Development of effective monitoring and management practices against invasive pest brown marmorated stink bug

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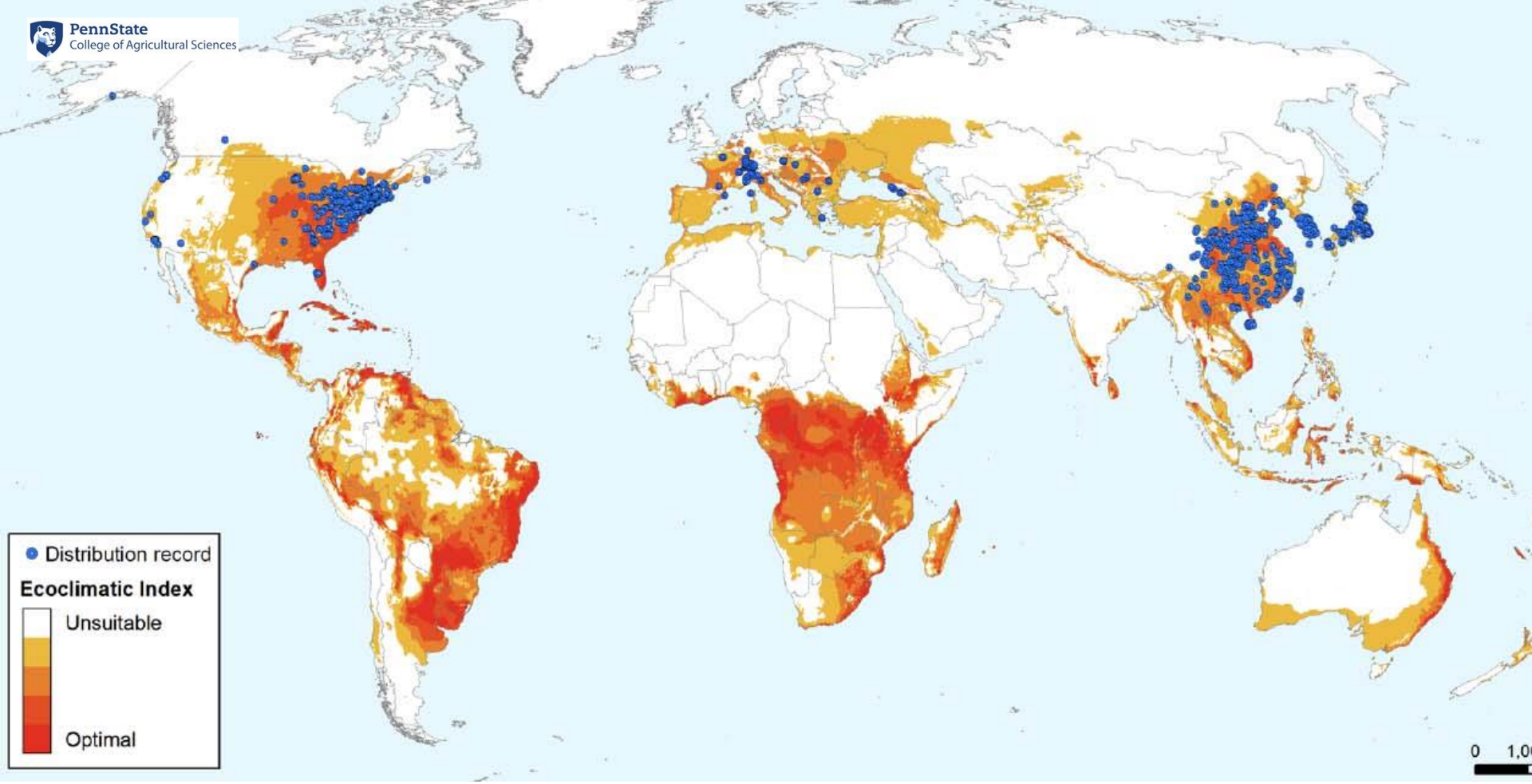

H. halys potential global distribution

Modelled climate suitability (CLIMEX Ecoclimatic Index) for *Halyomorpha halys*, including reported distribution locations.
(from Kriticos et al. 2017. J. Pest. Sci. DOI 10.1007/s10340-017-0869-5)

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BMSB host range





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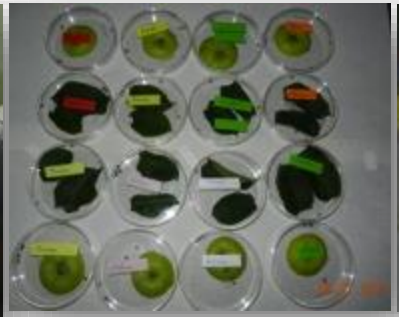
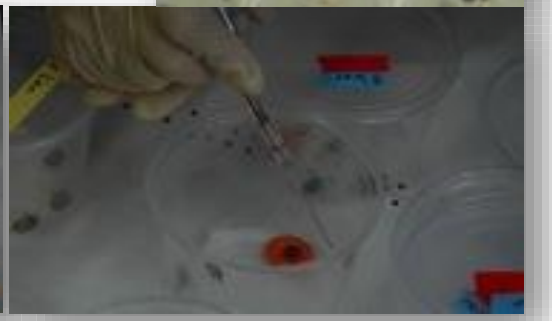
Evaluations of insecticide efficacies against BMSB

2010 - 2013





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Most effective insecticides against BMSB

Compiled data based on research info from T. Leskey (USDA ARS), T. Kuchar (VTech) and G. Krawczyk (PSU)

PYRETHROIDS

IRAC Group 3A

- **bifenthrin**
- **fenpropathrin**
- **cyfluthrin**
- **λ-cyhalothrin**

NEONICOTINOIDS

IRAC Group 4A

- **dinotefuran**
- **thiametoxam**
- **clothianidin**
- **imidacloprid**
- **acetamiprid**

OTHER

(IRAC Groups 1A, 1B, 2A

- **methomyl** (carbamate)

Products approved for organic pest management ???

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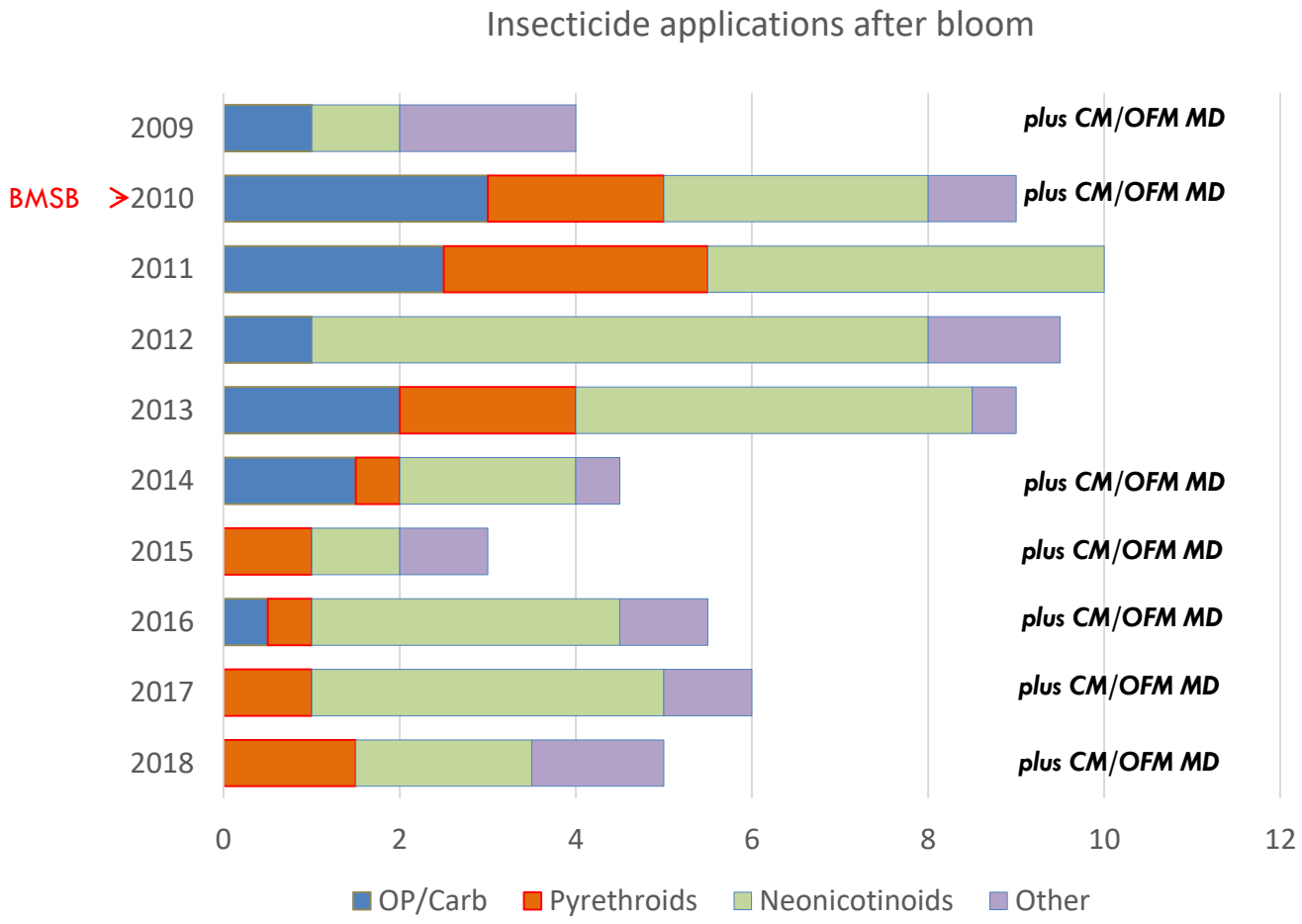
Changes in seasonal insecticide applications - apples

2009-2018 seasons

(Commercial orchard, PA)



Potential other controlled pests:

- *Codling moth*
- *Oriental fruit moth*
- *Plum curculio*
- *Japanese beetle*
- *Tufted apple budmoth*
- *Spirea aphids*
- *European apple sawfly*
- *Scales*
- ……

Insecticides:
Carbamates (IRAC Group 1A) – methomyl,
Organophosphates (IRAC Group 1B) – phosmet,
Pyrethroids (IRAC Group 3A) – fenpropathrin, lambda cyhalothrin, bifenthrin,
Neonicotinoids (IRAC Group 4A) – acetamiprid, clothianidin, thiametoxam, dinotefuran, thiacloprid,
Other (IRAC Groups 5, 18, 28) – methoxyfenozide, spinetoram, rynaxypyr.

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Monitoring BMSB …

AlphaScent SB lure

USDA ARS #20

Trece BMSB lure

USDA ARS #10

Ag-Bio *Smart lure*

Harlequin bug lure

Hercon lure

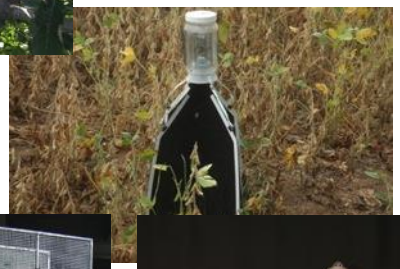
Rescue Stink Bug Attractant













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Challenges with monitoring of BMSB

Trap placement?

Trap designs?

Light traps?

Experimental lures?

Over 150 BMSB traps serviced per each season

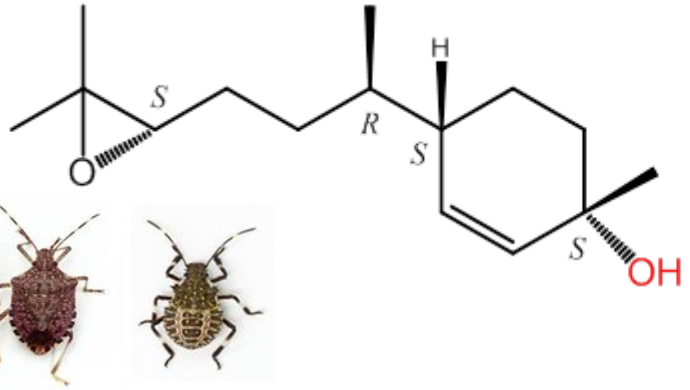
Treatment threshold development…?

Traps – 10 plus different traps designs
Lures – 7 plus BMSB lures

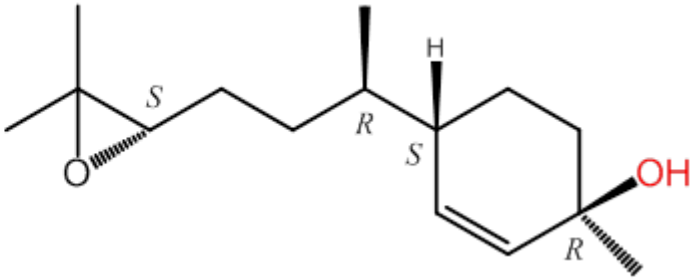
BMSB attractant

Slide courtesy of Dr. Tracy Leskey, USDA ARS

Main component of BMSB aggregation pheromone
(3*S*,6*S*,7*R*,10*S*)-10,11-epoxy-1-bisabolen-3-ol

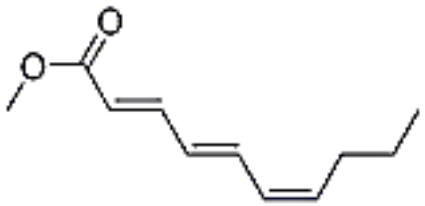


Minor component of BMSB aggregation pheromone
(3*R*,6*S*,7*R*,10*S*)-10,11-epoxy-1-bisabolen-3-ol



+

Methyl (*E*,*E*,*Z*)-2,4,6-decatrienoate (MDT) acts as a synergist for BMSB pheromone



= Synergism

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Trap comparison for monitoring BMSB

PSU FREC 2015

Traps lure combinations:

- Dead – Inn Pyramid trap (Ag-Bio) x Ag-Bio BMSB X-tra lure
- Clear sticky trap (AlphaScent) x Rescue lure
- Rescue Stink Bug Trap (Sterling Int.) x Rescue lure

Project description:

- Two commercial fruit orchards
- Three replicates per orchard
- Two locations (inside/outside) for each trap/lure combination per replicate

Observations period : May 01 - Oct 14, 2015

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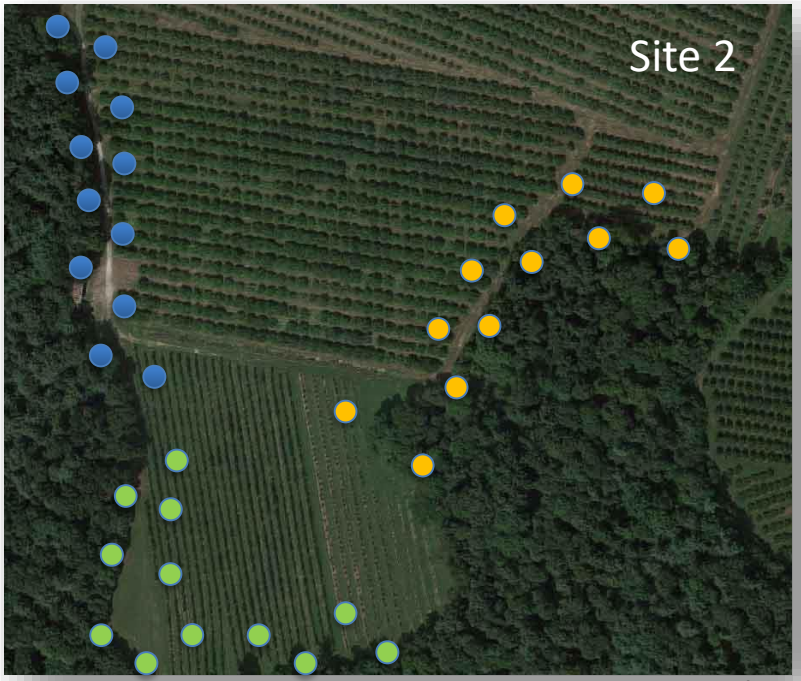
2015 BMSB trap locations

PSU FREC



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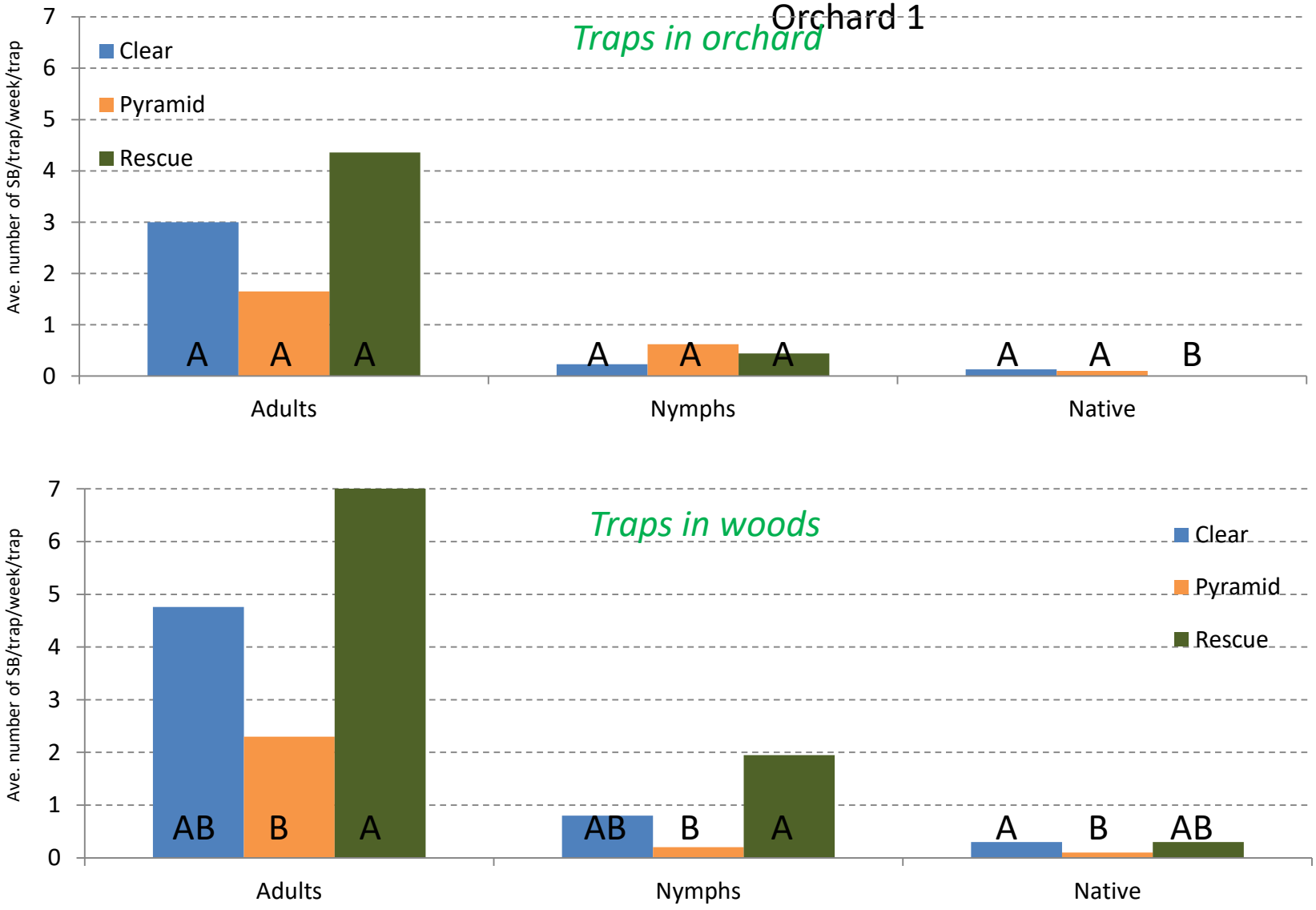
2015 PSU BMSB Trap Comparison Project



Trap data from all traps combined, n=6 traps per location;
Bars within the same category (i.e., adults, nymphs and native) with the same letter are not different (ANOVA, sqrt transformation, LSD All pairwise, $p < 0.05$)

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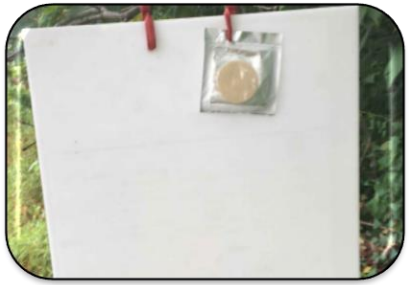
2016 BMSB trap comparison

PSU FREC 2016

Sticky clear traps



Sticky color traps

Other traps

Current standard traps

Commercial BMSB lures:

Trece®, Ag-Bio®, Rescue®, Hercon®, AlphaScent®, Scentry® and more…

Commercial BMSB traps:

Dead-Inn (Ag-Bio), Rescue (Sterling), clear sticky (AlphaScent, Ag-Bio, Trece), cylinder (Trece), and more...

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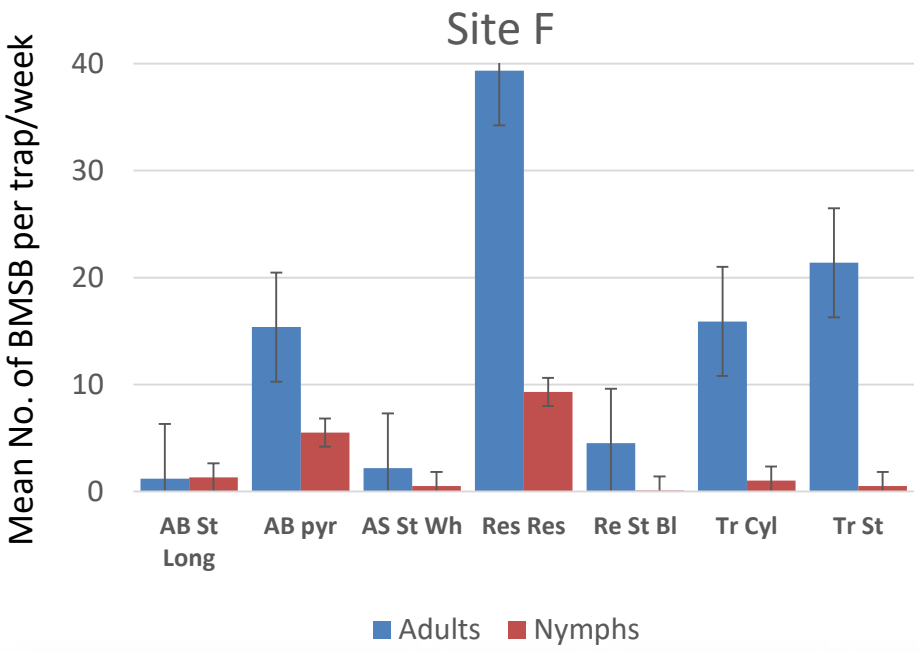
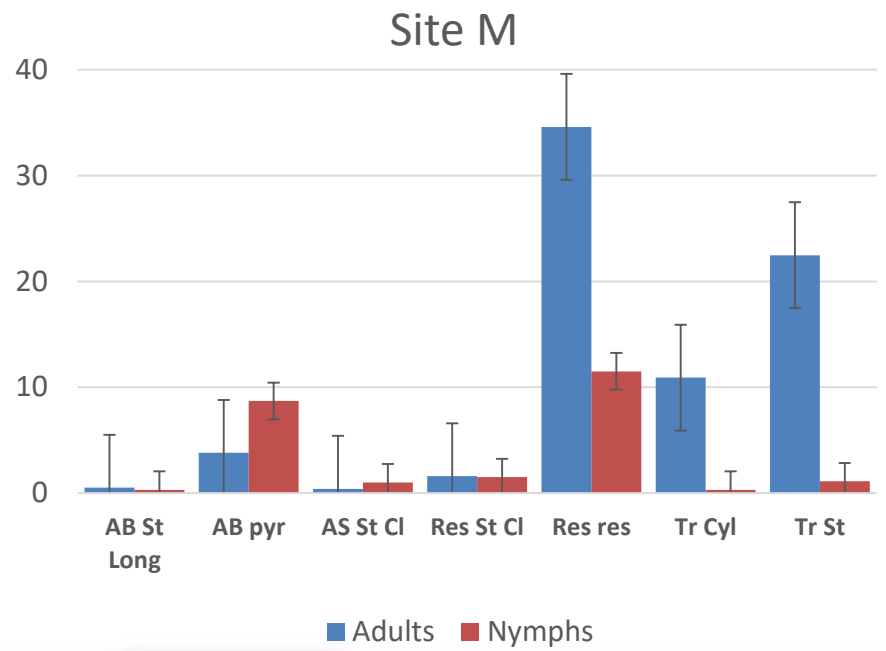
2016 BMSB trap comparison

Average BMSB captures per trap/week, PSU FREC 2016





AB pyr	AB ST Long	Re St Bl	AS St Cl	AS St Wh	Res St Cl	Tr Cyl	Tr St
Ag-Bio	Ag-Bio	AlphaScent	AlphaScent	AlphaScent	AlphaScent	Trece	Trece
Ag-Bio	Ag-Bio	Rescue	AlphaScent	AlphaScent	Rescue	Trece	Trece
Pyramid	*Sticky long*	*Sticky blue*	*Sticky clear*	*Sticky white*	*Sticky clear*	*Cylinder*	*Sticky clear*

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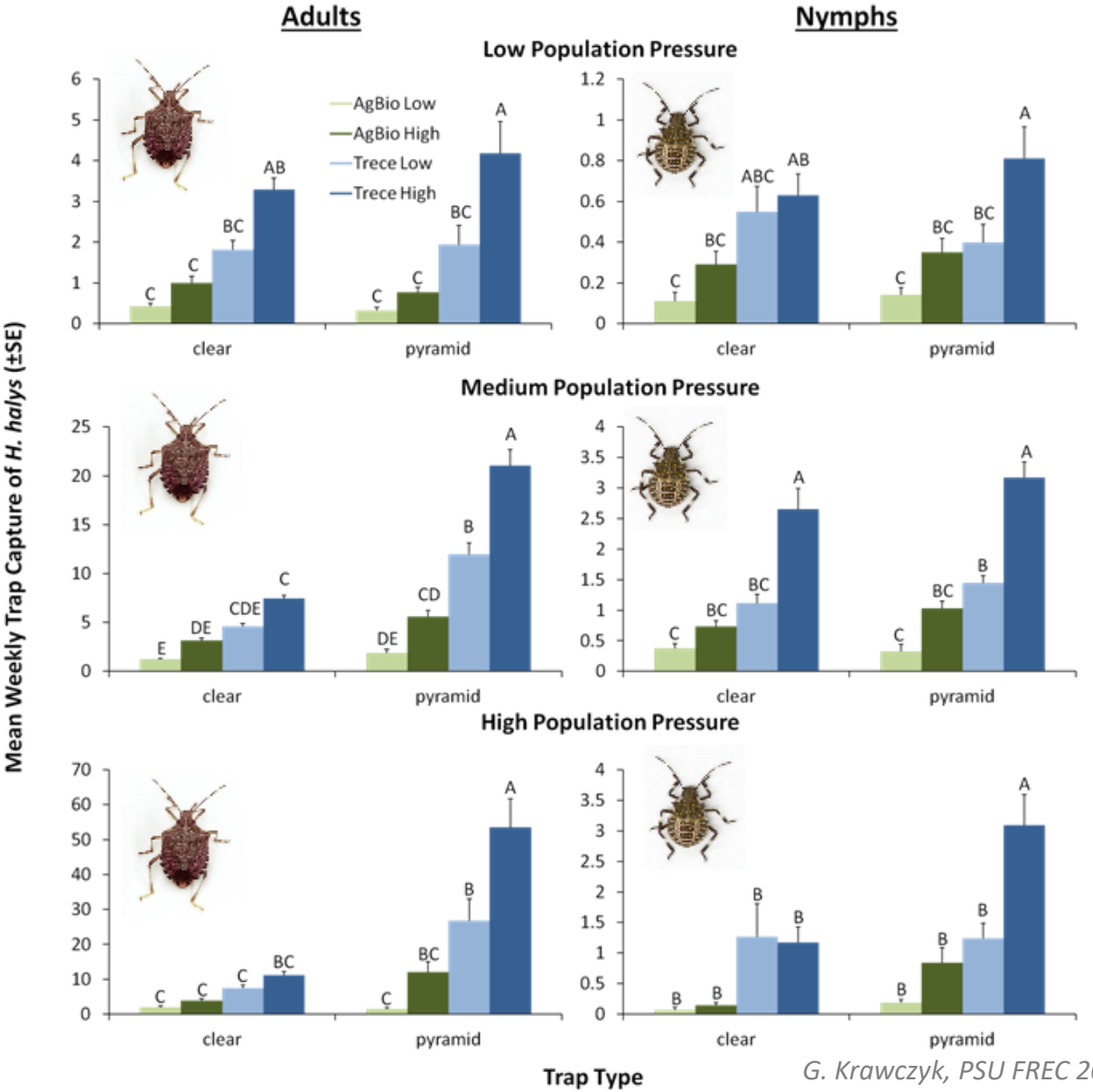
USDA ARS

Slide courtesy of T. Leskey *et al.*

BMSB monitoring: clear sticky traps vs pyramid trap



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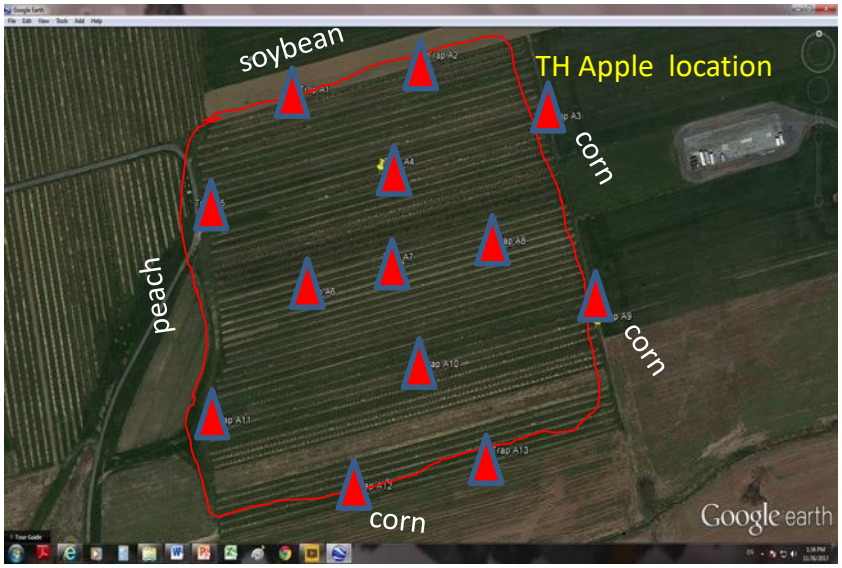
2013 - 2016 BMSB Trap Placement Grid Evaluations

Commercial apple orchard location

1. Ag-Bio lure in Ag-Bio tall Black trap,
2. Edge traps (4x2) and interior trap (4 + 1); total 13 traps,
3. Weekly trap and 12 min visual observations,
4. Fruit evaluations at 1, 3 and 5 tree from trap and 1 and 2 rows from trap.



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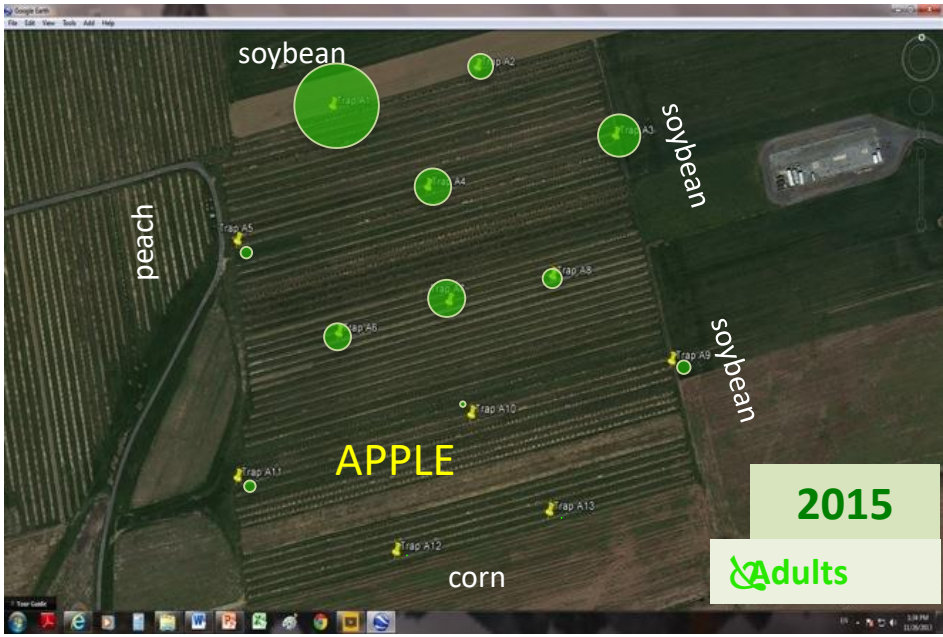
2013-15 BMSB trap placement grid evaluations – seasonal summary

BMSB pressure distribution (apples)

BMSB ADULTS PER TRAP/SEASON (cumulative)

217
BMSB

Size proportional to the number of collected BMSB



Number of BMSB per trap/season

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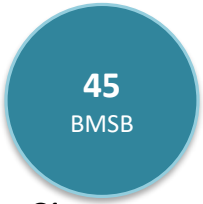
2013-15 BMSB trap placement grid evaluations – seasonal summary

BMSB pressure distribution (apples)

BMSB NYMPHS PER TRAP/SEASON (cumulative)



Size proportional to the number of collected BMSB

Number of BMSB per trap/season

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BMSB threshold challenge – apple orchard

Stage	Season	Number of weeks **threshold** met		Range of BMSB captured per trap (per season)		Actual number of insecticide applications
		Range based on single trap captures	Based on cumulative average (n=13 traps)			
Adults 	2013	0 - 10	7	9 - 217	(93.4)	10
	2014	0 - 6	4	1 - 104	(54.7)	5
	2015	0 - 4	2	3 – 96	(29.8)	2
Nymphs	2013	0 - 5	6	0 - 31	(14.6)	10
	2014	1 - 5	6	3 - 45	(18.3)	5
	2015	0 - 2	1	0 – 28	(5.6)	2

Provisional thresholds:

ADULTS - cumulative 10 BMSB adults per individual trap (USDA ARS);

NYMPHS – cumulative 5 nymphs per traps, or two consecutive weeks with nymphs present

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BMSB alternative management trials

Net exclusion trials

- net barrier between crop and potential source of BMSB infestation
- utilize existing deer fences

Crop trapping *(work of Deonna Soergel, former graduate student)*

- based on differences in attractiveness of various crops
- sunflowers and pepper, sunflowers and peaches…

Attract and kill

- Individual border trees baited with BMSB attractants
- Baited net traps outside orchards

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2013 BMSB net exclusion trial

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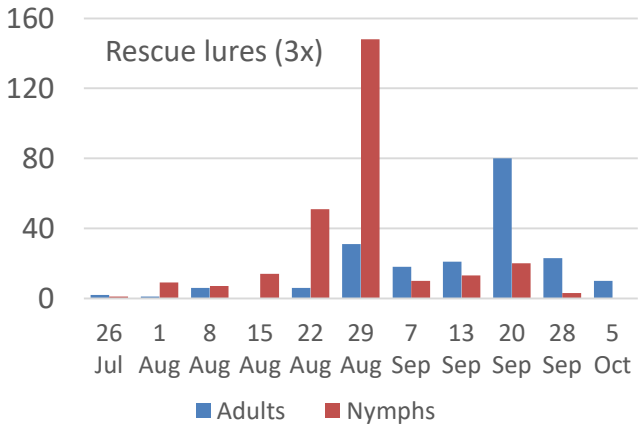
Evaluation of “ghost “ net trapping

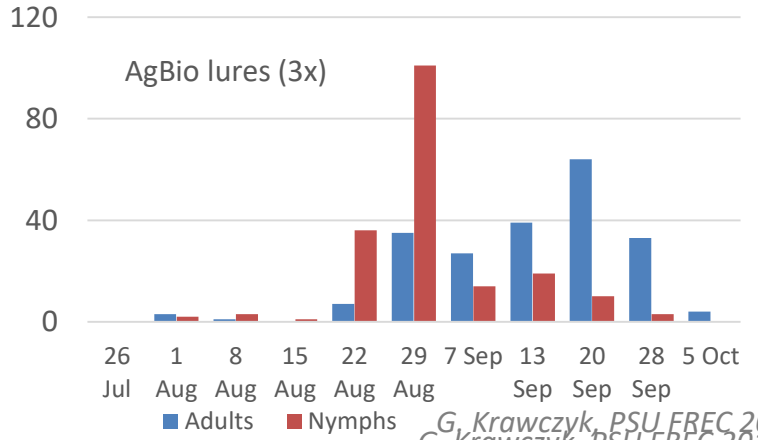
2014 - Grower made insecticide treated net

2015 - Nets treated with bifenthrin insecticide – season long project

2016 – PermaNet® commercial net from Vestergaard Frandsen Inc.



2016 season
- 3 ”ghost” traps for each lure combination



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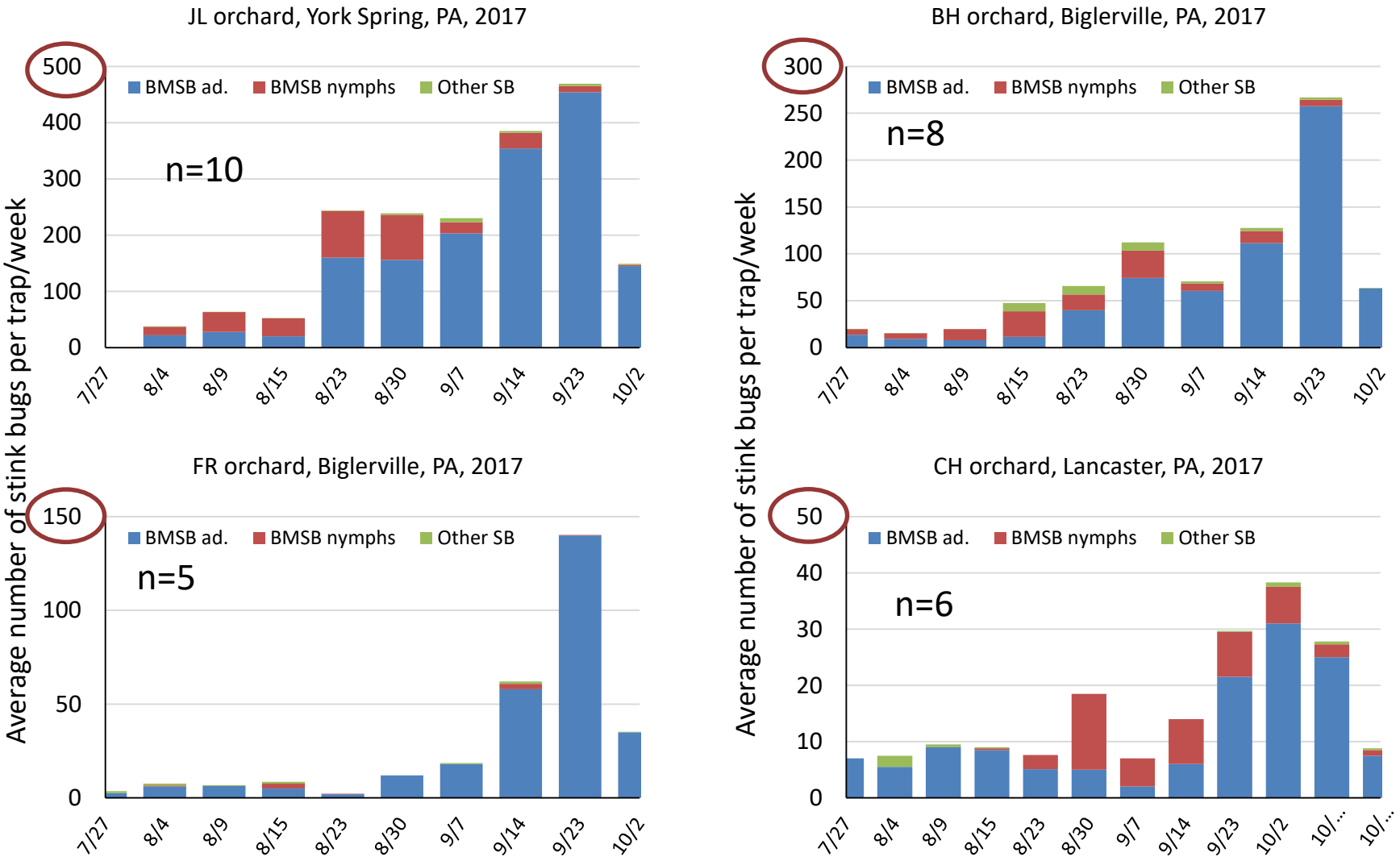
Average SB captures in ghost traps



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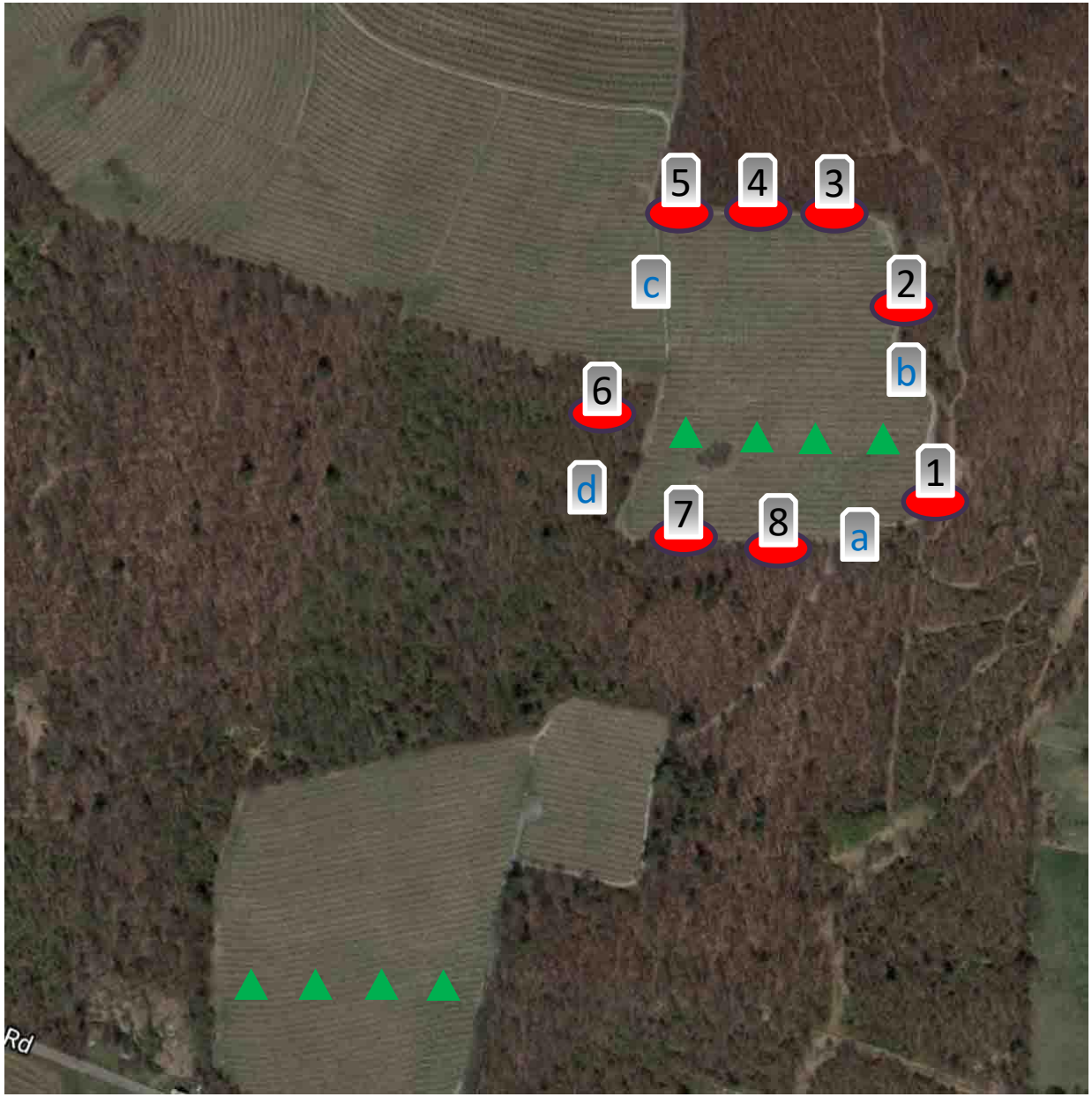
BMSB captures in monitoring traps

JL Orchard, 2017

BMSB	Ghost traps	Control
Adults	**0.58 a**	**2.86 b**
Nymphs	**0.31 a**	**1.28 b**

Average BMSB captures per trap/week. Rescue traps baited with Ag Bio lures. Four traps per treatment



a Ghost trap

1 Ghost trap with tarp

Monitoring trap

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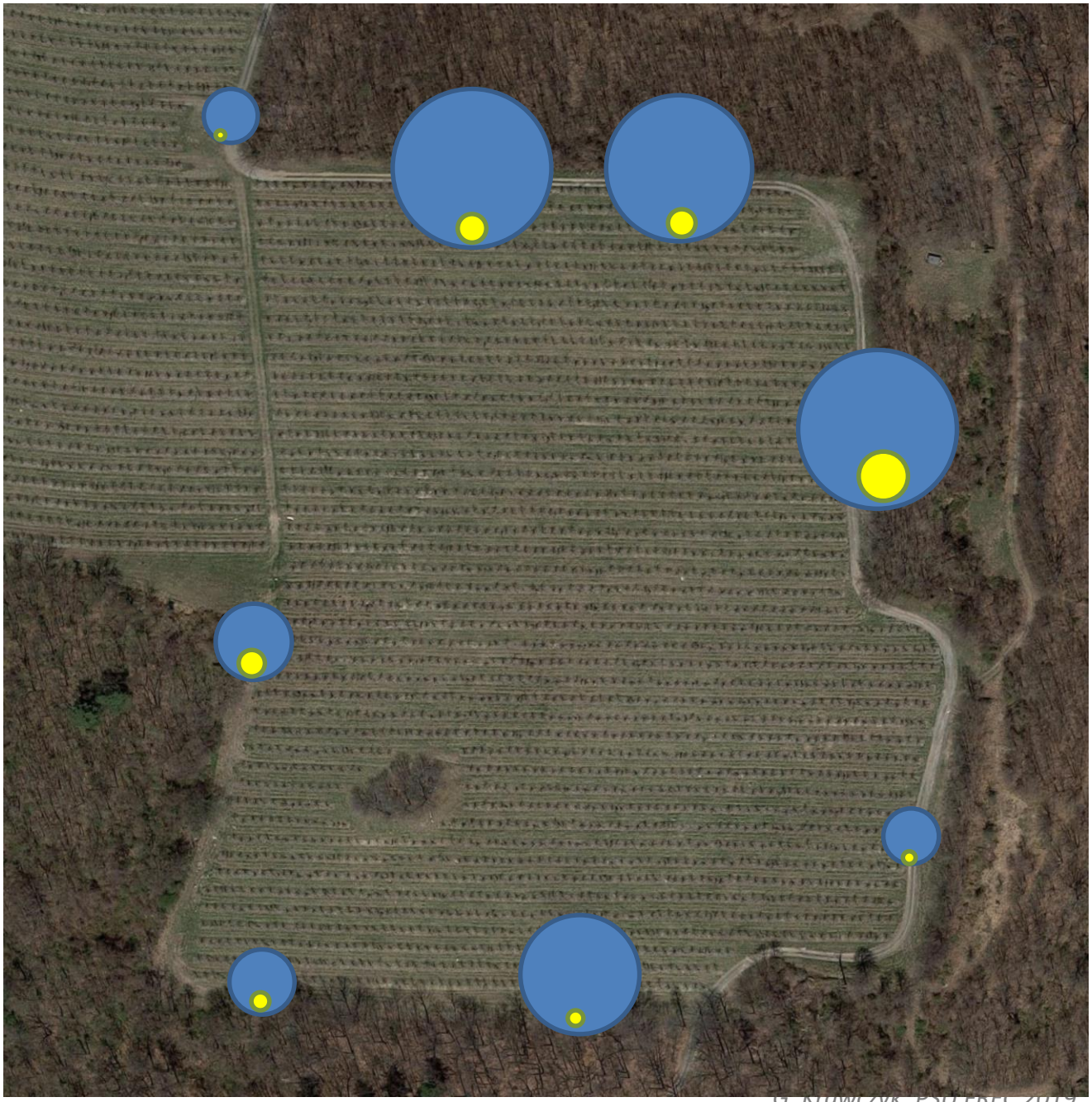
BMSB captures in ghost traps

JL Orchard, 2017

2351 BMSB adults

2351 BMSB nymphs

*Size equivalent of **2351** dead SB*



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Summary…

BMSB lures and traps are effective in detecting the presence of BMSB and should be used to decide if BMSB treatments are needed

The placement of traps is affecting attractiveness of lures to BMSB adults and nymphs. Understanding of “active space” for various BMSB lure/trap combinations is crucial for the development of practical trapping recommendations.

Sticky traps are effective under a low BMSB pressure (BMSB presence survey), while container based traps are suited much better for BMSB monitoring in areas of known BMSB presence.

Alternative BMSB management options such as attract and kill or “ghost” nets are needed to support IPM based fruit pest management programs

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Thank you

Ally
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