

Managing BMSB as part of the total insect pest management system



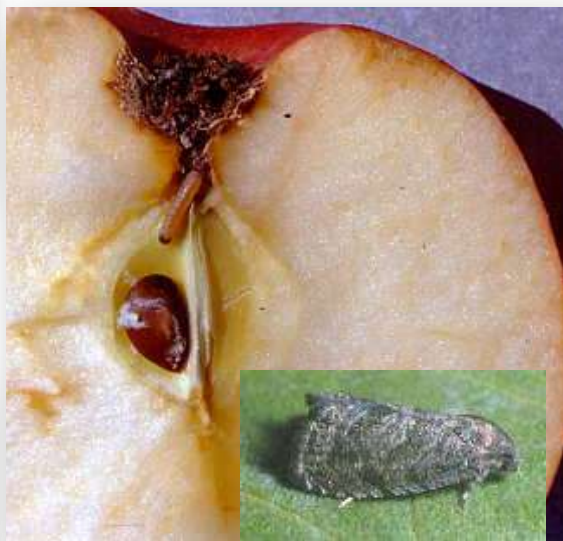
Greg Krawczyk and Lauren Shaak

*Pennsylvania State University
Department of Entomology
Fruit Research and Extension Center
Biglerville, PA
e-mail: gxk13@psu.edu*

Lepidopteran pests are still very important...



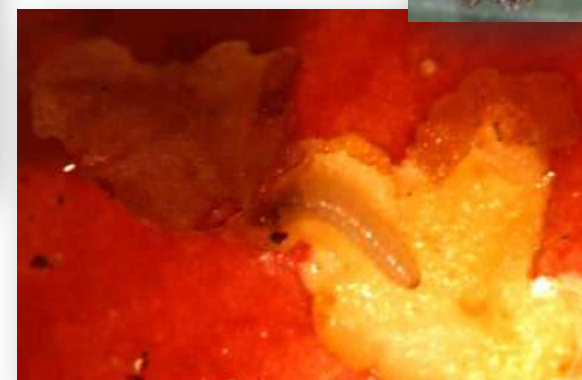
Codling moth (CM)
Cydia pomonella (L.)



Oriental fruit moth (OFM)
Grapholita molesta (Busck)



Lesser appleworm (LAW)
Grapholita prunivora (Walsh)



Changes in insecticide usage - the AWMD project

Grower 2, Adams County PA

3 years in
WFMD program

Maintained low
insect populations

Reduced insecticide
output by half

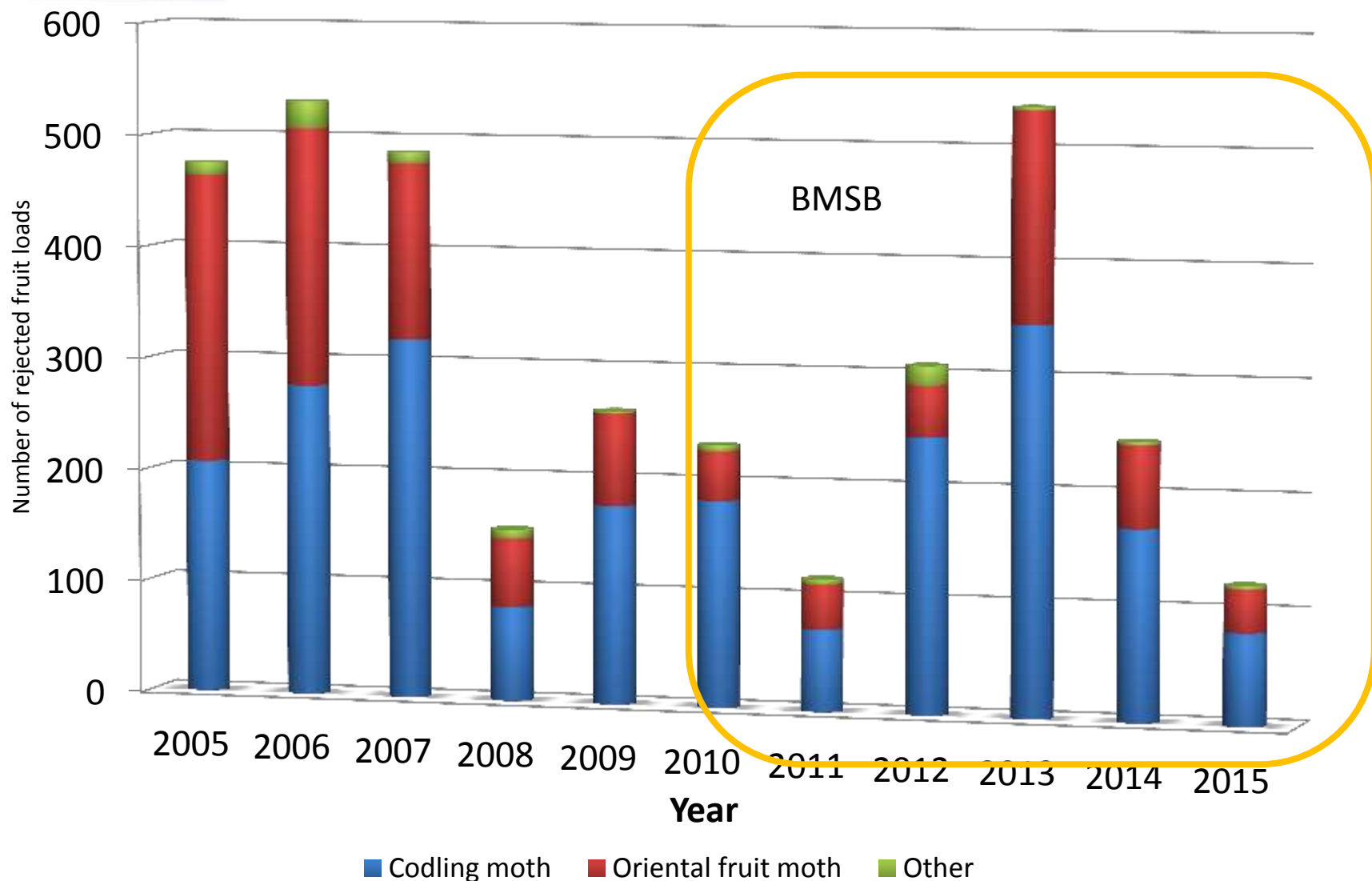
MAY			JUNE				JULY		AUG/SEPT		2006: 6 complete
5-5	5-13	5-16	6-2	6-7	6-17	6-28*	7-6	7-15	8-8	9-9	
Guthion 1.0 lb	Guthion 1.0 lb	Guthion 1.0 lb	Diazinon 2.0 lb	Intrepid 12.0 oz Imidan 3.0 lb	Intrepid 12.0 oz Imidan 3.0 lb	Imidan 4.0 lb	Diazinon 1.0 lb	Imidan 2.0 lb	Intrepid 16.0 oz	Imidan 2.0 lb	
5-5		5-13	6-7		6-17				8-8	8-13	2007: 3 complete
Diazinon 50W 1.0 lb		Diazinon 50W 1.0 lb	Intrepid 8.0 oz		Intrepid 8.0 oz				Intrepid 12.0 oz	Intrepid 12.0 oz	
5-5			6-7		6-17				8-8	8-22	2008: 2.5 complete
Assail 2.3 oz			Intrepid 16.0 oz		Intrepid 16.0 oz				Altacor 2.0 oz	Altacor 2.0 oz	
5-5	5-16		6-7		6-17		7-15				2009: 2.5 complete
Assail 3.4 oz	Assail 2.3 oz		Delegate 4.0 oz		Delegate 4.0 oz		Altacor 2.0 oz				

Rates of formulated products are the actually applied rate, all sprays ARM

Fruit loads rejected by PA fruit processors



2005-2015 seasons



CM and OFM available mating disruption products

2016 season (based on information provided by manufacturers)



Codling moth

- CheckMate® CM-XL 1000
- Cidetrak® CM
- Cidetrak® CMDA Combo PP
- Cidetrak® CMDA Combo Meso-A
- Cidetrak® DA MEC
- CheckMate® CM-F
- CheckMate® Puffer CM



Oriental fruit moth

- CheckMate® OFM
- Cidetrak® OFM-L
- Isomate® OFM TT
- CheckMate® OFM-F
- CheckMate® Puffer OFM



CM and OFM

- Cidetrak® CM-OFM Combo
- Isomate® CM/OFM TT
- CheckMate® Puffer CM/OFM
- Isomate® CM/OFM Mist



Hand applied dispensers;
30-200 dispensers/acre;



Aerosol dispensers;
1-3 dispensers/ac;



Sprayable;
aiblast applications.

2015 Mating disruption field trials

Treatments:

- Sprayable OFM plus CM high rate - CM PUM at 2.8 fl oz/acre *plus* OFM MEC at 1.1 fl oz/acre *plus* DAC MEC at 0.4 fl oz/acre;
- Sprayable OFM plus CM low rate - CM PUM at 1.4 fl oz/acre *plus* OFM MEC at 1.1 fl oz/acre *plus* DAC MEC at 0.4 fl oz/acre;
- Hand applied dispensers – CideTrak CM/OFM/DA (MESO) at 32 disp/acre;
- Insecticides plus DA MEC - grower standard insecticides plus DA MEC at 0.4 fl oz/acre;
- Insecticides only – grower's standard insecticide program.






Experimental mating disruption products from TRECE Inc.

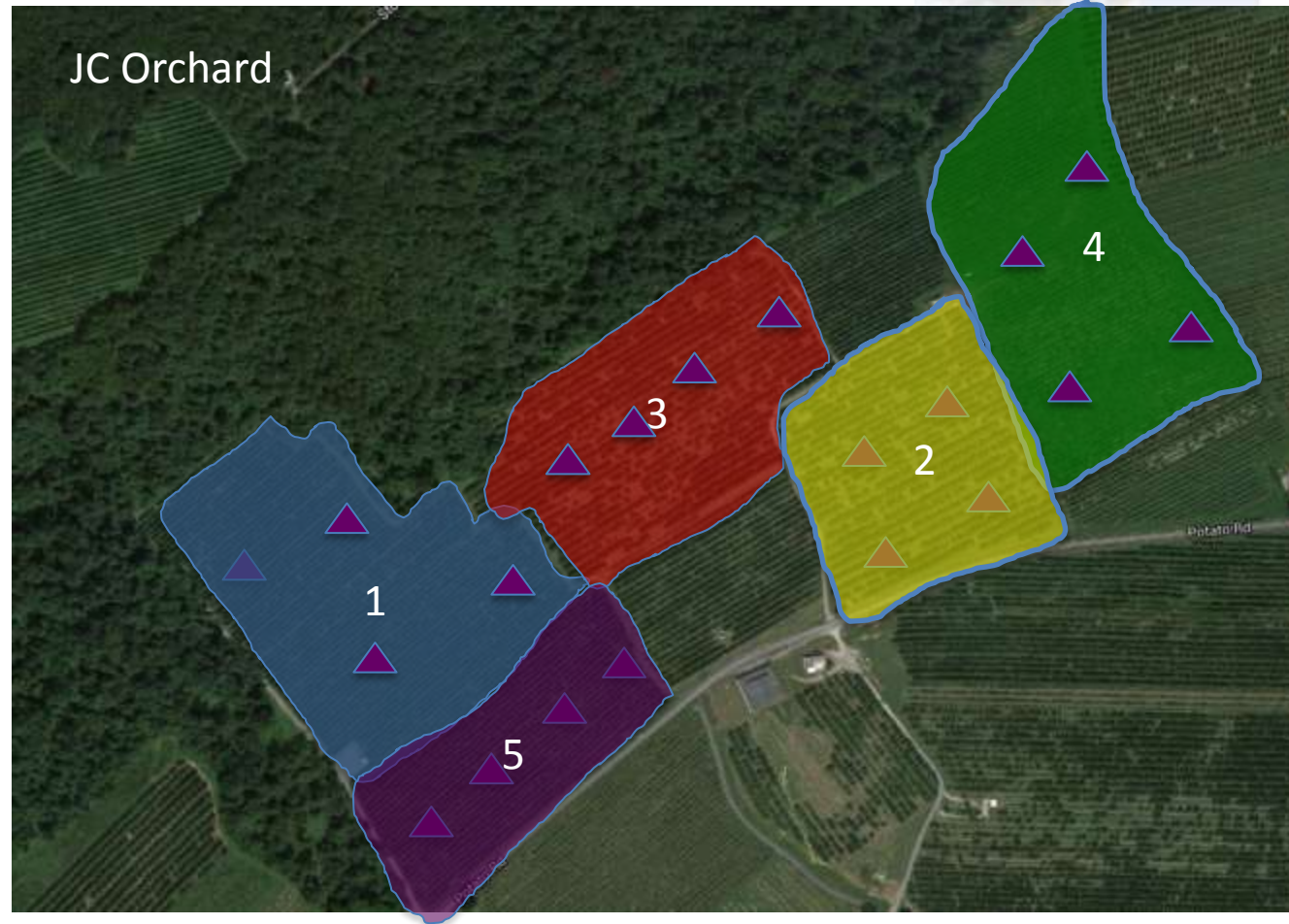
2015 Mating Disruption Field Trials



Sites:

- 4 commercial apple orchards
- Plots size from 2 to 10 acre
- All plots were grower maintained

-  Hand Applied MD
-  CM High
-  CM Low
-  Insecticides +DA
-  Insecticides only

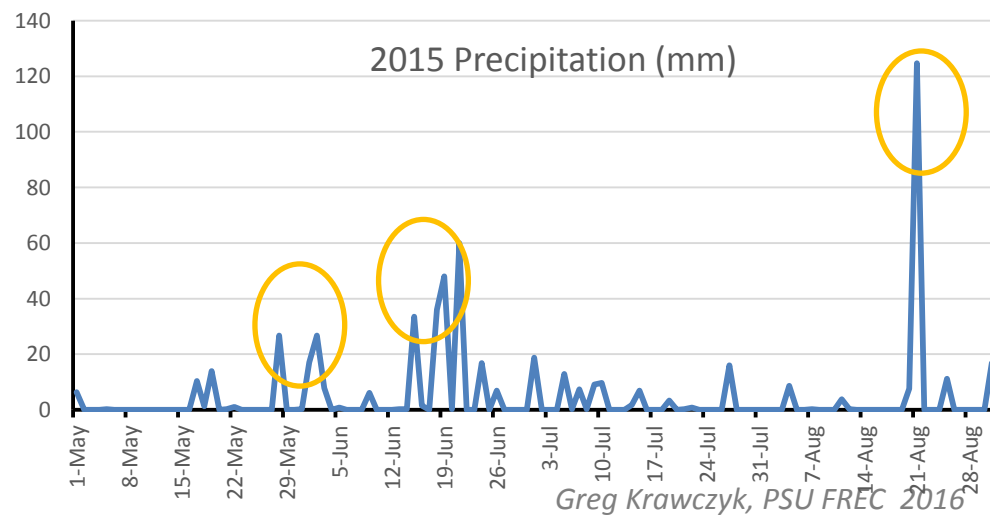


2015 Mating disruption trials: apples

Harvest fruit evaluations

Treatment	Percent injured fruit at harvest (apples only)	
	CM	OFM
<i>Sprayable CM High (exp)</i>	0.0 a	0.0 a
<i>Sprayable CM Low (exp)</i>	0.0 a	0.0 a
<i>Cidetrak CM/OFM/DA Meso (exp)</i>	0.0 a	0.0 a
<i>Insecticides plus DA</i>	0.0 a	0.0 a
<i>Insecticides only</i>	0.0 a	0.0 a

Average from four commercial orchards, PA, 3000 fruit evaluated per treatment
ANOVA, sqrt transformation, $p < 0.05$



Most effective insecticides against BMSB

(based on combined data from T. Leskey, T. Kuchar and G. Krawczyk; 2010-2015)

PYRETHROIDS

IRAC Group 3A

~~bifenthrin
(Brigade)~~

fenpropathrin
(Danitol)

cyfluthrin
(Baythroid)

λ -cyhalothrin
(Warrior)

NEONICOTINOIDS

IRAC Group 4A

~~imidacloprid
(Venom, Scorpion)~~

thiametoxam
(Actara)

clothianidin
(Belay)

imidacloprid
(Provado, Admire Pro)

acetamiprid
(Assail)

OTHER

(IRAC Groups 1A, 1B, 2A)

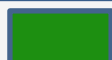
methomyl
(carbamate)
(Lannate LV and SP)

Products removed
from the market

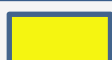
BMSB effective insecticides and other pests...

	Products	BMSB	CM	OFM	LR	Aphids	Mites	Leaf - hoppers	Apple maggot	Jap. beetle
Pyrethroids	Danitol	1	2	2	2	3	0	2	2	2
	Baythroid	2	3	2	2	3	0	2	2	2
	Warrior	2	2	2	1	2	0	1	2	2
	Actara	1	4	4	0	1	0	1	0	2
Neonicotinoids	Assail	1	2	2	4	1	0	1	3	2
	Belay	1	3	2	0	1	0	1	0	0
	Admire Pro	2	0	0	0	1	0	1	4	3
CB	Lannate	1	2	2	2	3	0	2	4	0

Efficacy
ranking:



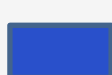
1 - Excellent



3 - Fair



0 - No rated

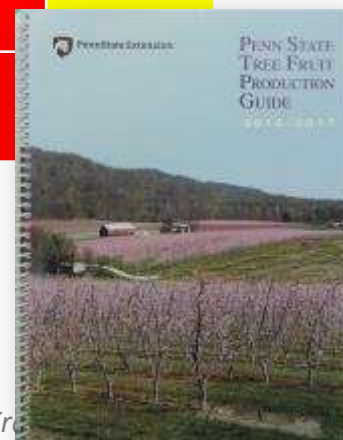


2 - Good



4 - Poor

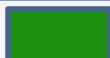
Ranking based on the
2016-2017 PA TFGP



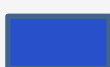
BMSB effective insecticides and other pests...

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Pyrethroids	Danitol	1	3	3	3	3	0	2	2	2
	Baythroid	2	3	3	3	3	0	2	2	2
	Warrior	2	3	3	3	2	0	1	2	2
	Actara	1	4	4	0	1	0	1	0	2
Neonicotinoids	Assail	1	2	2	4	1	0	1	3	2
	Belay	1	3	3	0	1	0	1	0	0
	Admire Pro	2	4	4	0	1	0	1	4	3
CB	Lannate	1	3	3	2	3	0	2	4	2

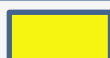
Efficacy
ranking:



1 - Excellent



2 - Good



3 - Fair



4 - Poor



0 - No rated

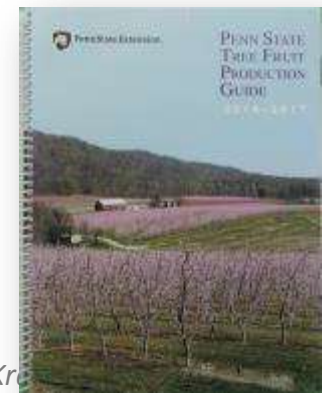
Reality check -
resistance

OFM Pheromone Trap Catch Thresholds for Apple and Peach in Pennsylvania



No. adult males/trap/week			
Brood 1*		Broods 2-4*	Recommended action
Apple	Peach	Apple & Peach	
0 – 15	0 – 5	0 - 5	Not a problem
16 – 30	6 – 15	6 – 10	Potential problem
31 – 60	16 – 30	11 – 25	Treatment required
>60	>30	>25	Severe problem

**average moth captures from a minimum of 2 traps per 10 -15 acres
(Recommendations from the 2016-2017 PSU Tree Fruit Production Guide)*



Trap comparison for monitoring BMSB - 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



Site 1

2015 BMSB trap trial locations

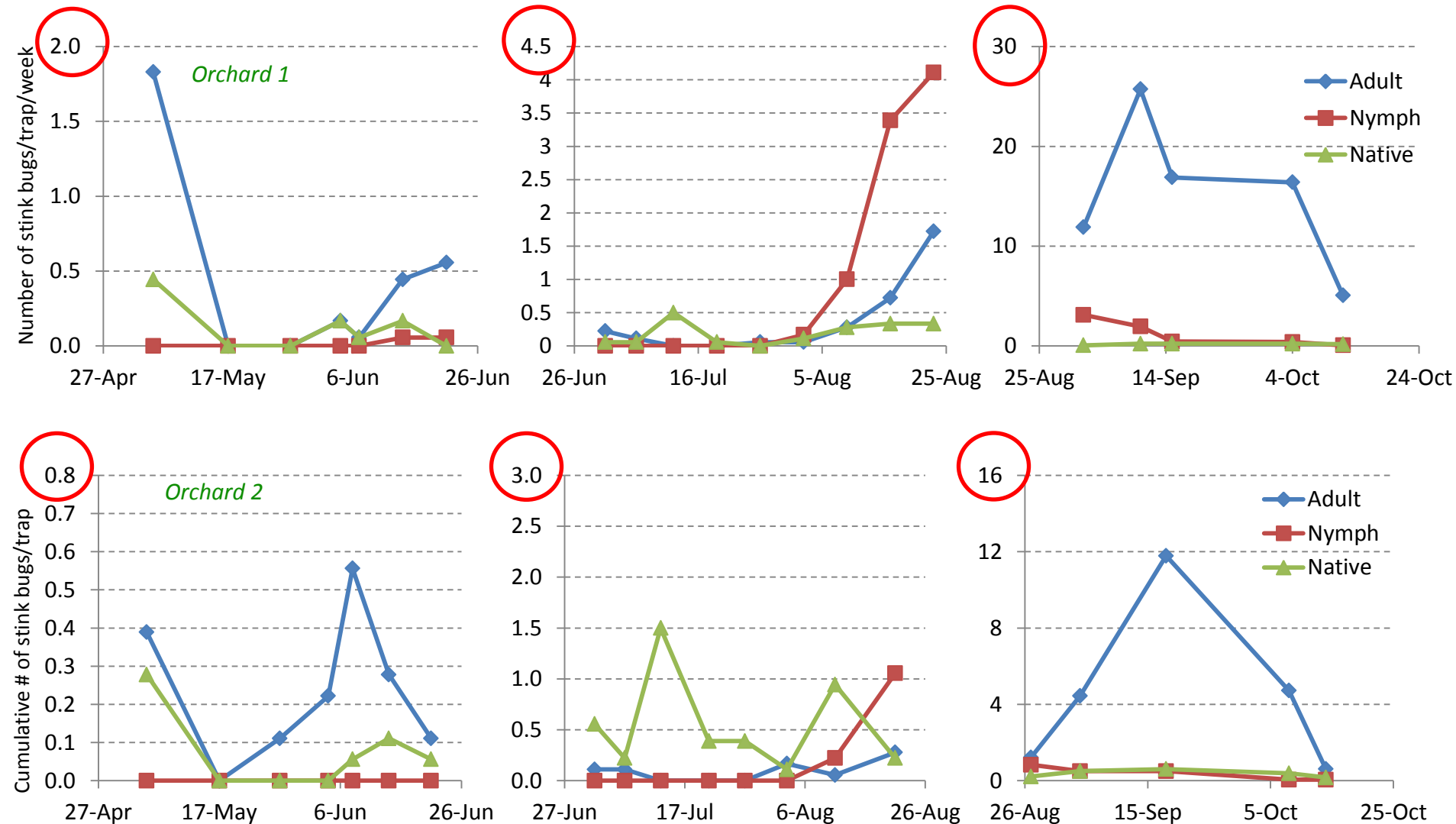
Two commercial orchards in Adams County



Site 2



2015 PSU BMSB Trap Comparison

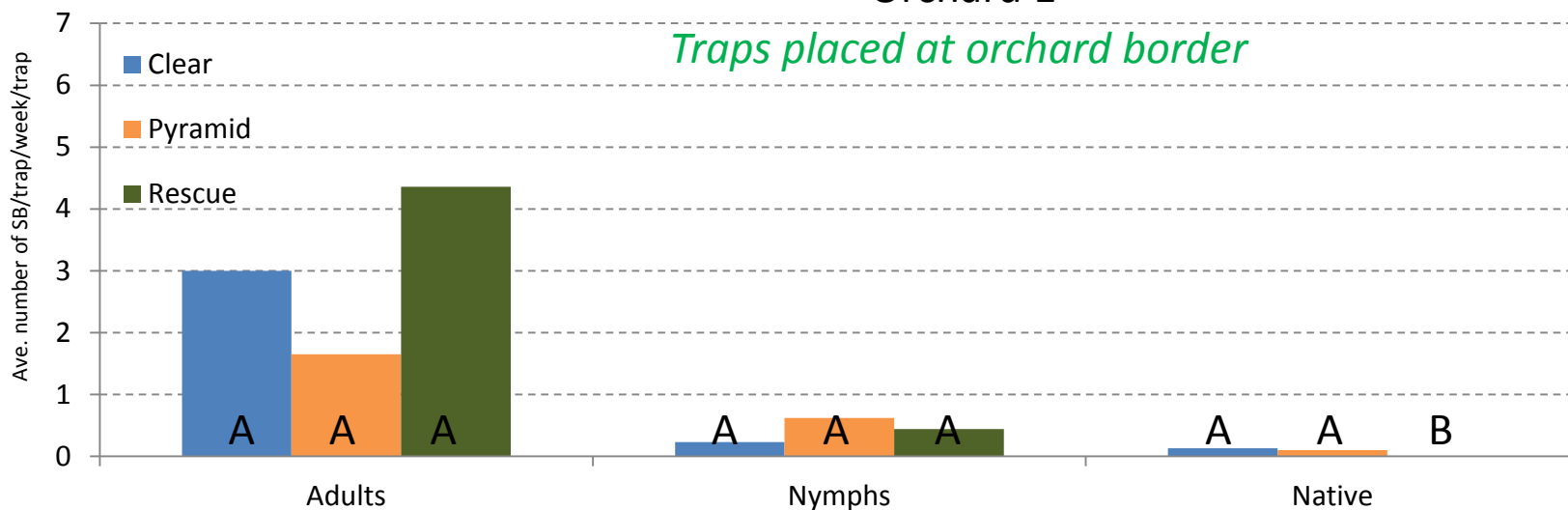


Trap data from all traps combined, n=18 traps per location

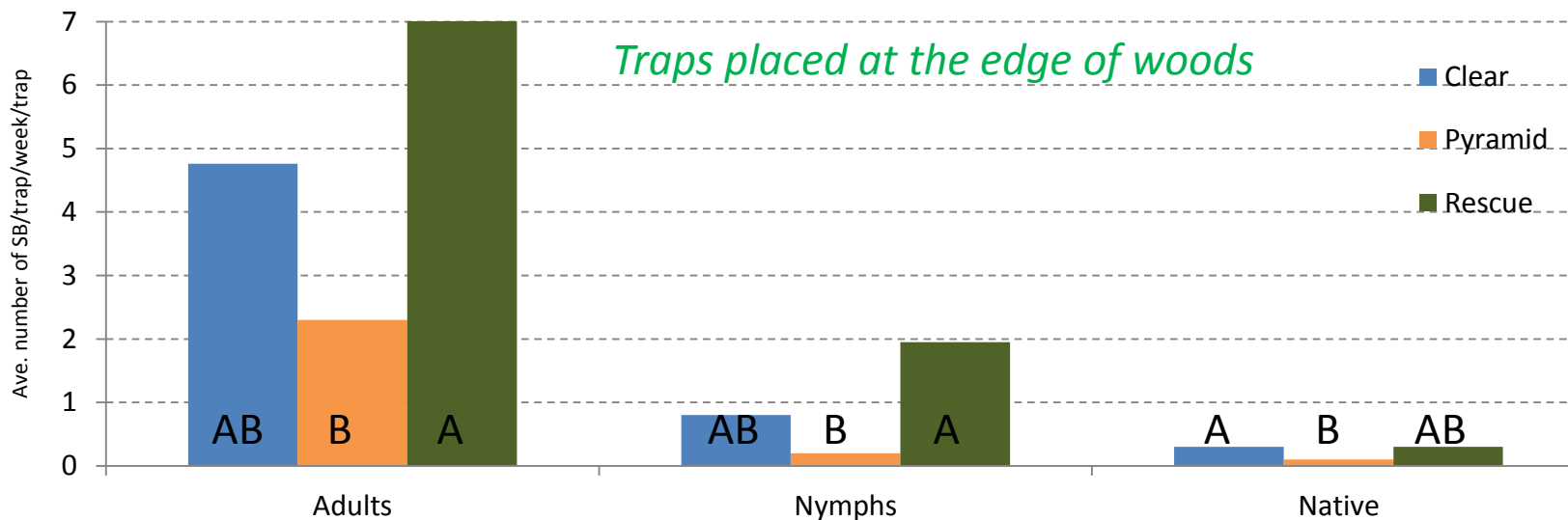
2015 PSU BMSB Trap Comparison

Orchard 1

Traps placed at orchard border



Traps placed at the edge of woods

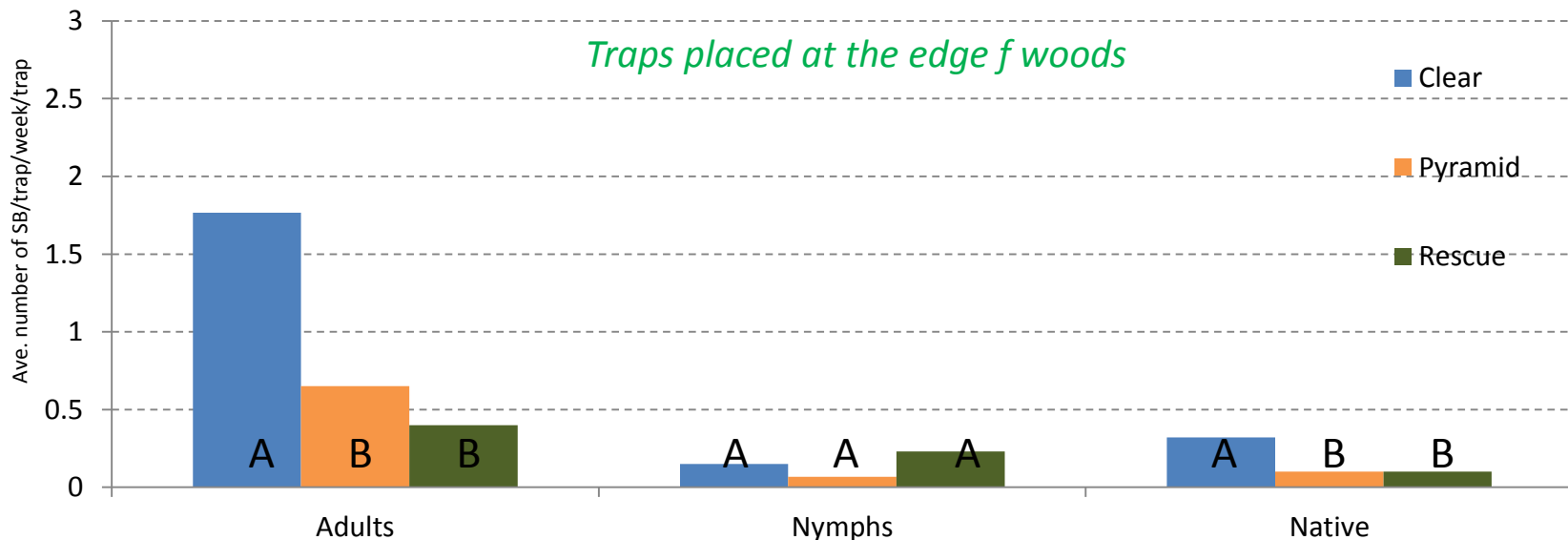
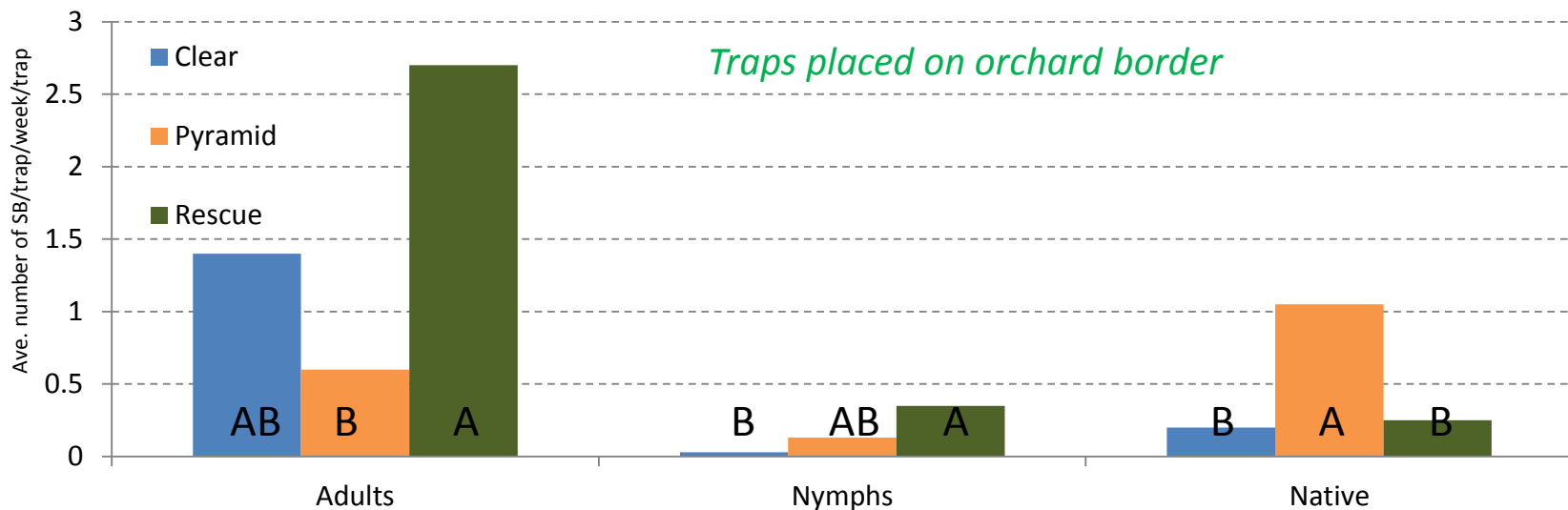


Trap data from all traps combined, n=6 traps per location;

Bars within the same category (i.e., adults, nymphs and native) with the same letter are not different (ANOVA, sqrt transformation, LSD All pairwise, $p < 0.05$)

2015 PSU BMSB Trap Comparison

Orchard 2



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, $p < 0.05$)

Putting BMSB traps into work...

Can this be done practically?

Provisional insecticide treatment thresholds:

COUNTING ADULTS - cumulative capture of 10 BMSB adults per individual trap (concept developed by the USDA ARS);

COUNTING NYMPHS – cumulative capture of 5 BMSB nymphs per traps, or two consecutive weeks with nymphs present in trap

2013 - 2015 BMSB Trap Placement Grid Evaluations

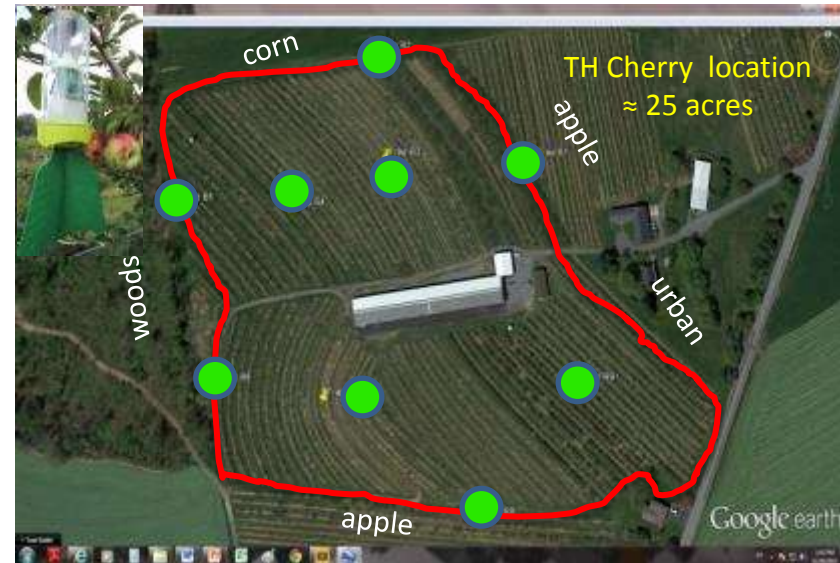
TH apple location:

1. USDA ARS #20 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.
5. **Full insecticide programs**



TH cherry location:

1. Rescue BMSB lures in Rescue traps,
2. Edge traps (5) and interior trap (4); total 9 traps,
3. Weekly trap capture and 12 min visual observations around each trap
4. **Low insecticides during the trial (post-harvest)**

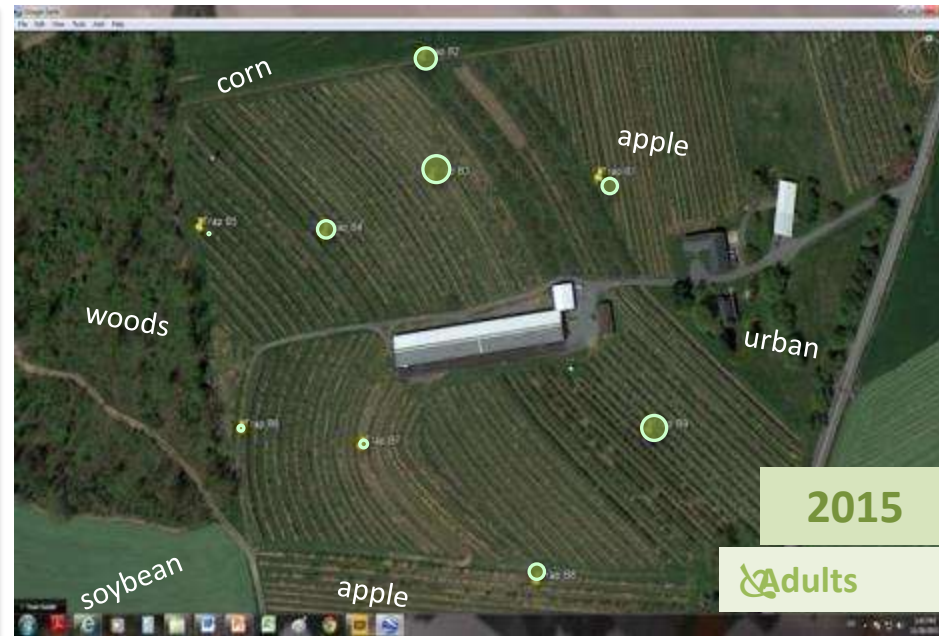
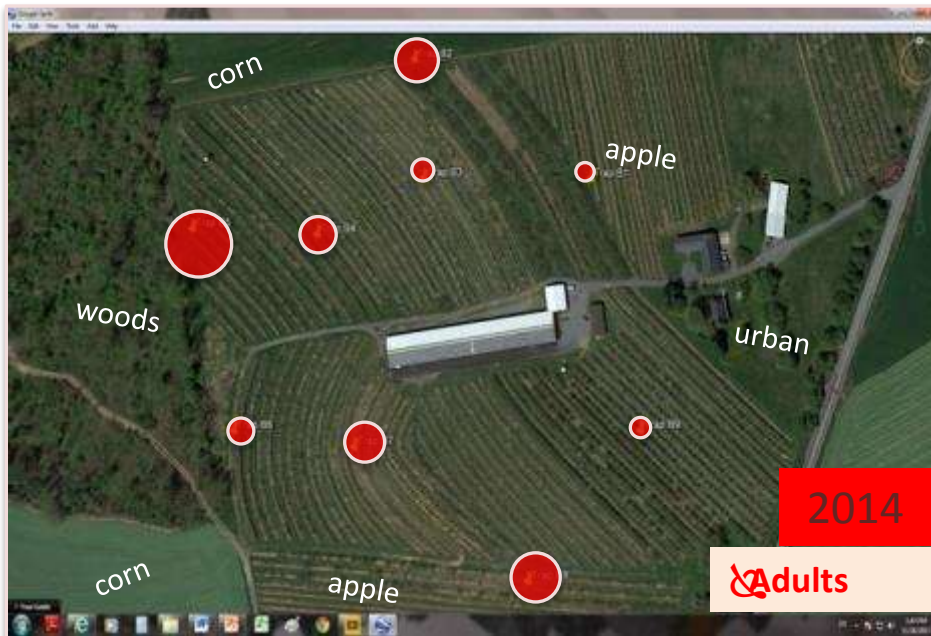
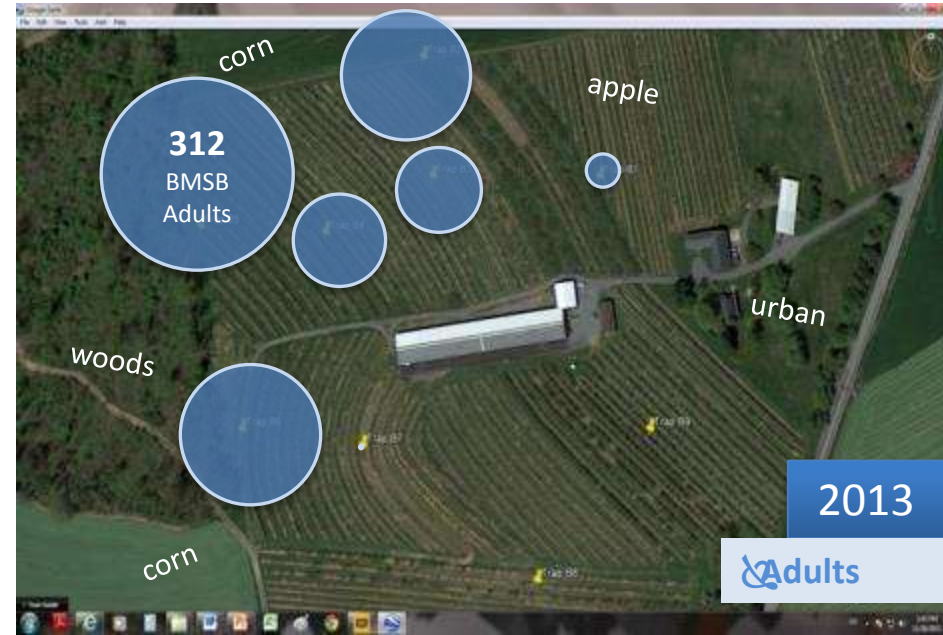


BMSB Trap Placement Grid evaluations (2013 – 2015)

BMSB pressure distribution (**cherry orchard**)
BMSB ADULTS PER TRAP/SEASON (cumulative)

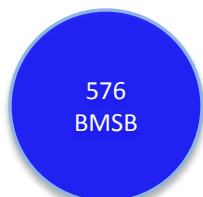


Size proportional to the number of collected BMSB

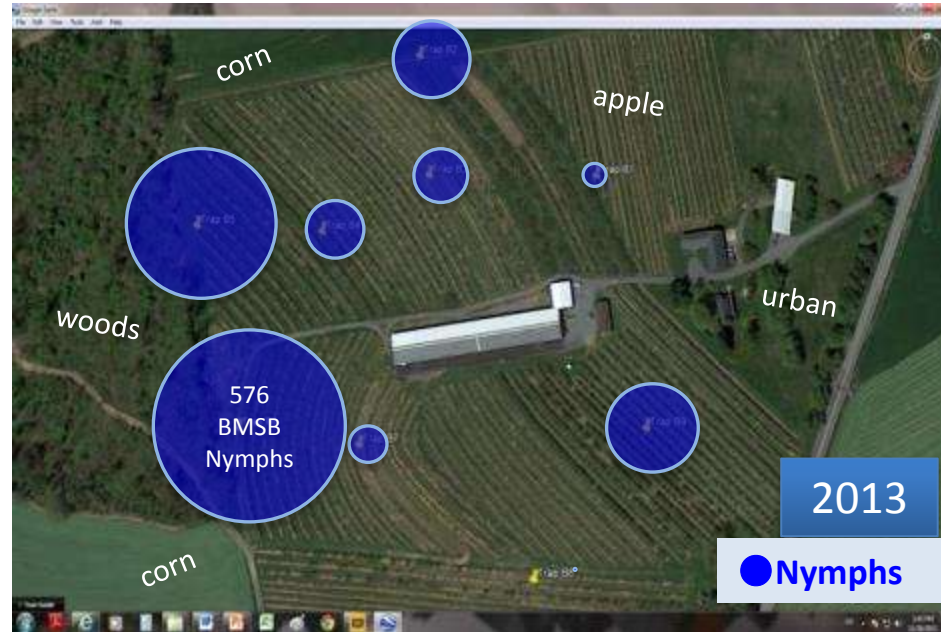


BMSB Trap Placement Grid evaluations (2013 – 2015)

BMSB pressure distribution (**cherry orchard**)
BMSB NYMPHS PER TRAP/SEASON (cumulative)



Size proportional to the number of collected BMSB

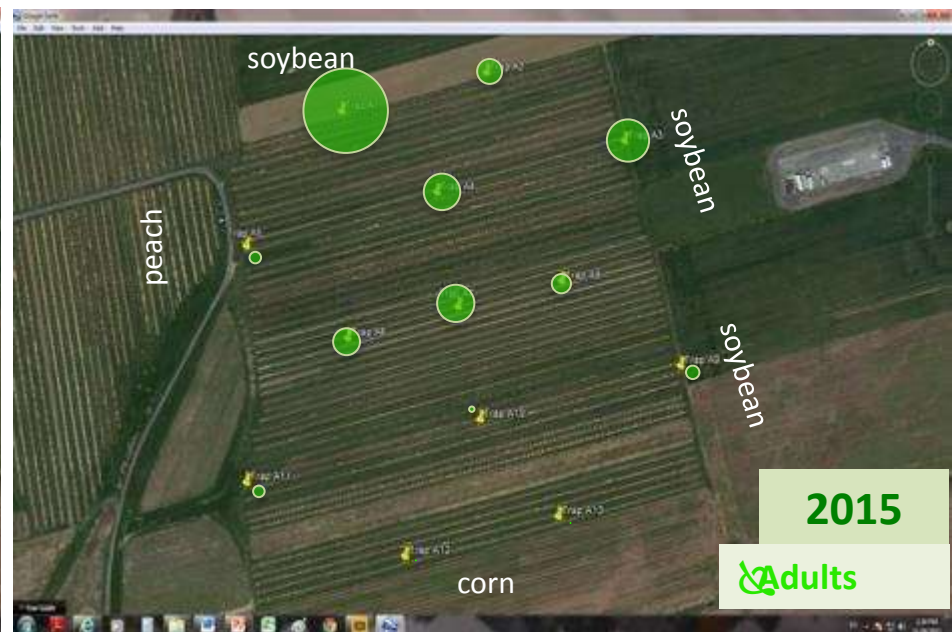


BMSB Trap Placement Grid Evaluations (2013-2015)

BMSB pressure distribution (**apple orchard**)
BMSB ADULTS PER TRAP/SEASON (cumulative)



Size proportional to the number of collected BMSB



BMSB Trap Placement Grid evaluations (2013 - 2015)

BMSB pressure distribution (**apple orchard**)


BMSB NYMPHS PER TRAP/SEASON (cumulative)



Size proportional to the number of collected BMSB



BMSB threshold challenge – apple orchard


Stage	Season	Number of weeks when treatment threshold was met		Total seasonal capture per trap	Actual number of insecticide applications
		Per individual trap (13 traps in orchard)	(average from all traps)		
Adults 	2013	0 – 10	(7)	9 - 217	10
	2014	0 – 6	(4)	1 - 104	5
	2015	0 – 4	(2)	3 - 96	2
Nymphs	2013	0 – 5	(6)	0 - 31	10
	2014	1 – 5	(6)	3 - 45	5
	2015	0 – 2	(1)	0 - 28	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

Threshold challenge – cherry orchard

Stage	Season	Number of weeks threshold was met		Total seasonal capture per trap	Actual number of insecticide applications
		Range per individual trap (average from all traps) <i>(9 traps in orchard)</i>			
	2013	1 – 8	(7)	14 - 312	2
	2014	2 – 6	(4)	3 - 107	1
	2015	0 – 3	(2)	2 - 43	0
Nymphs	2013	0 – 10	(10)	4 - 576	2
	2014	2 – 7	(10)	6 - 65	1
	2015	0 – 4	(7)	0 - 44	0

Provisional thresholds:

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

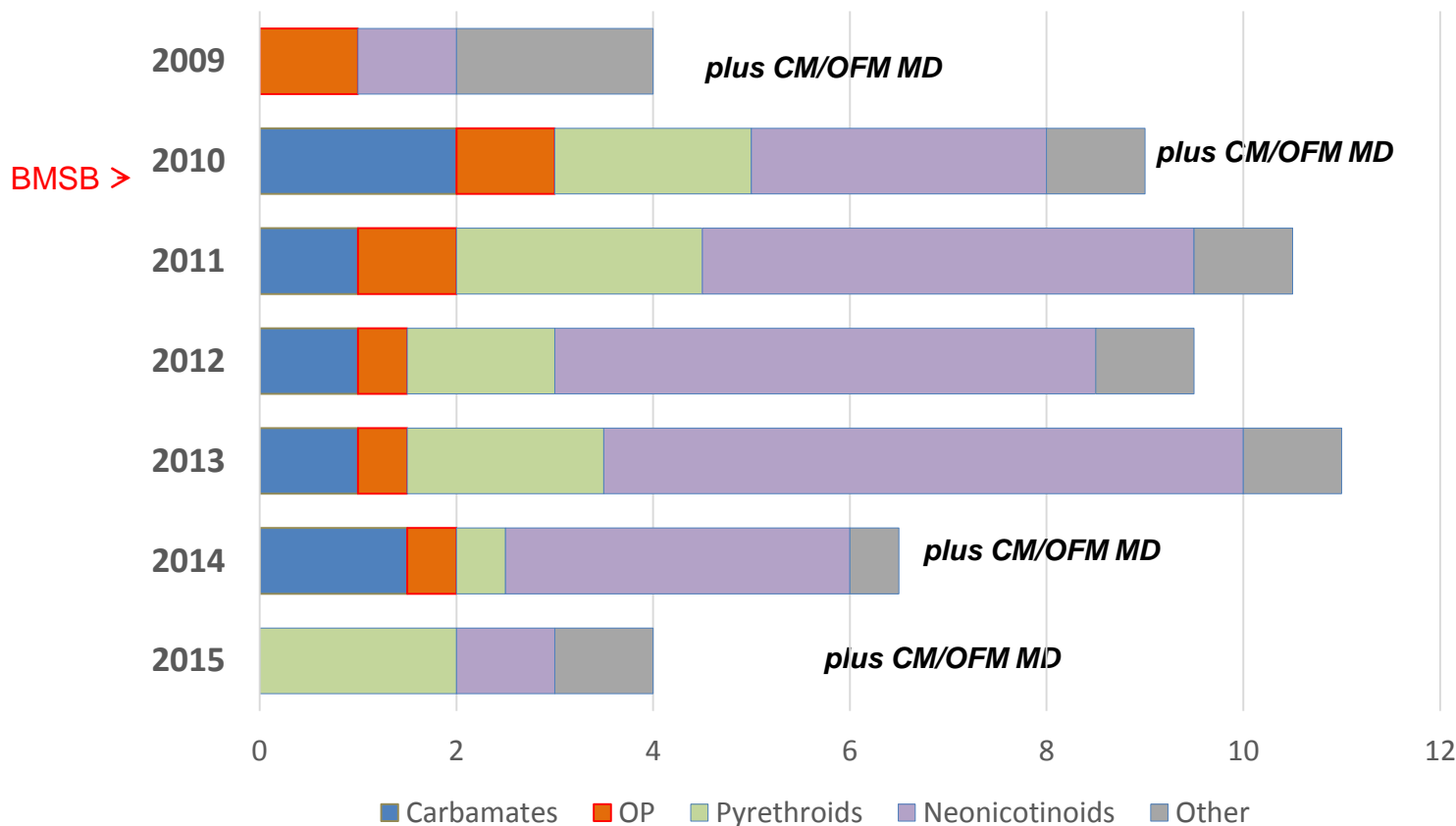
NYMPHS – cumulative 5 nymphs per traps, or two consecutive weeks with nymphs present

Changes in seasonal insecticide applications - apples

2009-2015 seasons

(Commercial orchard, PA)

Insecticide applications per season



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.

Alternative BMSB management endeavors



Attract and Kill project



Ghost traps project

Comments...



Commercial lures and traps are effective in monitoring BMSB and should be used as an indicator to decide if BMSB specific management is needed (action thresholds, movement, etc...)



Understanding of “action thresholds” for various BMSB lure/trap combinations is crucial for development of practical management recommendations. The placement of traps is affecting attractiveness of lures to BMSB adults and nymphs.



The clear plastic BMSB traps are as effective as traditional pyramid shaped traps however “attracting” does not always equal “capturing” of BMSB adults and nymphs



Use of BMSB attractants/pheromones for alternative BMSB management methods such as commercial light trapping, nets or attract and kill tools are very promising tools to support rational IPM based BMSB management programs in fruit



Thank you



Ally
Lock Haven University



Chandler
Penn State University



Dalton
Penn State University



Kristlyn
Elizabethtown College



Lauren
Hood College



Martha
Penn State University



Nikki
Penn State University

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