

Management of Brown Marmorated Stink Bug in Apple Orchards Using Attract and Kill Technology

Objective 3c. *Improve agroecosystem sustainability through spatially focused management*

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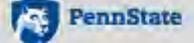
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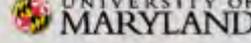


Funding

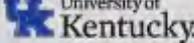
 United States Department of Agriculture National Institute of Food and Agriculture
Specialty Crop Research Initiative

Collaborating Institutions

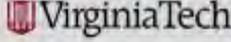
  

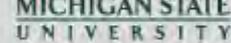
  

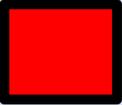
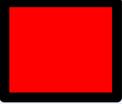
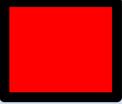
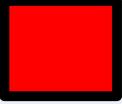
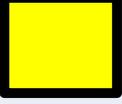
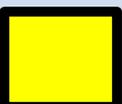
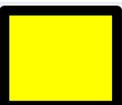
 

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JUNE 2011

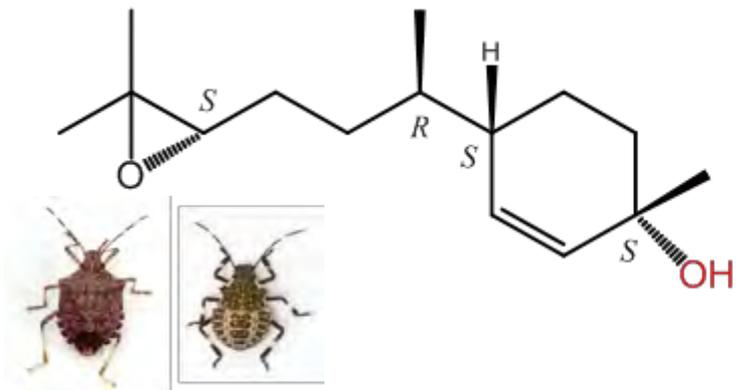
		SPRAY SCHEDULE - BMSB		- ARMS IN, STONE Fruit POME FRUIT + Brambles		apples - peaches -	McHenry Highland Festival*
		* every other row lg. apples, peaches * every 4th row bellis apples					Blueberries Brambles Cherries (4-1)
5	6	apples peaches, plums strawberries (OUTSIDE)	cherries) 1/2 potatoes tomatoes vegetables	cherries 1/2 1/2 brambles 1/2 blueberry blackberry	apples peaches, plums (INSIDE)	blueberries 37/40 +4 Brambles 13, 15, 16, 44, 41	Early Summer Sea- rates begin this weekend check spray cherries
12	13	Apples Peaches (OUTSIDE)	vegs. tomatoes cherries grapes, gooseb plums, apricot	Apples peaches (INSIDE)	check spray cherries cherries tomatoes, flowers	Blueberries Brambles vegetables	Peach Apple (OUTSIDE)
19	20	Brambles, Blueberries, grapes, gooseberries (OUTSIDE)	Peaches Apples (INSIDE)	Cherries/plums (inside)	cherry check spray	cherry check spray	18
26	27	Brambles Blueberries (outside)	apples peaches cherry	tomatoes vegs. flowers potatoes	Blueb. (advised)	peach apple (outside)	Summer Season rat begin this weekend
(50/48) 26	27						
	28						
	29						
	30						
	7/1						
	7/2						

Insecticides Used Against BMSB in Tree Fruit

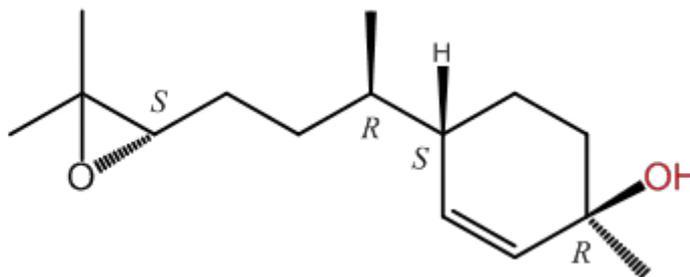
Insecticide	Lethality	Residual Activity (3d)	Beneficials
Methomyl (Lannate)	HIGH	LOW - MODERATE	
Endosulfan (Thionex)	HIGH	LOW	
Bifenthrin (Brigade)	HIGH	LOW	
Fenpropathrin (Danitol)	HIGH	LOW	
Lambda-Cyhalothrin (Warrior)	MODERATE	LOW	
Clothianidin (Belay)	MODERATE	MODERATE	
Dinotefuran (Scorpion, Venom)	HIGH	LOW	
Thiamethoxam (Actara)	MODERATE	LOW - MODERATE	

Two-Component BMSB Aggregation Pheromone and Synergist

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

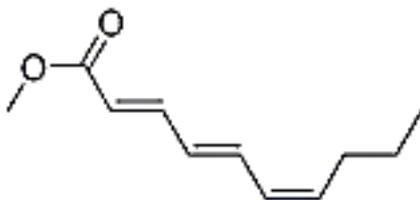


Minor component of BMSB aggregation pheromone
(3*R*,6*S*,7*R*,10*S*)-10,11-epoxy-1-bisabolen-3-ol



+

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



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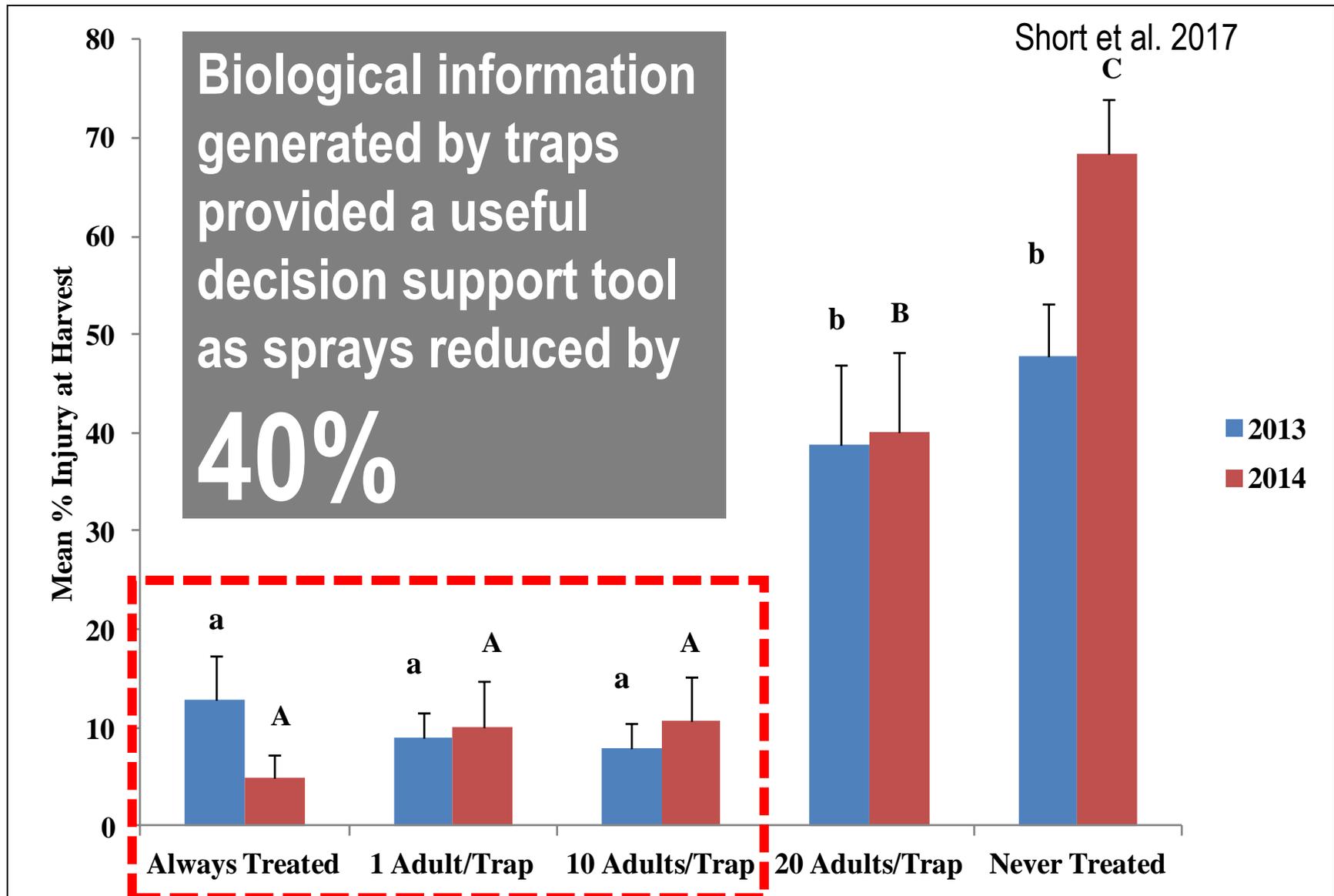
Synergism

Standard Monitoring Traps



- **Visual Stimulus**
 - Large black pyramid (trunk-mimicking stimulus)
- **Olfactory Stimulus**
 - PHER + MDT
- **Capture Mechanism**
 - Tapered pyramid attached to inverted funnel jar with DDVP strip
- **Deployment Strategy**
 - Traps placed in peripheral row or border area

Decision Support Tools for BMSB



Aggregation Vs. Sex Pheromone

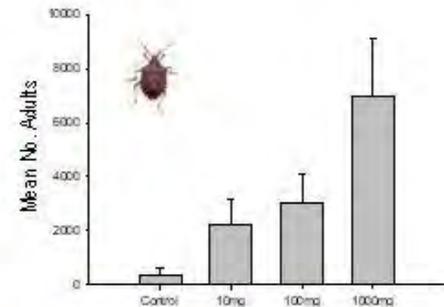
Area Response
Attractive To Males, Females and
Nymphs



Behavioral Basis for Attract and Kill in Apple

- Dose-Response to Pheromone and Synergist

Over 55,000 BMSB in 6 days with 3x more at high dose trees



- Attraction To A Spatially Precise Location

>90% in baited tree, spillover ~2.5 m



- Long Retention Time

Remain on baited tree for > 24h

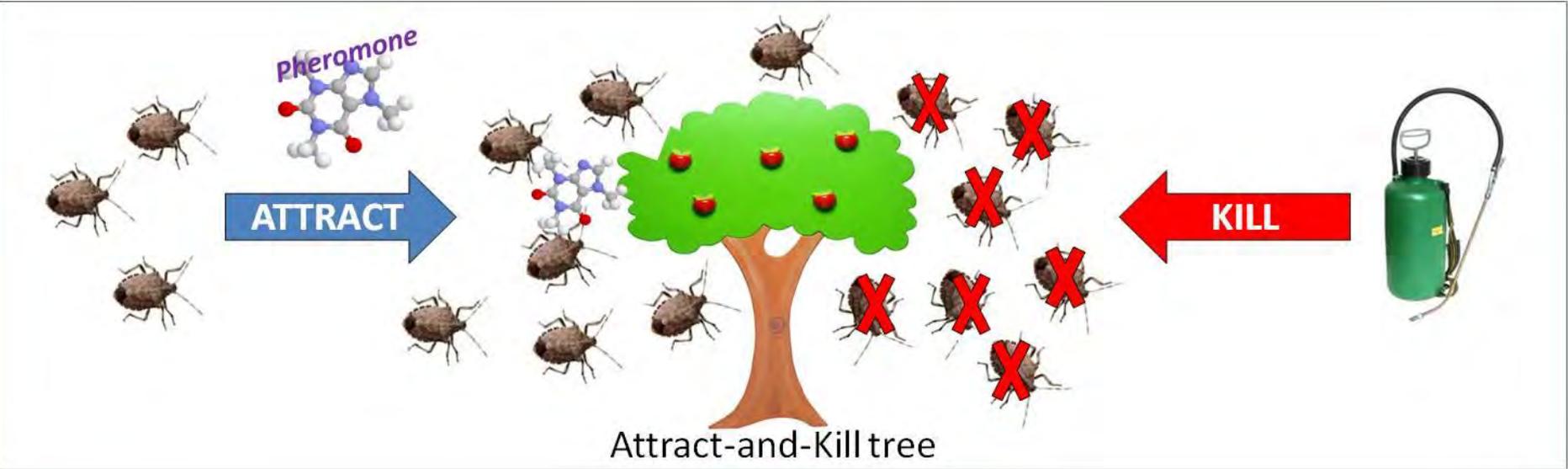


- Effective Killing Mechanism

Season-long insecticide program



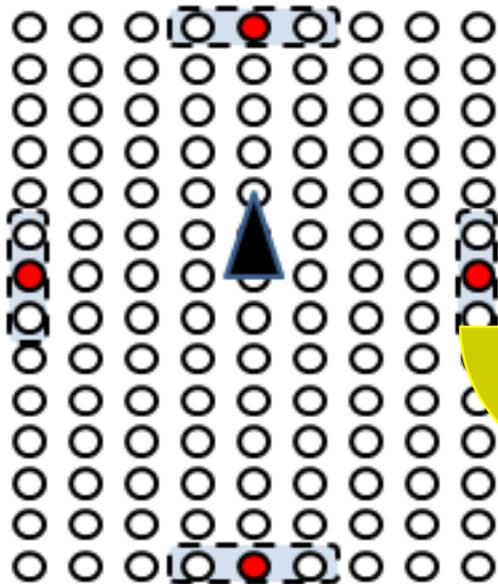
Can We Reduce Insecticide Inputs Further?



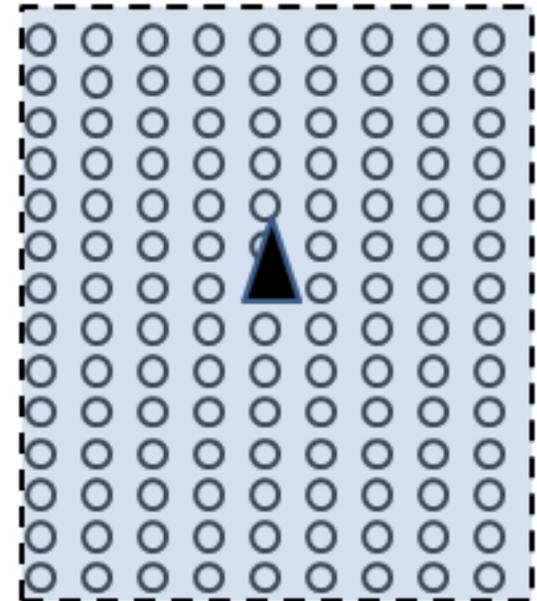
Commercial Attract-and-Kill Set-Up

- 10 Orchard Blocks in MD, WV, VA, PA and NJ.
- Two treatments: 'Attract and Kill' and Grower Standard.
 - 'Attract and Kill' trees spaced every 50 m and baited with 840 mg murgantiol + 66 mg MDT and treated weekly.
 - Grower Standard treated with BMSB materials based on grower experience/preferences.
- Both blocks monitored with baited pyramid traps (if threshold hit, 2 ARM sprays applied).

Attract-and-Kill Block



Grower Standard

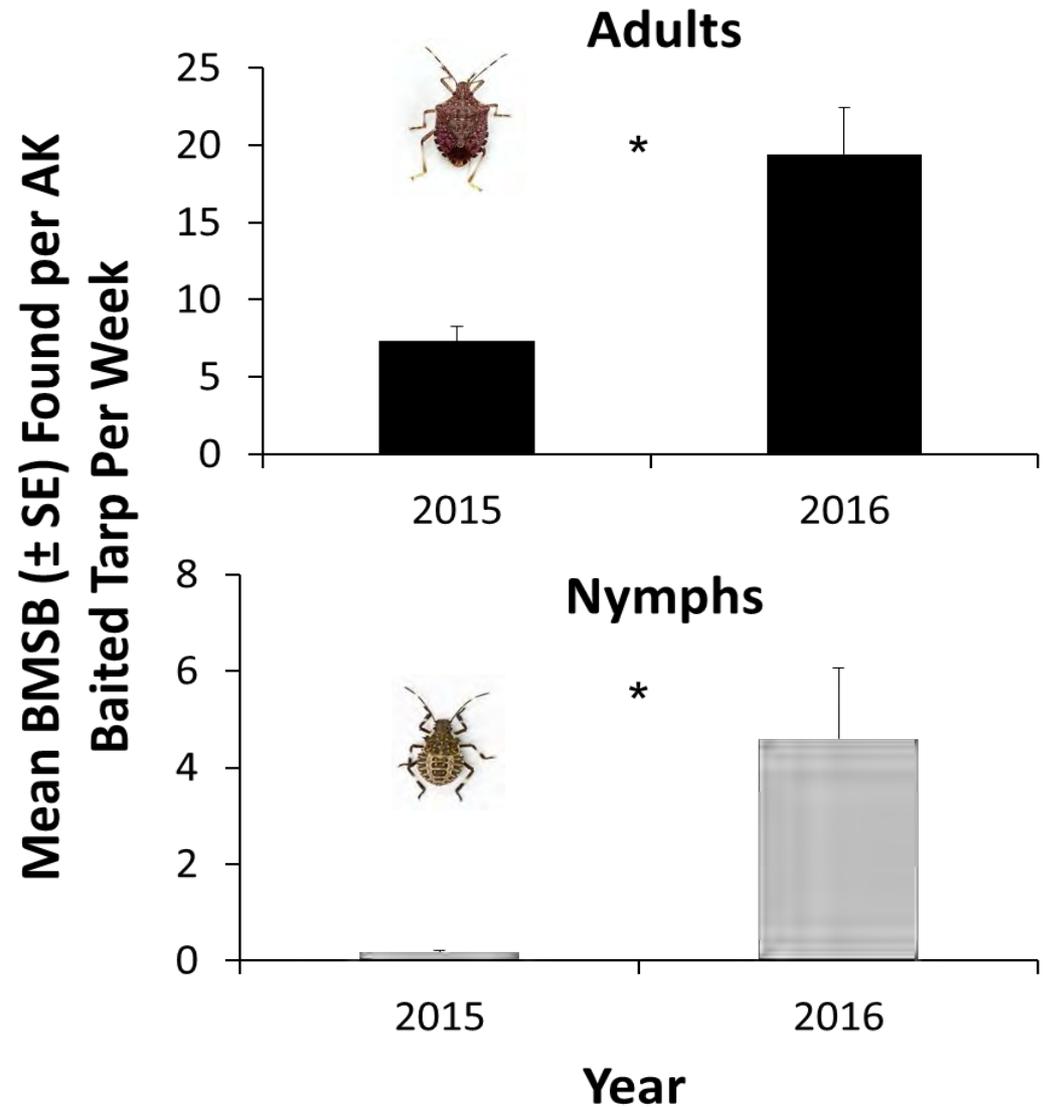


Results Generated

- Counts of adults and nymphs killed at 'Attract and Kill' trees per week.
- Damage samples taken at harvest from exterior and interior trees from 'Attract and Kill' and Grower Standard blocks.
- Natural enemy and secondary pest surveys.
- Costs and Benefits.



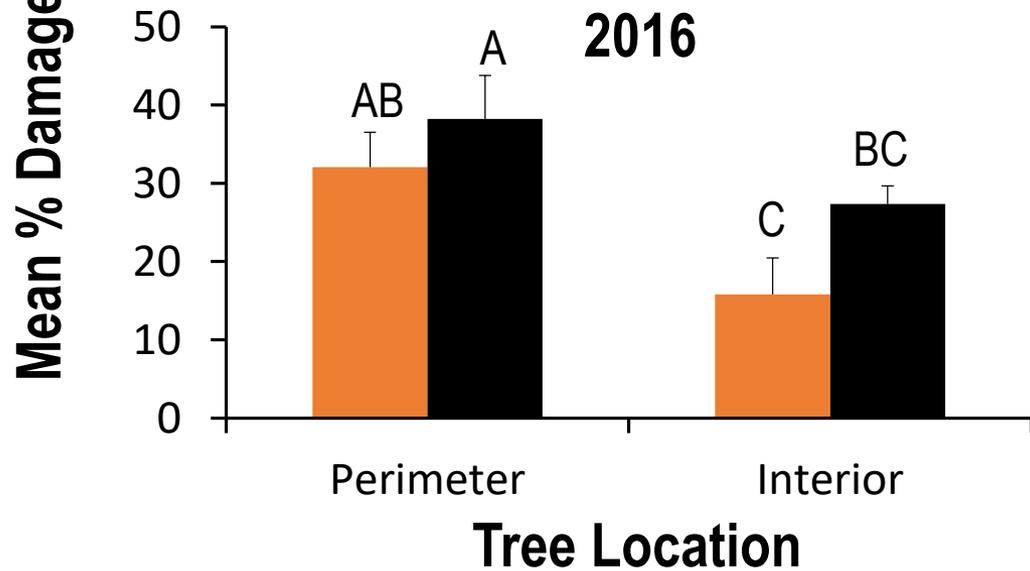
Relative Population Densities at 'Attract and Kill' Trees



Damage at Harvest



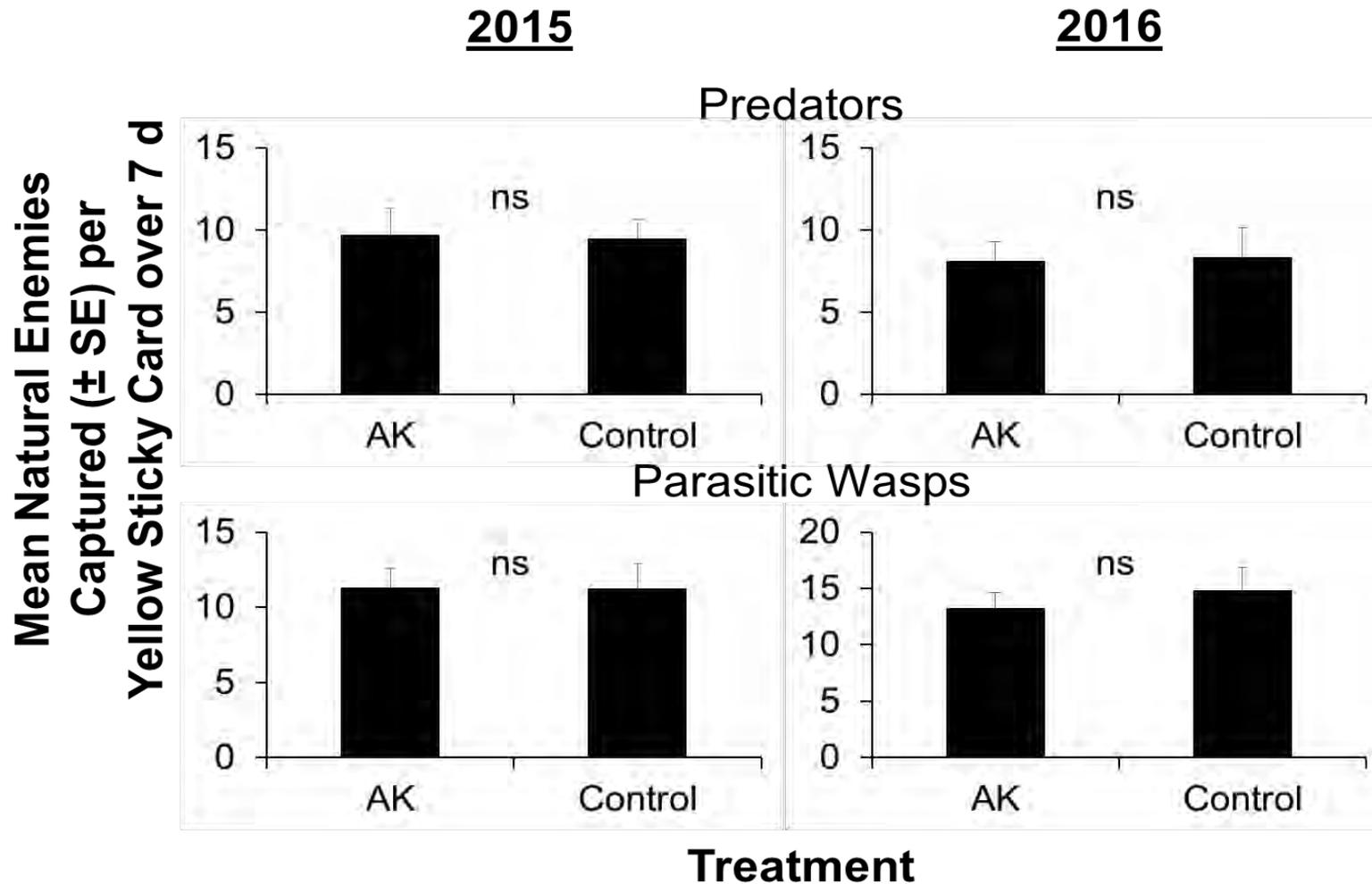
Lower Population Density



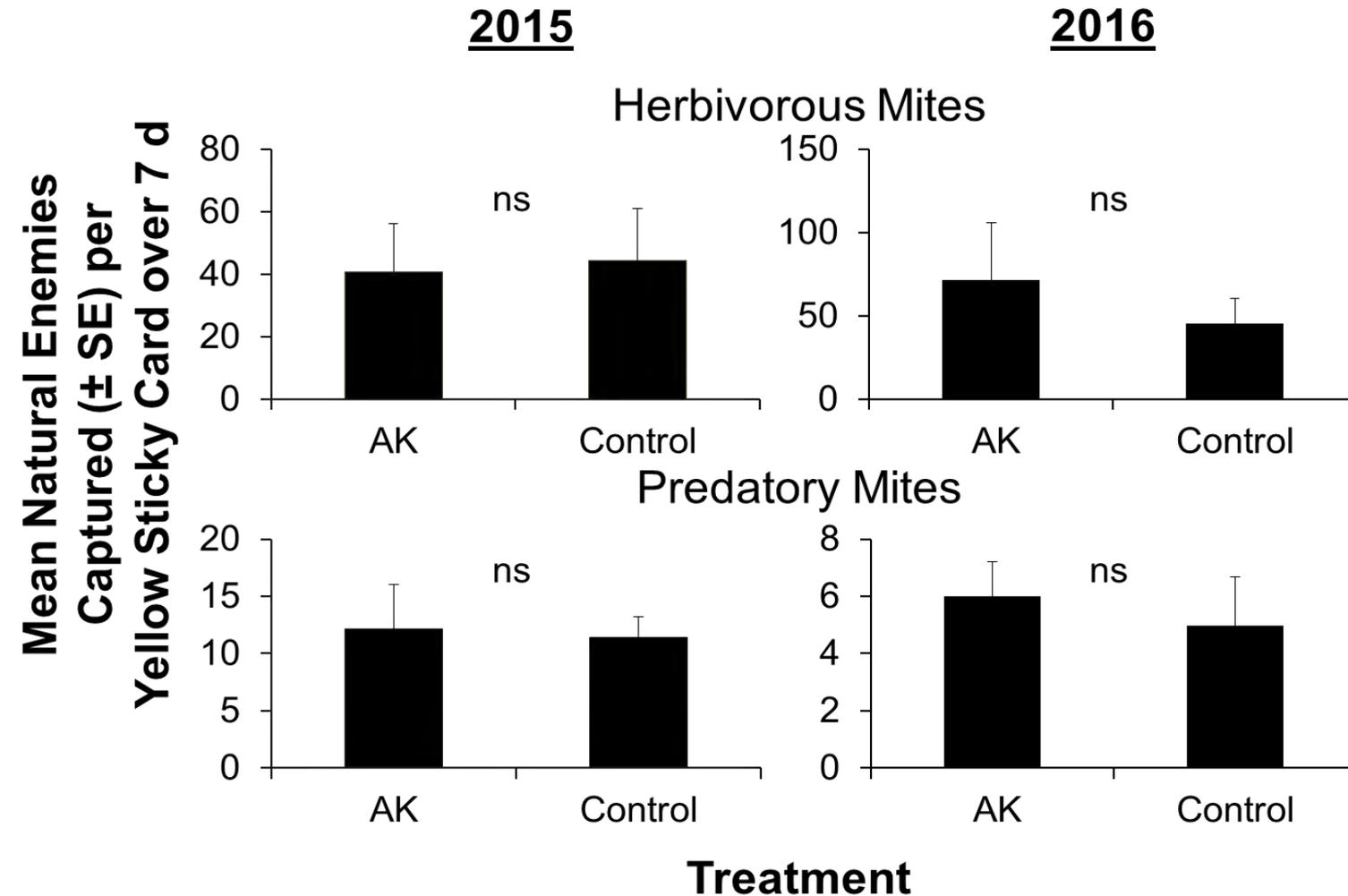
Higher Population Density



Natural Enemies and Secondary Pests



Natural Enemies and Secondary Pests



Costs and Benefits

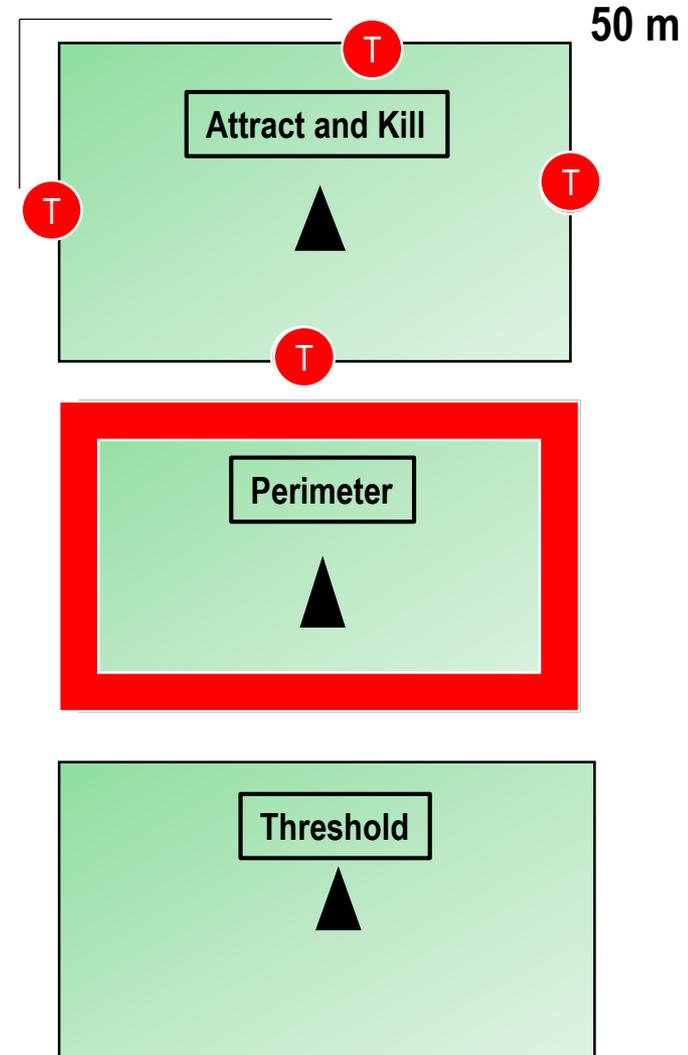
	Attract-and-Kill	Grower Standard
% Orchard Block Treated For BMSB	3-4% (15 spray events)	100% (3 spray events)
Additional Triggered Sprays/Block	0.7	1.6
BMSB Management Costs/ha	\$6186/ha (88% in PHER)	\$811/ha
Whole Bushel Losses/ha	\$5147	\$7080

How can we make 'Attract and Kill' more affordable and achievable?

2015-2016 Perimeter-Based Management Trials

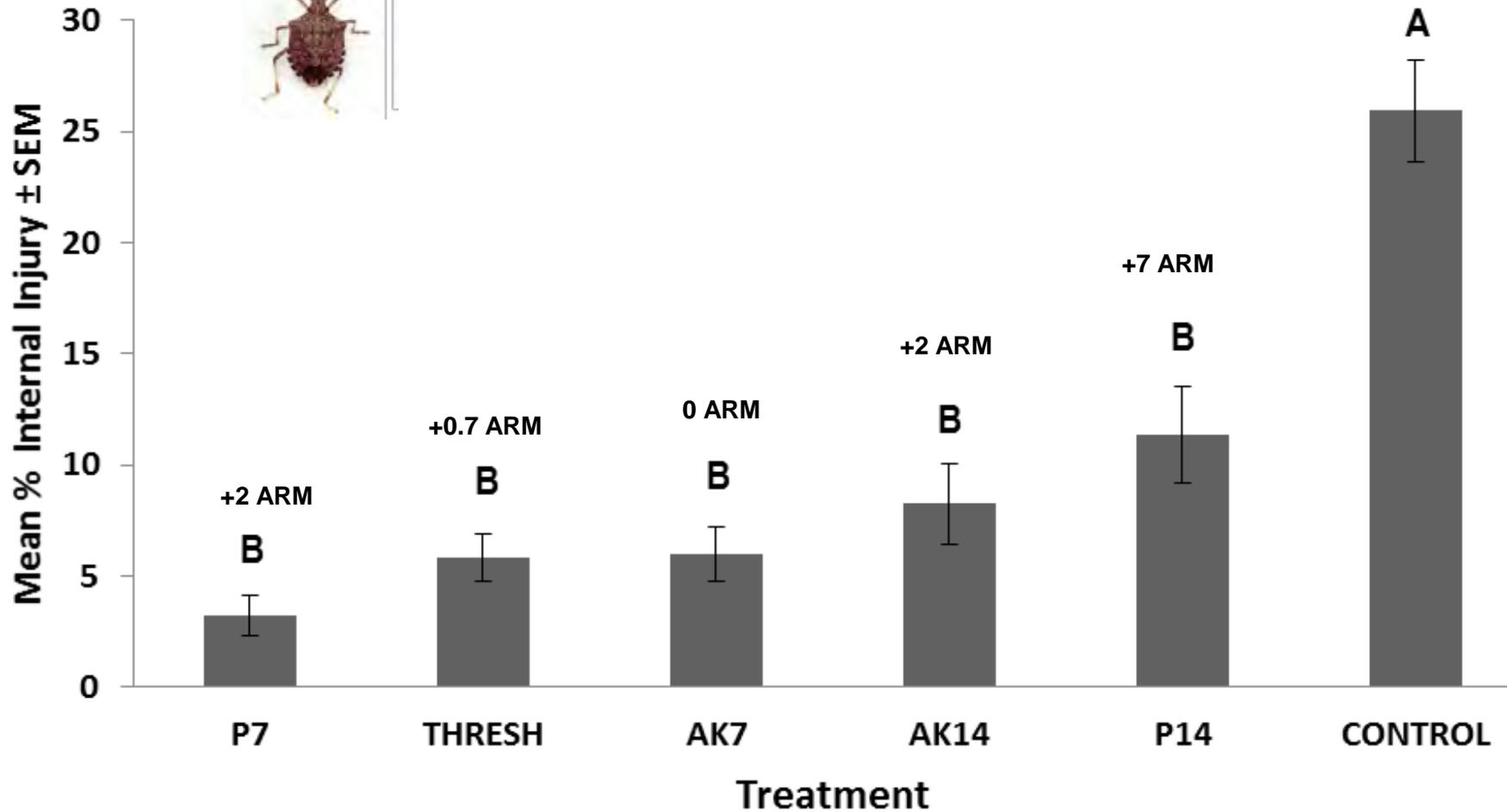
- Can we reduce spray intervals for perimeter-based management?
- Apple blocks managed by the following perimeter-based management strategies and compared with treatment threshold and an unsprayed control.

- 1) Standard AK – 7-d intervals
- 2) Modified AK – 14-d intervals
- 3) Standard Full Perimeter – 7-d intervals
- 4) Modified Full Perimeter – 14-d intervals
- 5) Treatment Threshold (10 BMSB/Trap)
- 6) Control (No Insecticide Applications)

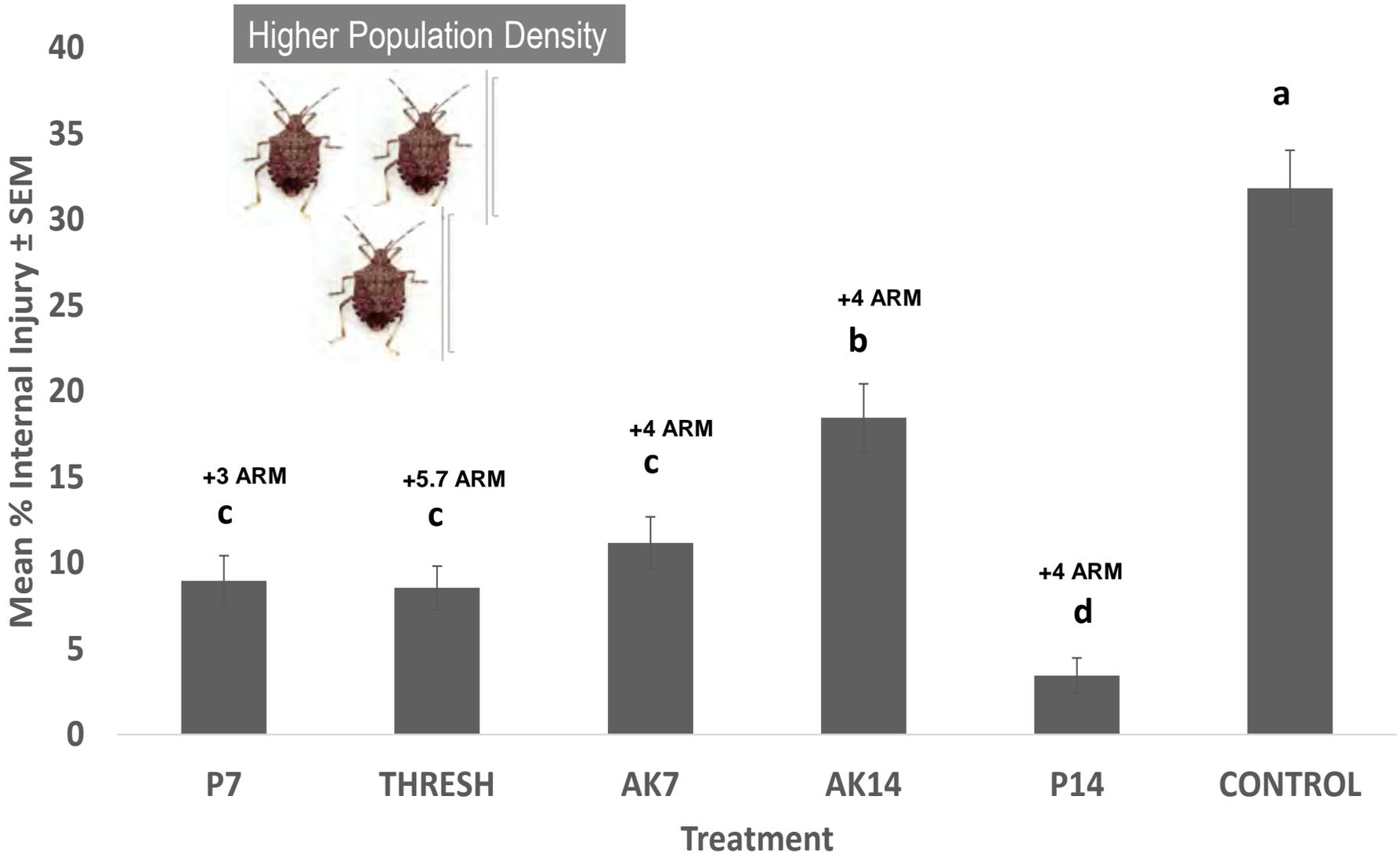


2015 Harvest Results

Low Population Density



2016 Harvest Results



Tentative Conclusions

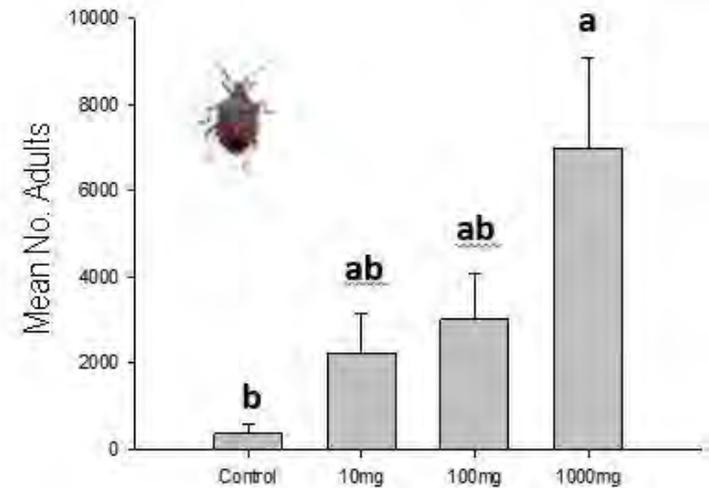
- Increasing the spray interval for 'Attract and Kill' and Perimeter sprays is probably not viable due to constant pressure, particularly from the mid-season onward and short residual activity seen from labeled products.
- In terms of overall grower inputs, the threshold based approach provided reasonable control with reduced inputs.

Key Questions

- Can we reduce the amount of pheromone, thereby reducing cost?
- What is the optimal spacing for 'Attract and Kill' sites?
- Can we replace the sprays with LLINs?

Amount of Pheromone and Pheromone Synergist

- Compared with a 1x loading, a 10x increase in pheromone resulted in almost no difference in numbers responding/killed. With 100x increase in pheromone, we only saw a 3x increase in BMSB. It is likely reductions can be made in amounts deployed.
- Attractiveness and longevity of lures has increased significantly while the cost has dropped significantly since this study was conducted.



Preliminary Results for Trap Spacing

- Plume Reach < 3m.
- Trapping Radius ~121 m.
- Trapping area ~4.83 hectares.

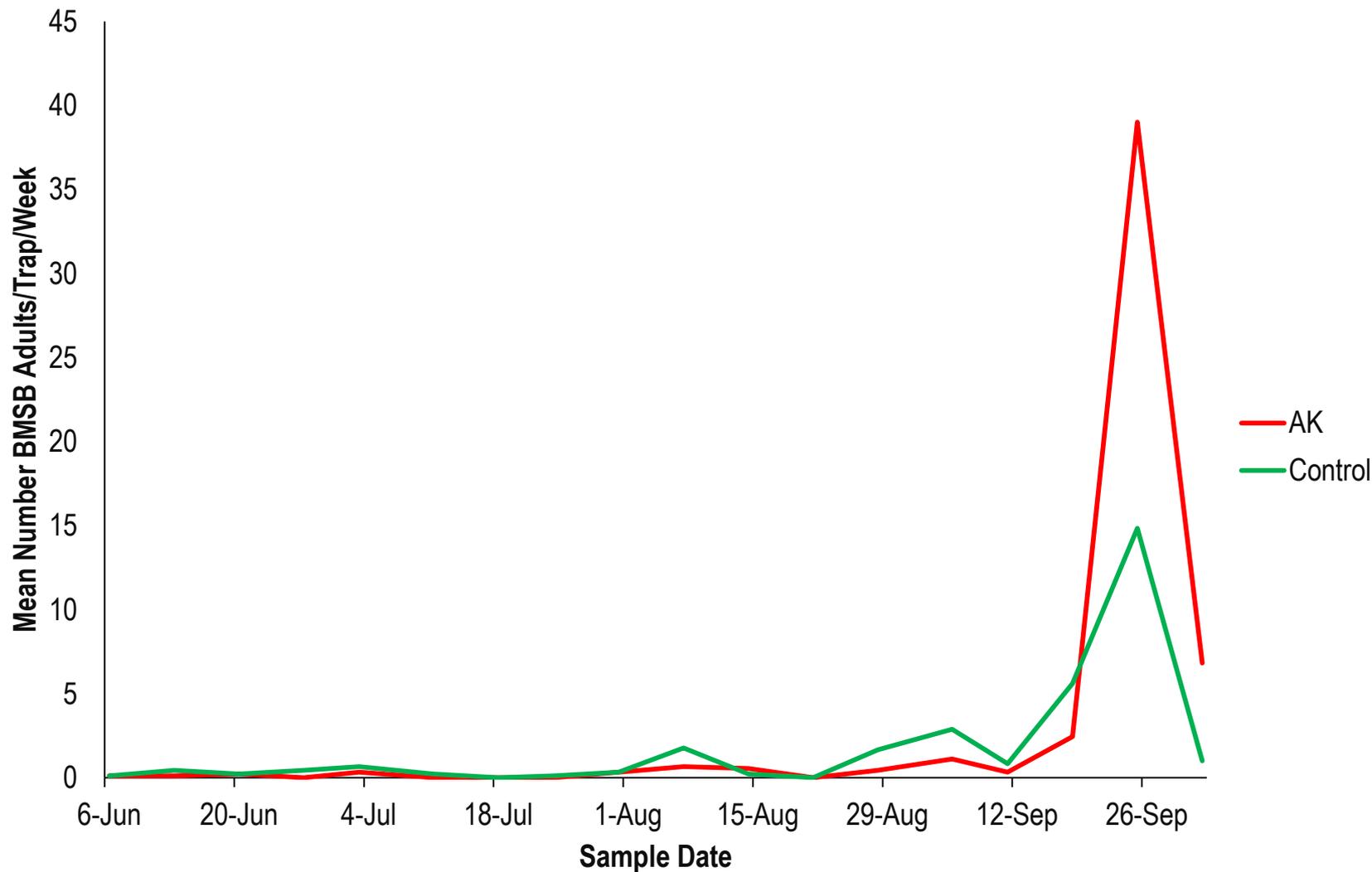


Can we replace sprays with LLINs in apple orchards?

- Trees baited with a 4x Trece Lure (50 mg PHER/200 MG MDT) on each of three (1m x 1m) nets.
- Compared with grower standard.
- Both blocks were monitored in interior with 3 baited traps. If any trap reached threshold, ARM sprays applied.
- Three participating growers.
- Injury taken at harvest.



Trapping Results

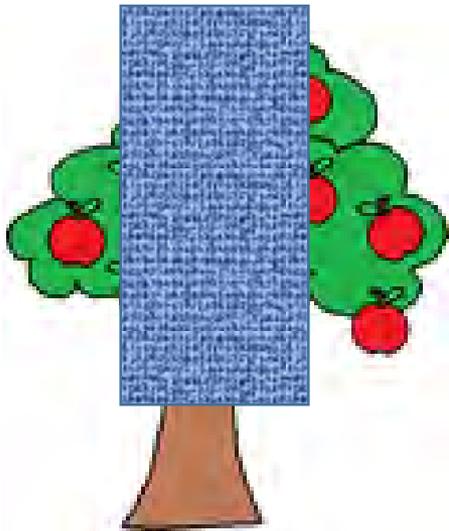


Harvest Results

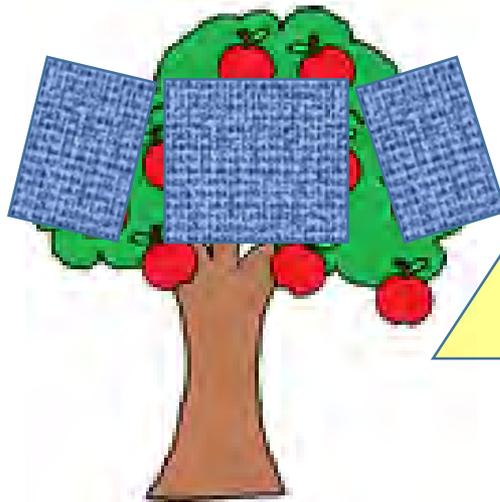
Treatment	Mean No. Triggered Sprays	Tree Location	Mean Prop. Injury \pm SE	Mean Severity \pm SE
Attract and Kill	2.00	Interior	0.02 \pm 0.01 a	2.38 \pm 0.60
Grower Standard	3.33	Interior	0.13 \pm 0.02 b	2.84 \pm 0.29

Net Deployment Strategy Comparison

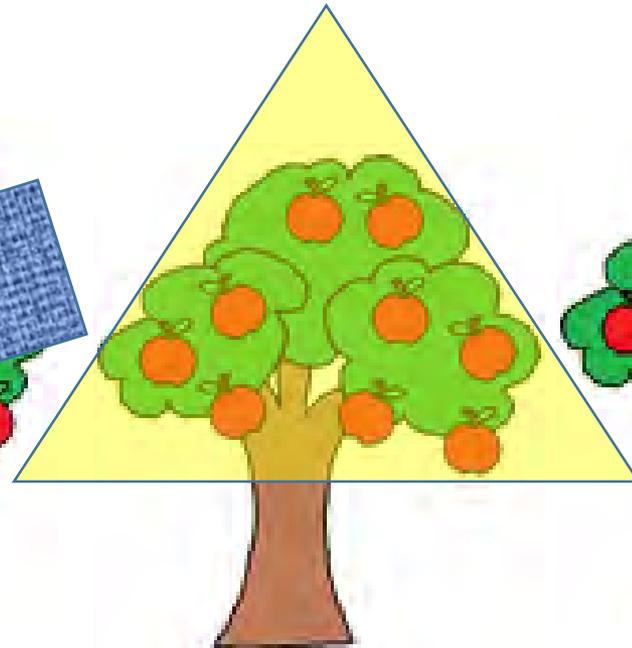
- How many BMSB do we kill with nets oriented vertically and horizontally compared with weekly sprays and a control?



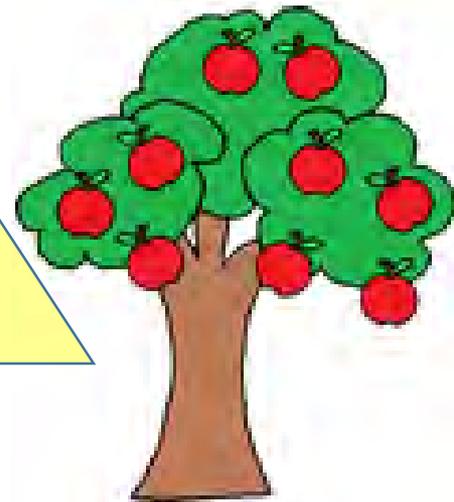
Vertical



Horizontal

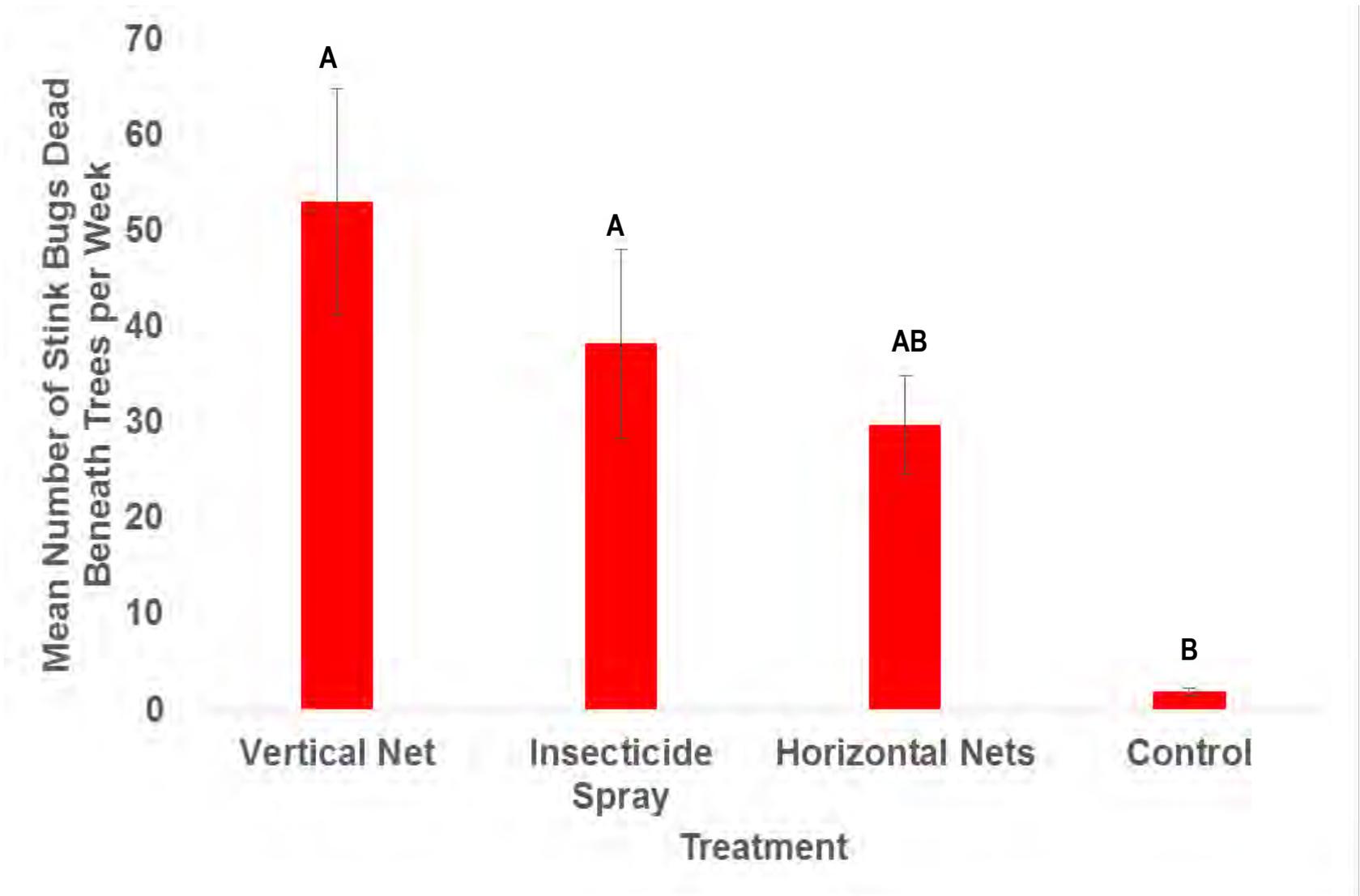


Weekly Spray



Control

Net Deployment Strategy Comparison



Next Steps

- Spacing for 'Attract and Kill' sites based on further refinement of trapping area studies in presence of apple.
- Repeat orchard trials with LLINs and continue experimentation of deployment strategy for LLINs.
- Retention times and movement patterns of adults on trees with LLINs and various pheromone loadings. Overall efficacy.
- Couple with refined monitoring traps.

Acknowledgements



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