbia	24-Sep	2	59	A. altissima (Tree of Heaven)	42°14'48.18"N	73°43'25.07"W
20	Milton	Ulster	26-Sep	3	87	Acer saccharum (*Sugar Maple)*	41°38'39.48"N	73°58'6.6"W
21	Poughkeepsie	Dutchess	28-Sep	3	76	Robinia pseudoacacia (Black Locust)	41°40'40.28"N	73°53'50.91"W
22	Clintondale	Ulster	29-Sep	3	82	Acer saccharum (*Sugar Maple)*	41°40'39.00"N	74° 3'19.43"W
23	Clintondale	Ulster	29-Sep	3	84	Vitis riparia (Native Grape)	41°40'24.16"N	74° 3'30.29"W
24	Highland	Ulster	29-Sep	3	84	A. altissima (Tree of Heaven)	41°41'59.76"N	74° 3'7.90"W
25	Modena	Ulster	29-Sep	2	58	Robinia pseudoacacia (Black Locust)	41°40'6.74"N	73°59'39.28"W
26	New Paltz	Ulster	29-Sep	3	81	Juglans nigra (eastern black walnut)	41°42'43.82"N	74° 6'48.75"W
27	New Paltz	Ulster	29-Sep	3	86	Juglans nigra (eastern black walnut)	41°41'30.84"N	74° 7'43.96"W
28	Campbell Hall	Orange	6-Oct	3	71	Deer Fence	41°25'36.84"N	74°14'21.00"W
29	Cuddebackville	Orange	6-Oct	3	71	Corylus avellana (Hazelnut)	41°27'45.22"N	74°36'57.16"W
30	Cuddebackville	Orange	6-Oct	3	74	Corylus avellana (Hazelnut)	41°27'41.78"N	74°36'57.28"W
31	Cuddebackville	Orange	6-Oct	3	77	Corylus avellana (Hazelnut)	41°27'40.97"N	74°36'52.20"W
32	Warwick	Orange	6-Oct	3	76	Acer saccharum (*sugar maple)*	41°17'31.47"N	74°26'15.06"W


Sentinel Egg Placement
Samurai Wasp Release Sites
Kingston
Toronto
Lake Ontario
Orleans Co.
Monroe Co.
Wayne Co.
Ontario Co.
New York
Columbia Co.
Ulster Co.
Dutchess Co.
Connecticut
Orange Co.
Pennsylvania

Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

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

'17 Recollection of Parasitized Eggs

- Parasitized eggs collected in 11 of 32 sites in late October & November to determine % emergence.
- Of the 11 sites, 77% of clusters recovered.
- In 3 of the 11 sites Samurai Wasps was found guarding egg clusters

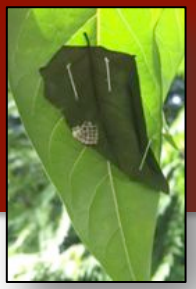
Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

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

'17 Recollection of Parasitized Eggs

- 168 or 24.4% (N=719) successfully emerge as adults
- 0.7% partially emerged from the egg
- 66.4% of the eggs showing no sign of emergence; eggs were parasitized and unsuccessful in development

Release Site Confirmation of Samurai Wasp Using Post Emergence Sentinel Eggs*



- Upon emergence, sentinel eggs were placed 30 meters from *T. japonicus* in two of the release sites .

- Egg parasitism by *T. japonicus* was observed in these 2 release sites from 15th September to 3rd October.

Site	County	Google Earth Coordinates	Sentinel Eggs Placed (date)
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	9-15-2017
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	9-22-2017
Schutt Orchard Site 1	Monroe	43°11'3.78"N 77°26'56.76"W	10-3-2017
Holly	Orleans	43°13'59.52"N 78°18'7.271"W	10-3-2017

Expanding the Range of the Parasitoid Wasp, Trissolcus japonicus, (Hymenoptera: Scelionidae) in NYS.

Photograph: **Christopher Hedstrom**
USDA-APHIS Quarantine Facility,
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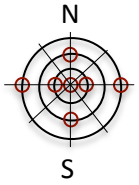
2018 Protocols (‘17 sites)

- Placement of sentinel egg masses in 2017 release sites for recapture of *T. japonicus*.



- 5d field exposure & return to HVRL.
- Rear eggs to confirm *T.* Japonicus presence to determine successful establishment.
- Re-establish sites as needed.
- Early establishment of additional sites (≈ 200). T.j. parasitized eggs to NY growers upon request.

Questions??

E-mail: pjj5@cornell.edu

The National March Madness
Citizen Science Project
To Find
The Brown Marmorated Stink Bug

Trissolcus japonicus

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