

Development of Effective Detection and Monitoring Tools



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- Tools that provide accurate measurements of presence, abundance, and seasonal activity of BMSB.
- Growers can make informed management decisions.

Key Components of Trap-Based Monitoring



- Visual Stimulus
 - Black pyramid (trunk-mimicking stimulus)
- Olfactory Stimuli
 - 2-component BMSB pheromone
 - MDT (acts as a synergist)
- Capture Mechanism
 - Tapered pyramid attached to inverted funnel jar
 - DDVP strip
- Deployment Strategy
 - Traps placed in border of crop. Greatest captures (highest risk location along woodlines).

Visual Stimuli



Attractive Visual Stimuli for Native Stink Bugs

- **Yellow was more attractive than other colors.**
- **Yellow considered a super-normal visual stimulus for foliar stimuli.**
- **Native stink bug species, particularly, *Euschistus* sp. use broadleaf hosts.**

Ground-Deployed
Pyramid Trap



One Attractant Available for BMSB until 2011

- Methyl (2E, 4E, 6Z)-decatrioneate is an attractant produced by the Asian stink bug, *Plautia stali*.
- Cross attractive to BMSB and other pentatomids.



2009-2010 BMSB Response to Visual Stimuli

Black

Green

Yellow

White

Clear



Trunk
Mimic

Foliar
Stimulus

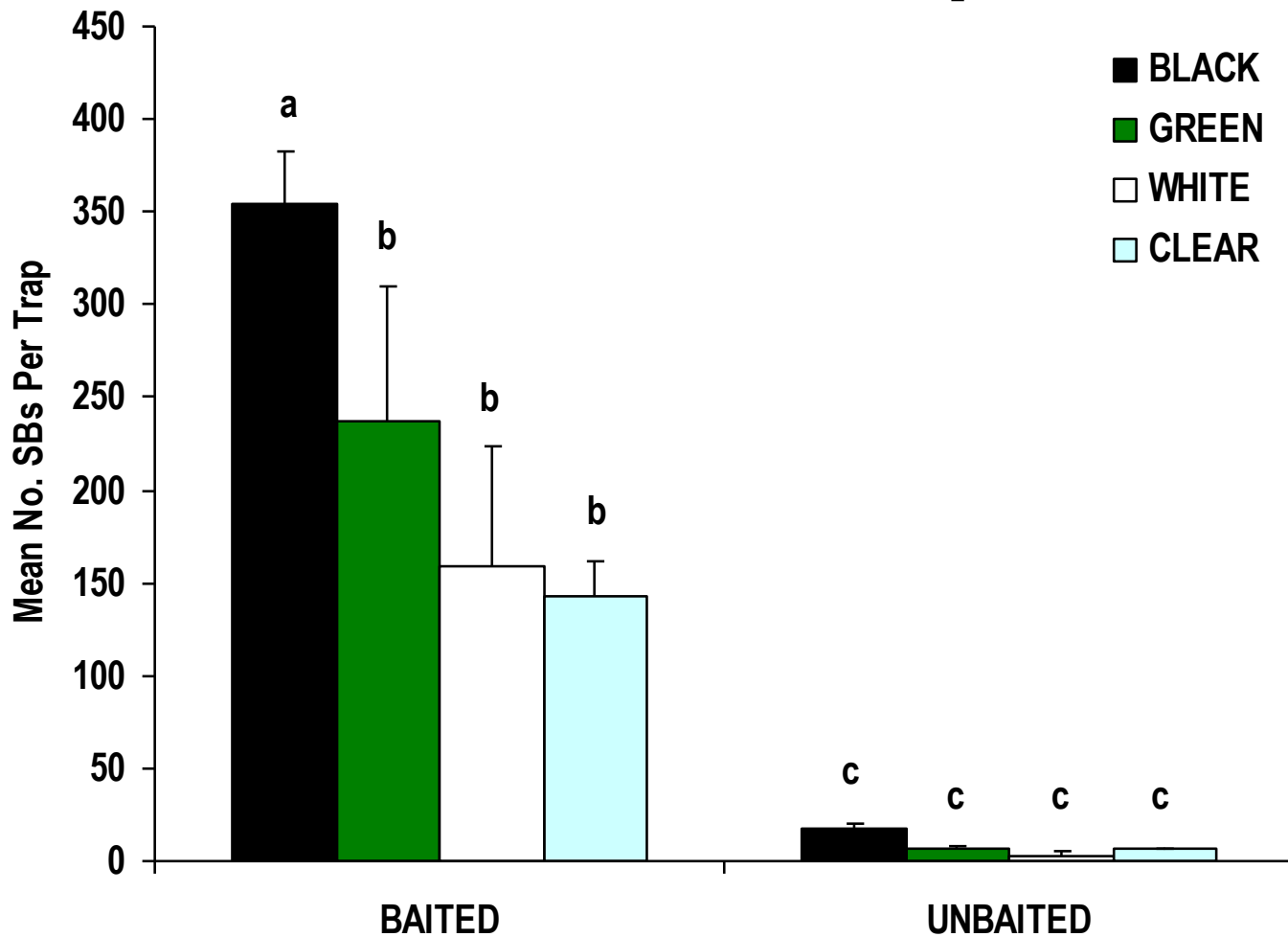
Foliar
Stimulus

Unapparent
Stimulus

Unapparent
Stimulus

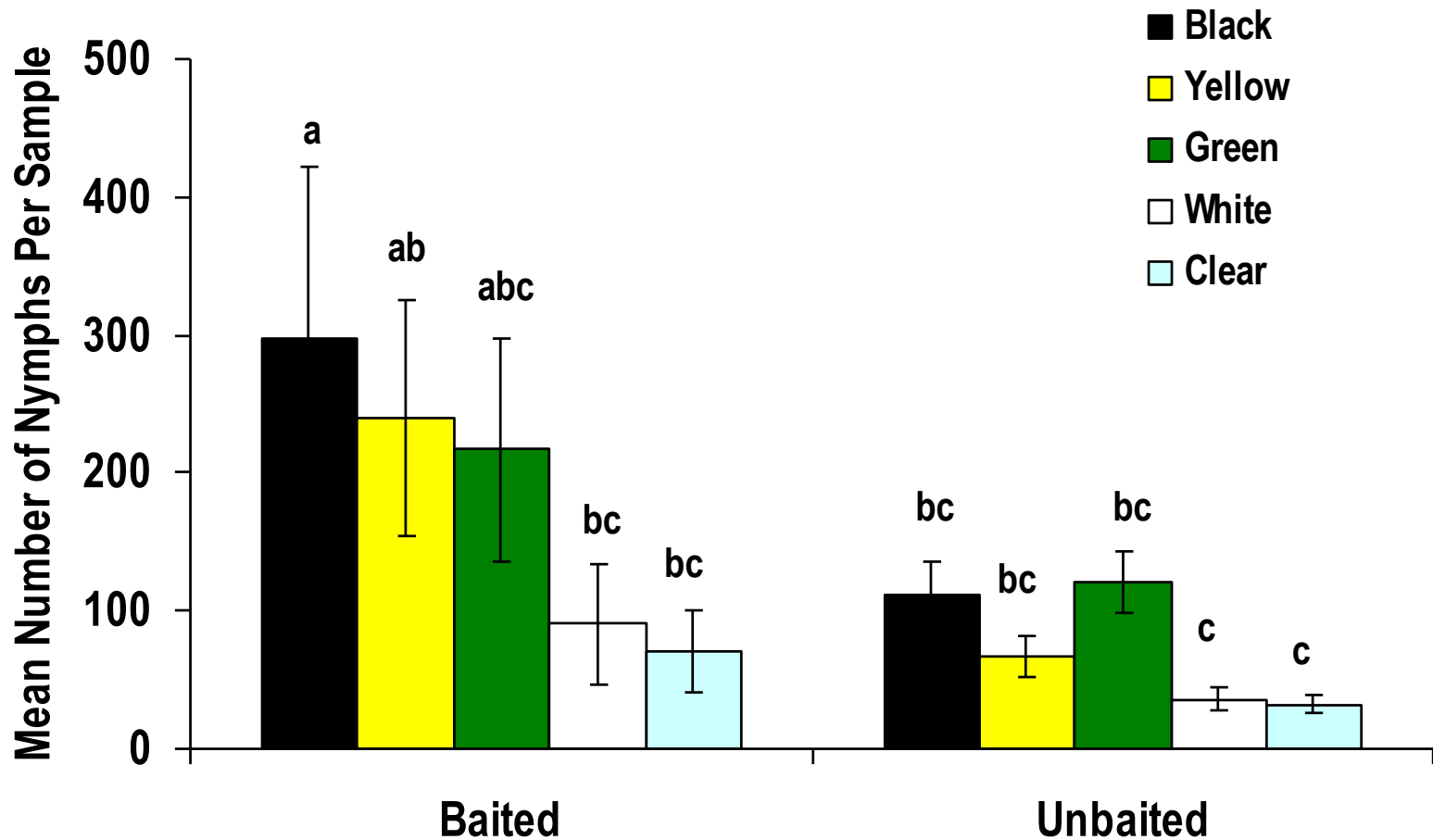
- Responses to visual stimuli associated with trap bases.
- Baited and unbaited traps at the periphery of orchards. Four replicates. Sampled twice weekly.
- Captures from October 7-November 17, 2009 and July 23-October 14, 2010.

2009 Adult Captures

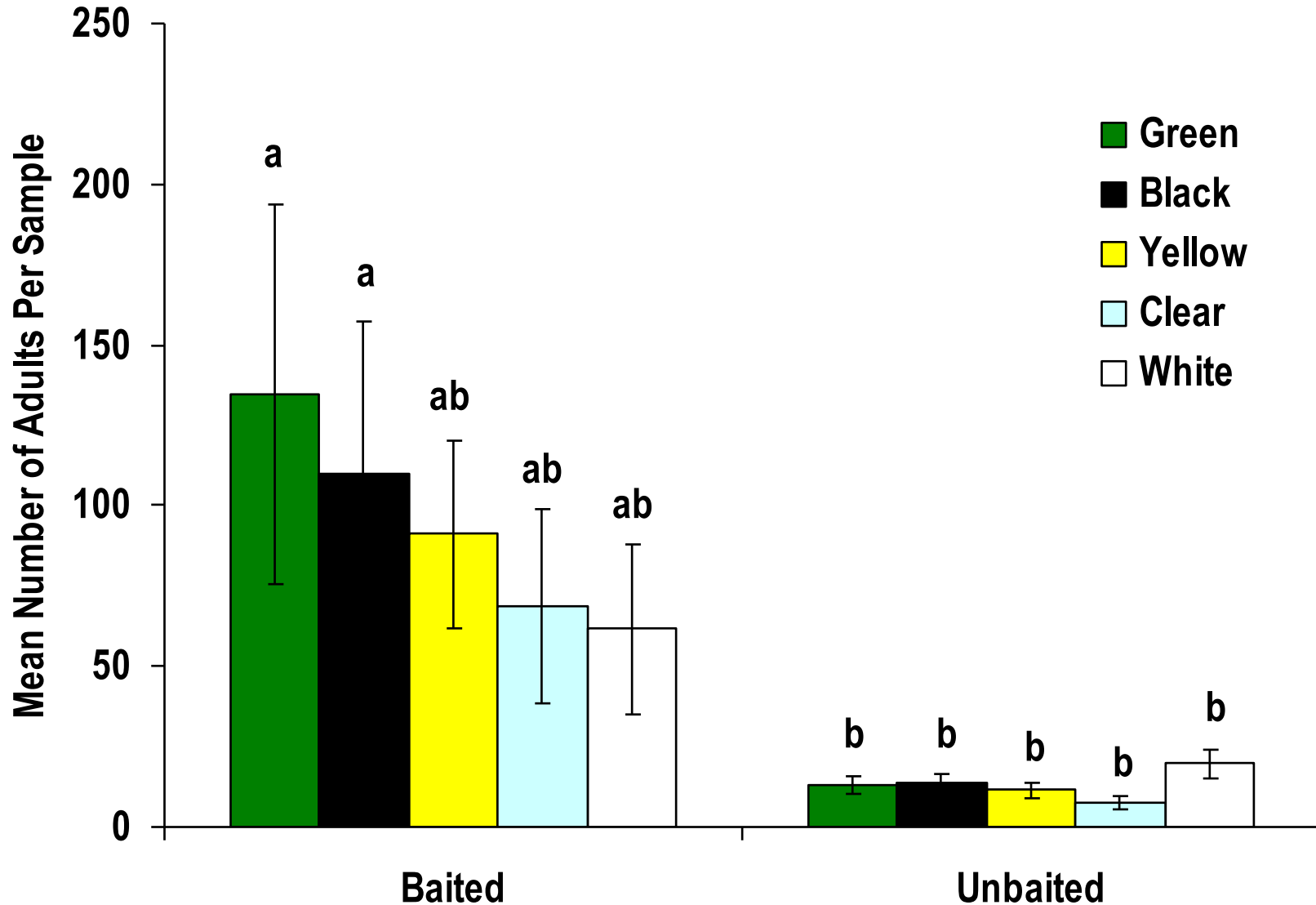


- **Significantly greater response to baited traps. Greatest captures in baited black pyramid traps. (October 7-November 17).**

2010 Nymphal Captures



2010 Adult Captures



Olfactory Stimuli

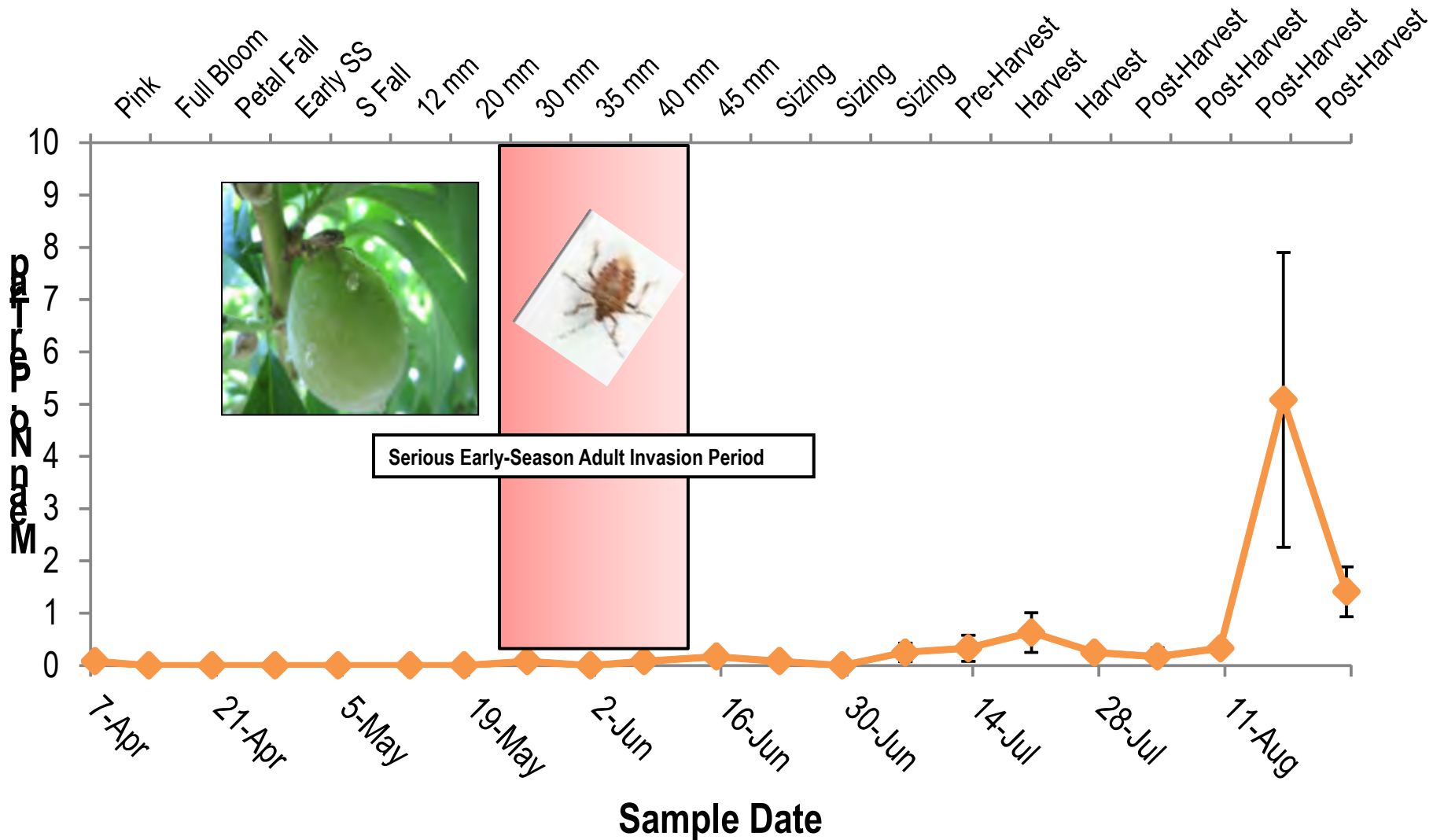


Will BMSB Respond to Methyl (2E, 4E, 6Z)-Decatrienoate early in the season?

- Reports of early-season attraction in Asia.
- Previous trials in the US had relied on low doses (<5 mg) but with little success.
- Evaluated 66 mg lures.



In 2011, We Confirmed Limitations of MDT



Attractive to BMSB adults in the Late-Season Only

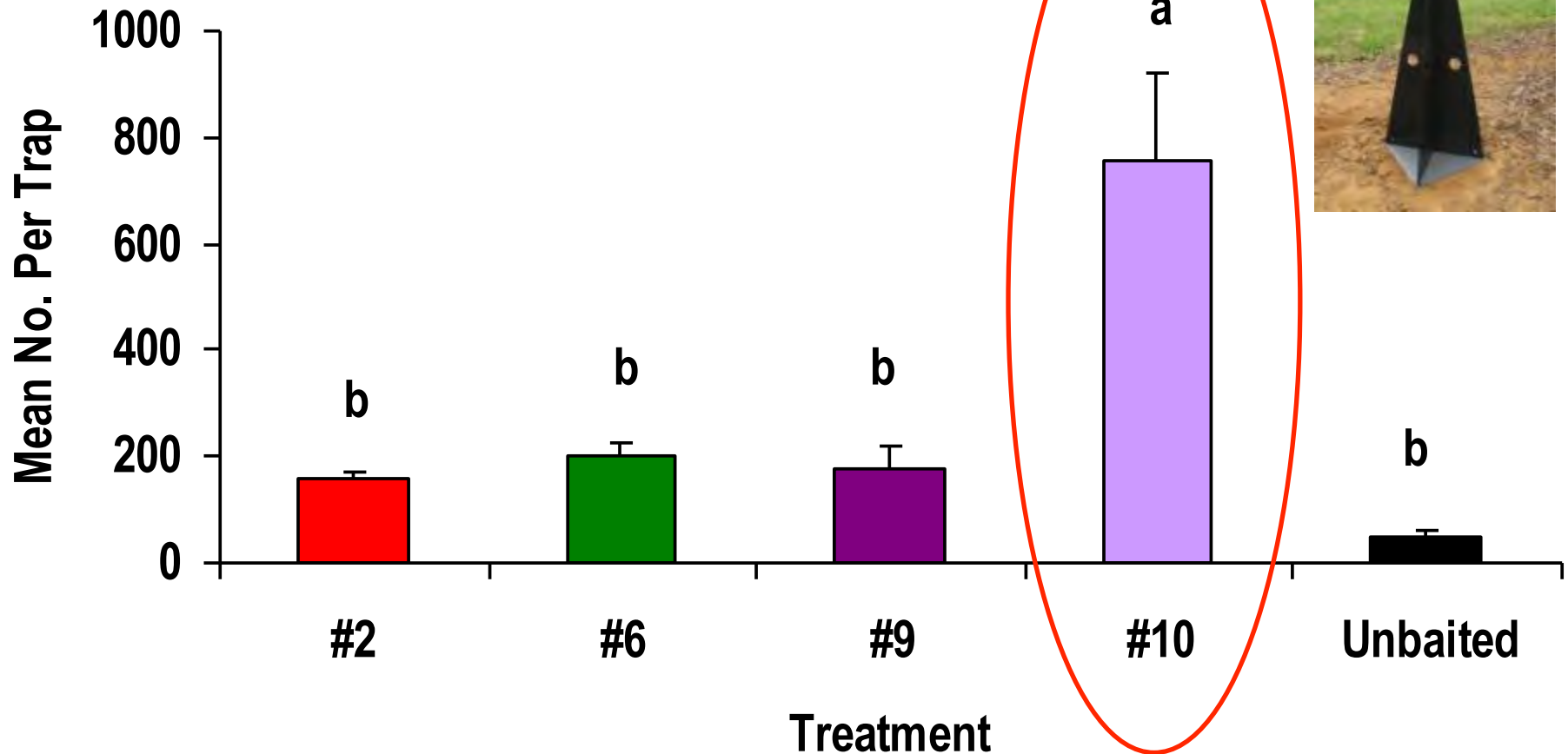
Progress Toward Identification and Commercialization of BMSB Aggregation Pheromone

USDA-ARS, Beltsville, MD and Kearneysville, WV



Identification of the BMSB Aggregation Pheromone

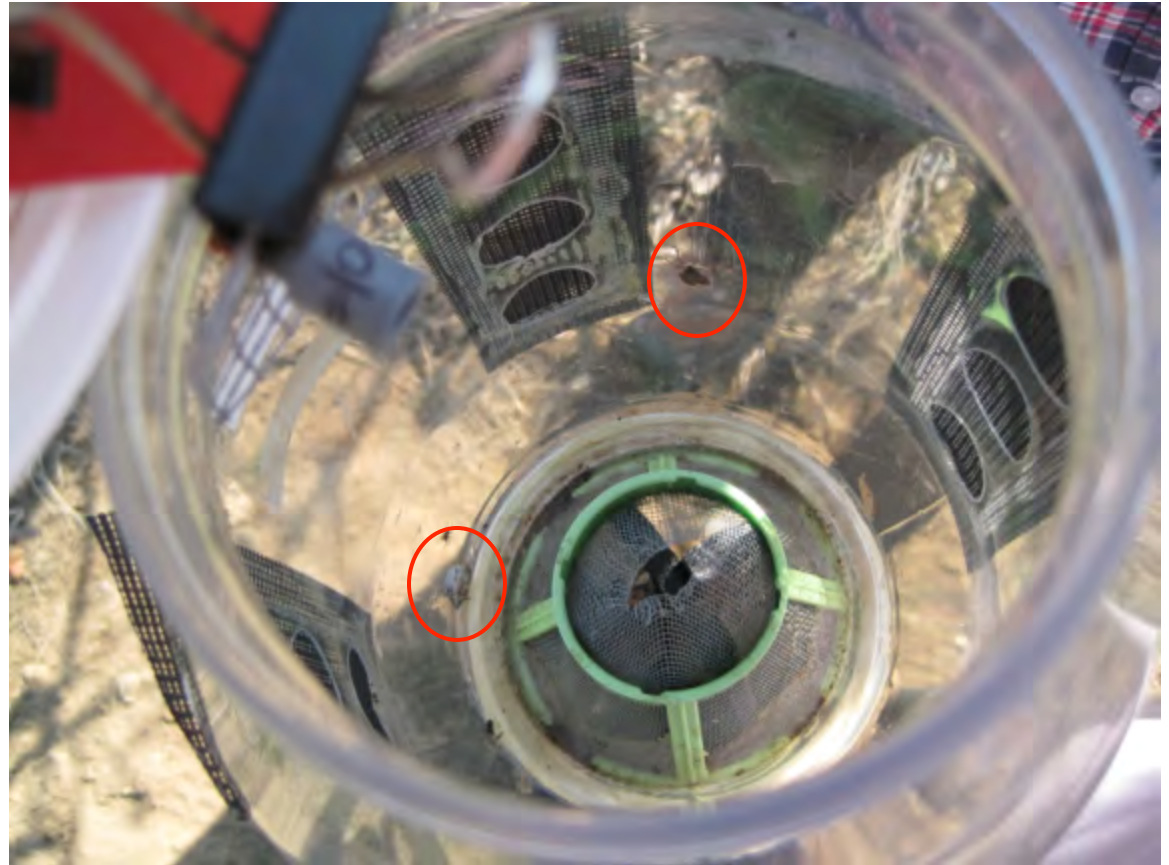
9-30 September 2011



Traps baited with #10 captured ~15x more than control and ~3-4x more than other treatments.

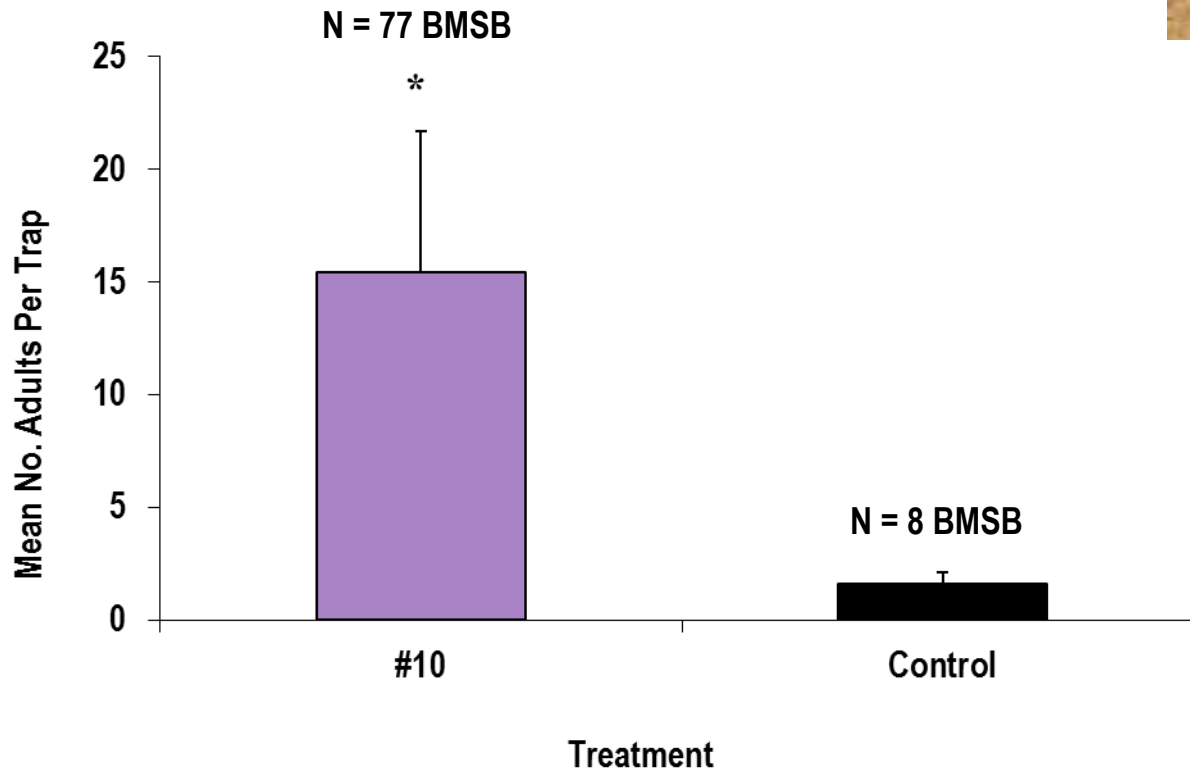
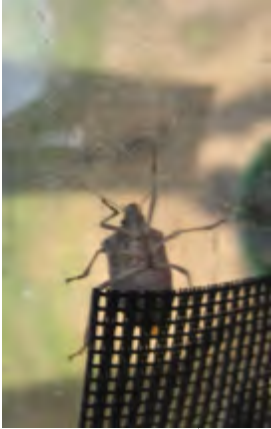
Is #10 Attractive in the Early Season?

Pre-Trial (March 20-April 17, 2012)



Early Season Attraction Documented for BMSB

March 20-April 17, 2012



2012 Broad Validation of #10 Attractiveness in Multi-State Trial

- Is BMSB attracted to #10 in the early season?
- Is BMSB attracted to #10 season-long?
- How attractive is this stimulus relative to MDT and unbaited traps?
- WV, MD, VA, PA, NJ, NY, DE, NC, OR, WA, OH, and MI



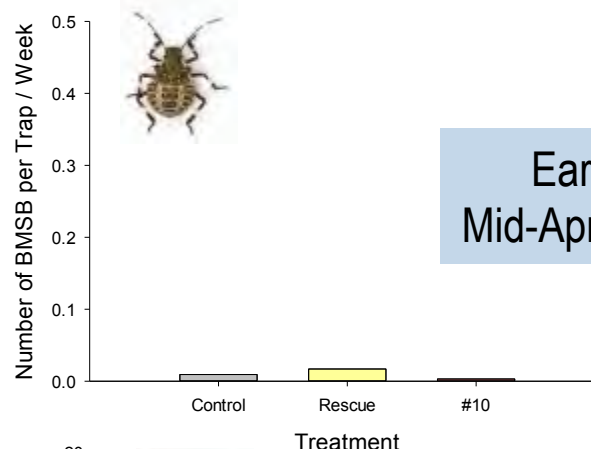
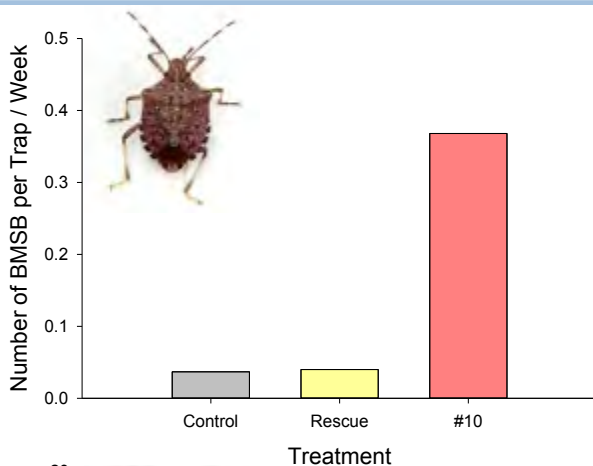
General Protocol

- **Black pyramid traps**
- **Three odor treatments**
 - 1) #10 (10 mg)
 - 2) MDT (119 mg) 10X greater
 - 3) unbaited control
- **Traps are deployed between wild host habitat and agricultural production areas.**
- **Traps were deployed in mid-April and left in place season-long.**

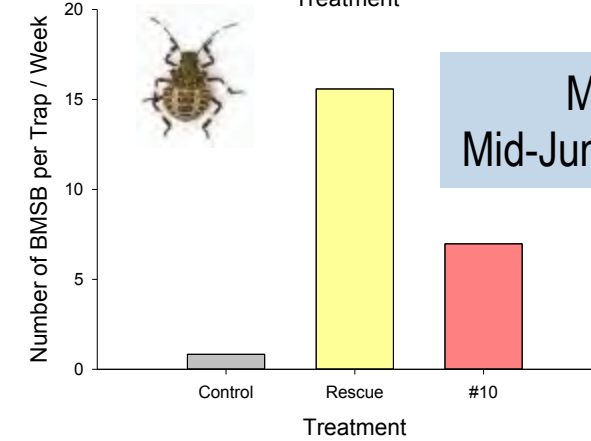
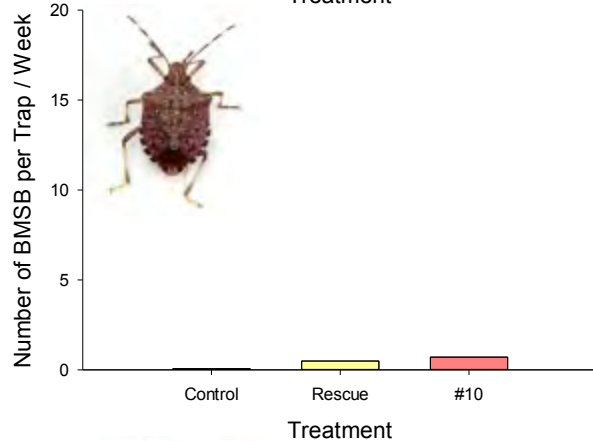


2012 Summary Results

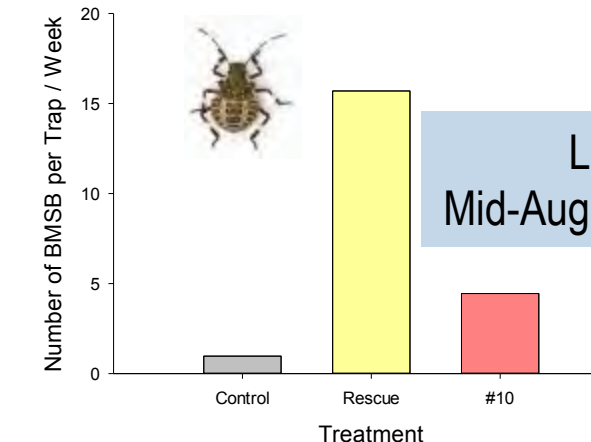
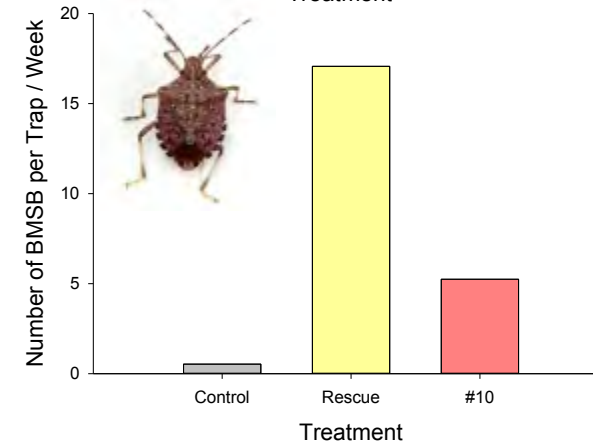
Mean number of BMSB / trap / week



Early Season
Mid-April to Mid-June



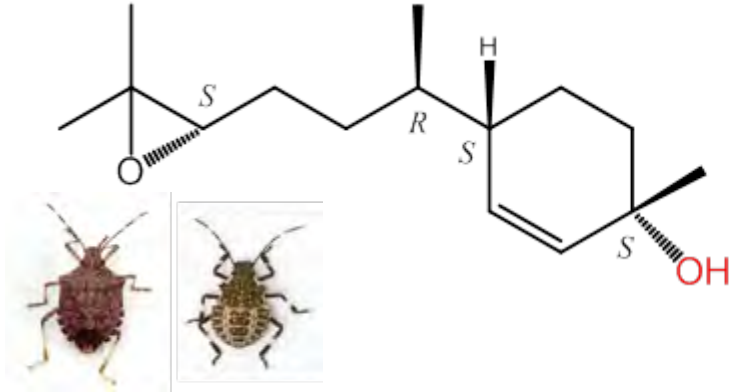
Mid Season
Mid-June to Mid-August



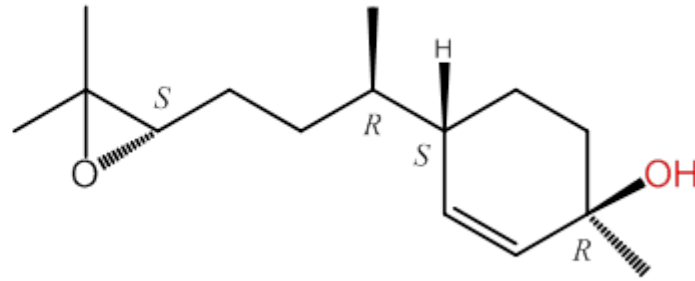
Late Season
Mid-August to Mid-October

Identification of Pheromone Structure and That MDT Acts As a Powerful Synergist

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

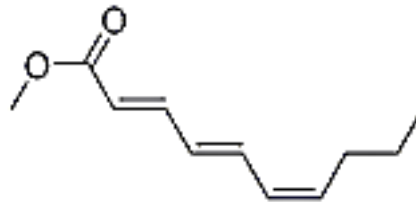


Minor component of BMSB aggregation pheromone
(3*R*,6*S*,7*R*,10*S*)-10,11-epoxy-1-bisabolen-3-ol



+

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



=

Synergism

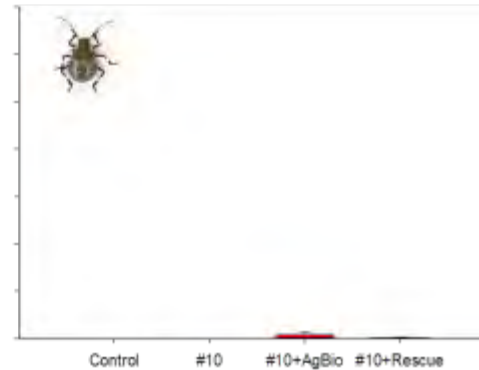
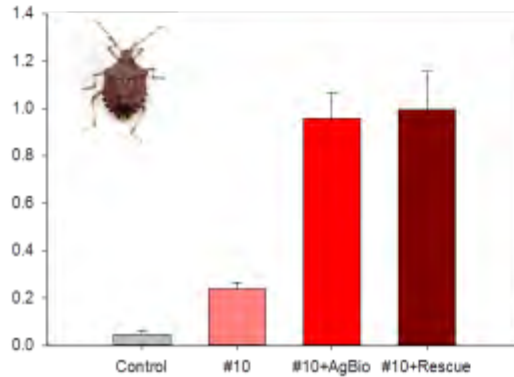
2013 Broad Multi-State Trial

- Document season-long patterns of activity with pheromone and pheromone + synergist.
- #10 (10 mg)
- #10 (10 mg) + AgBio MDT (66 mg)
- #10 (10 mg) + Rescue MDT (120 mg)
- Control
- ME, NH, CT, MA, PA, NJ, VA, WV, MD, DE, NC, FL, AL, MI, OH, IA, MO, UT, CA, OR, WA.
- Bulk synthesis funded by USDA.

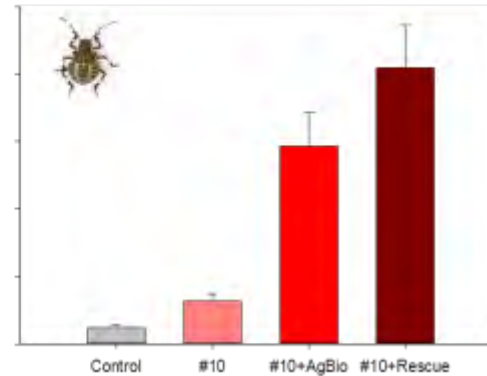
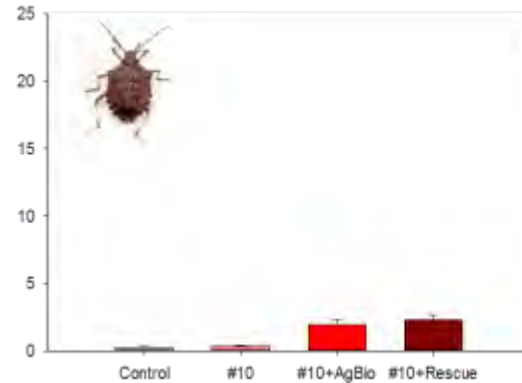


2013 Summary Results

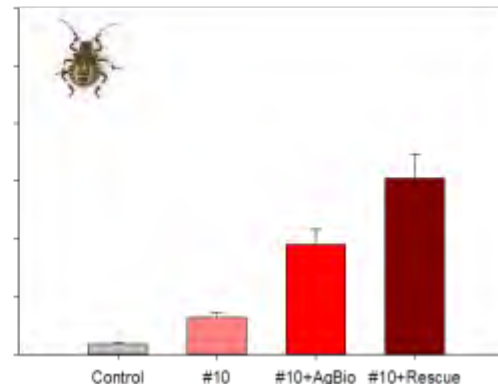
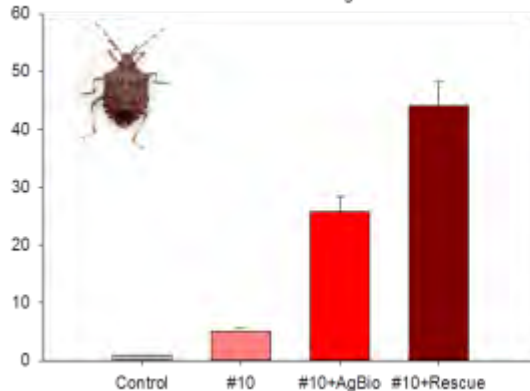
Mean number of BMSB / trap / week



Early Season
Mid-April to Mid-June

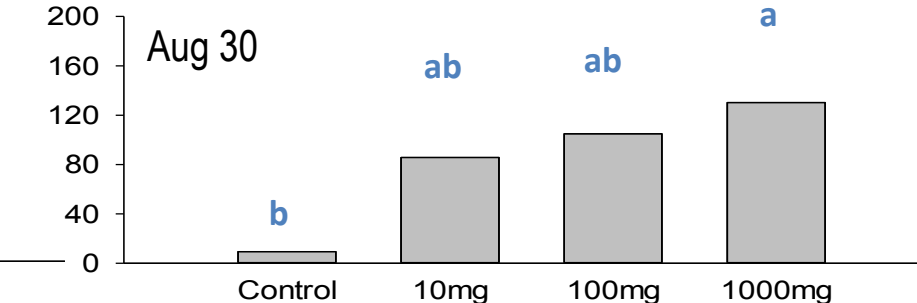
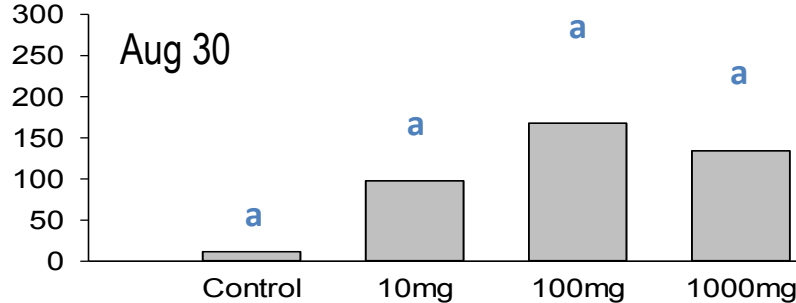
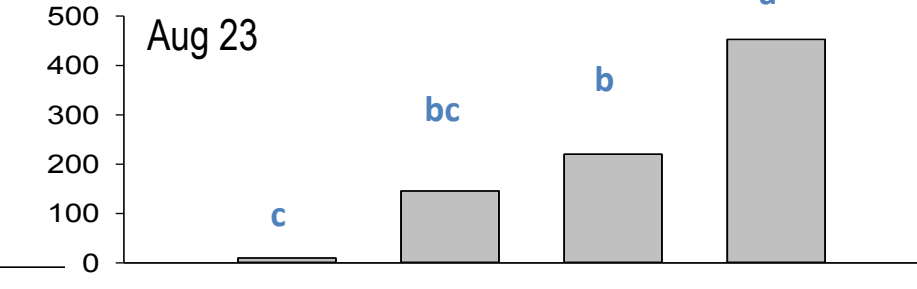
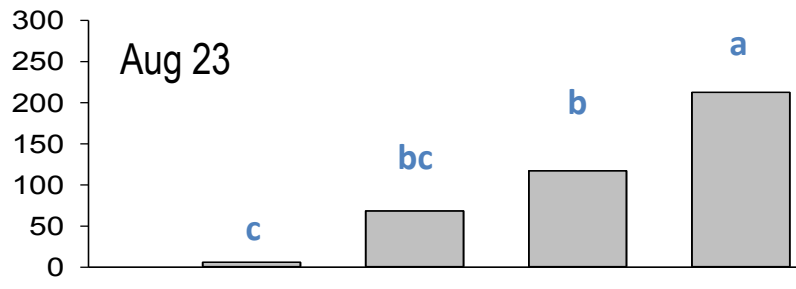
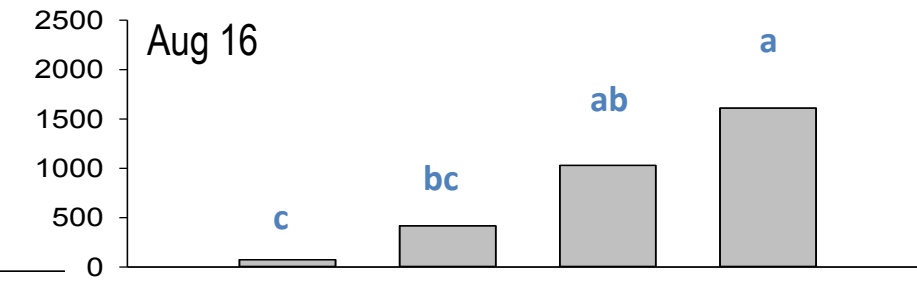
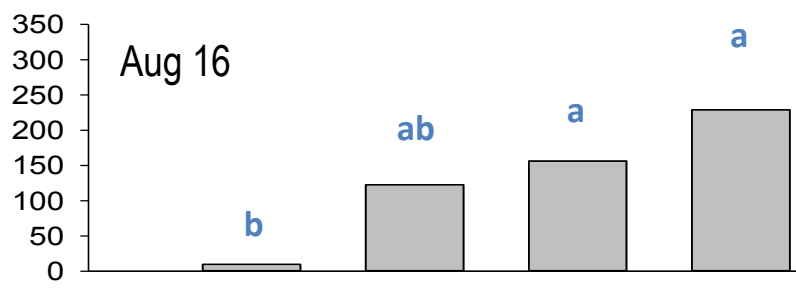
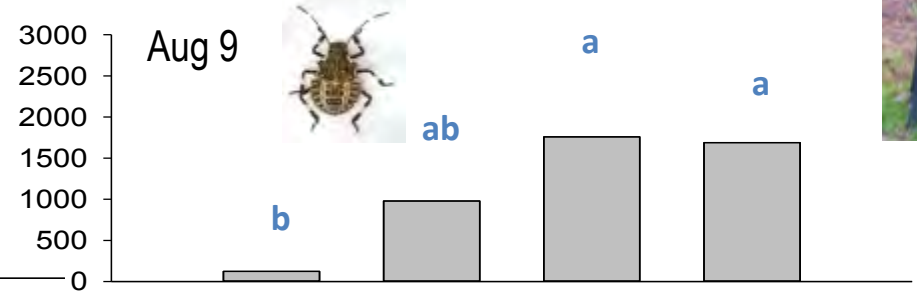
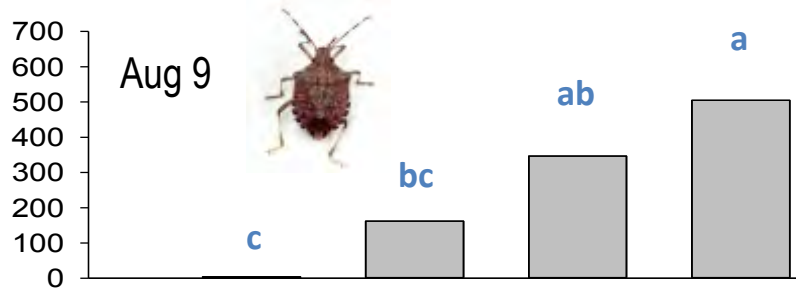


Mid Season
Mid-June to Mid-August



Late Season
Mid-August to Mid-October

Dose-Response Studies



Number of BMSB adults / Trap / Week

Conclusions

- BMSB aggregation pheromone and synergist have been identified.
- Can be synthesized at a commercial scale.
- Provide ability to reliably detect and monitor BMSB populations season-long.
- Sensitivity can be increased by increasing dose/release-rate of materials.

Capture Mechanism



Capture Mechanism



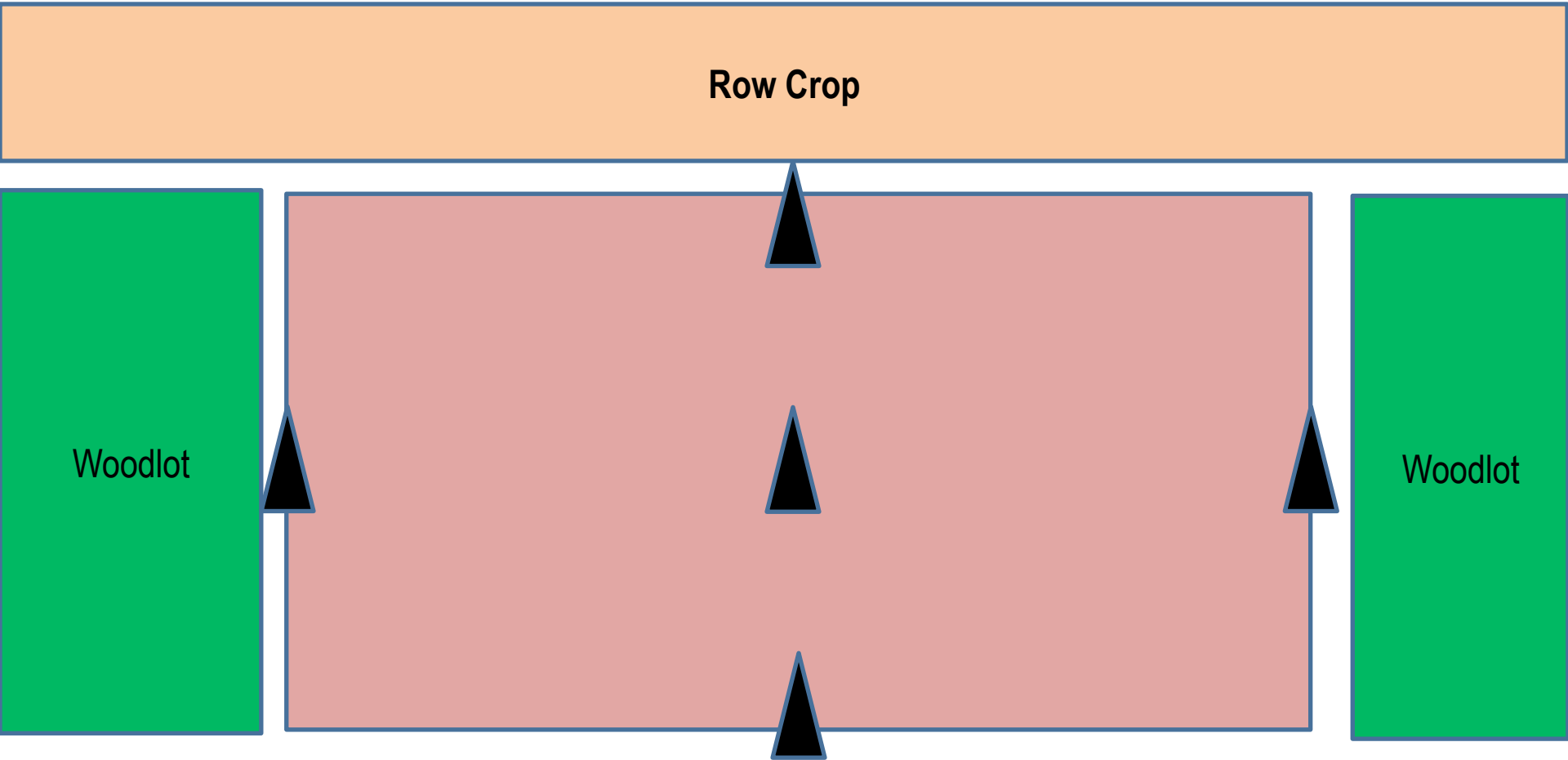
Kill Strip Increased Captures 250%



Deployment Strategy



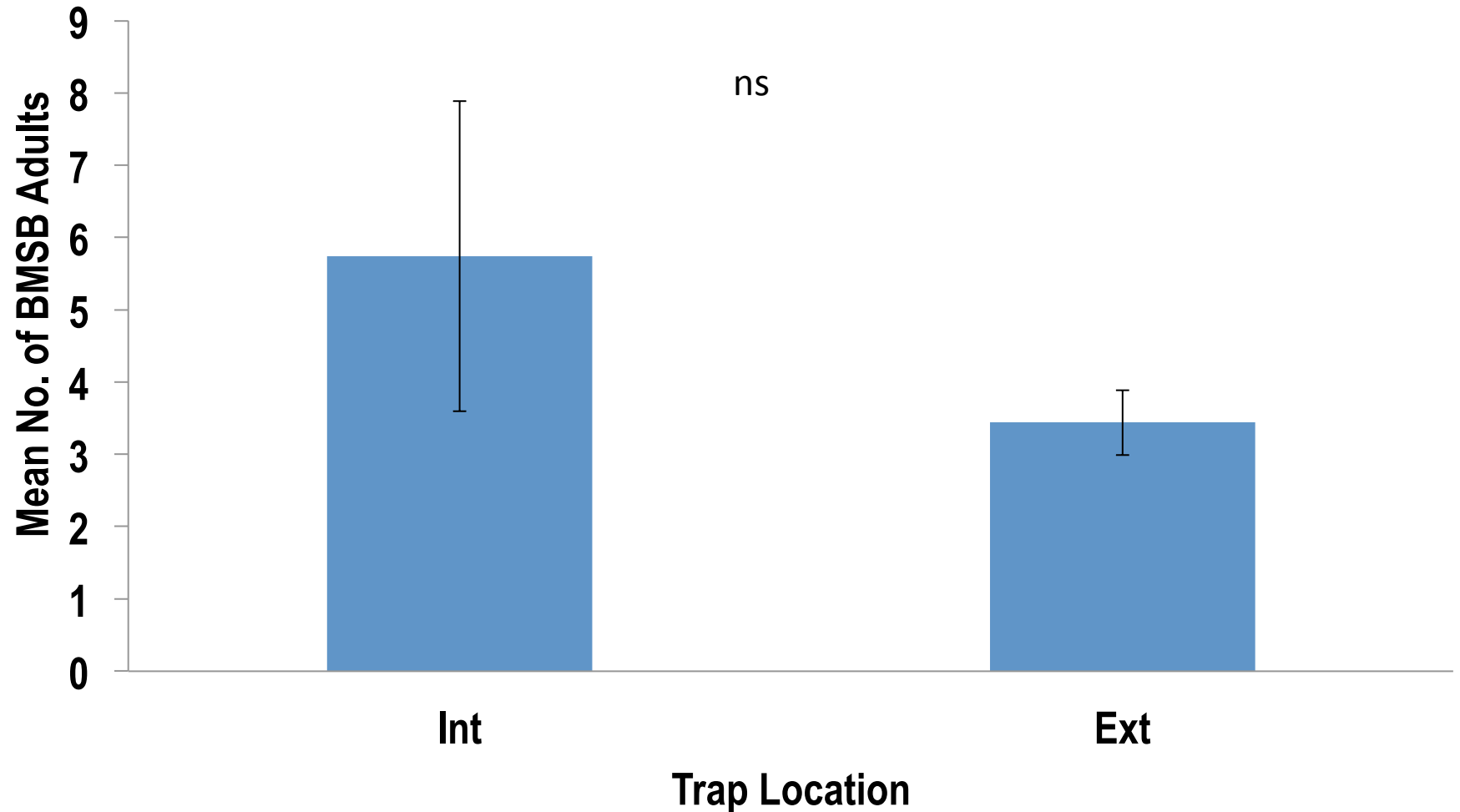
Trap Location



Questions

- **What is the optimal trap location?**
- **Do trap captures reflect locations where we would expect to higher captures of bugs through the season?**

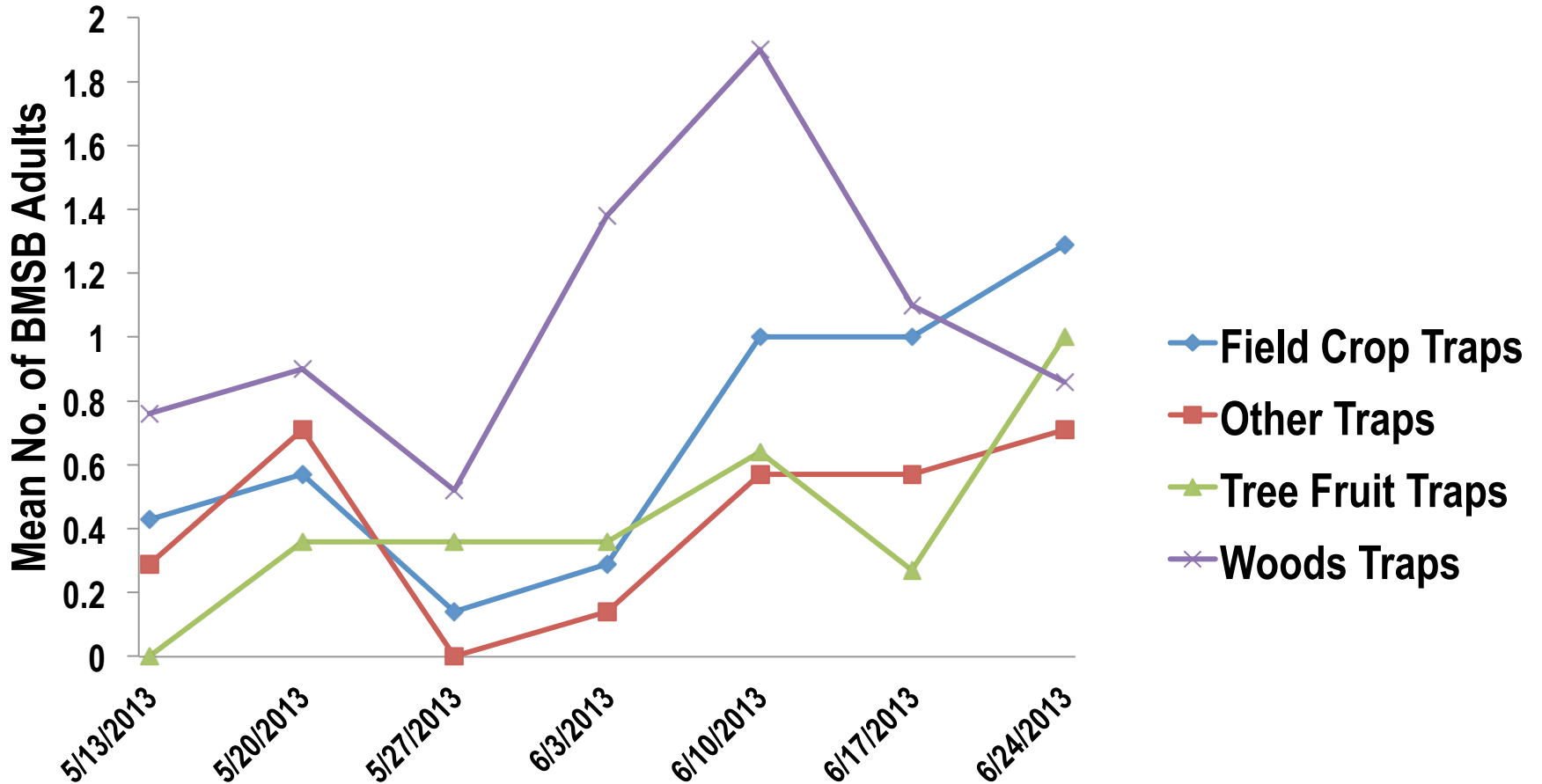
Season-Long Captures in Exterior and Interior Traps



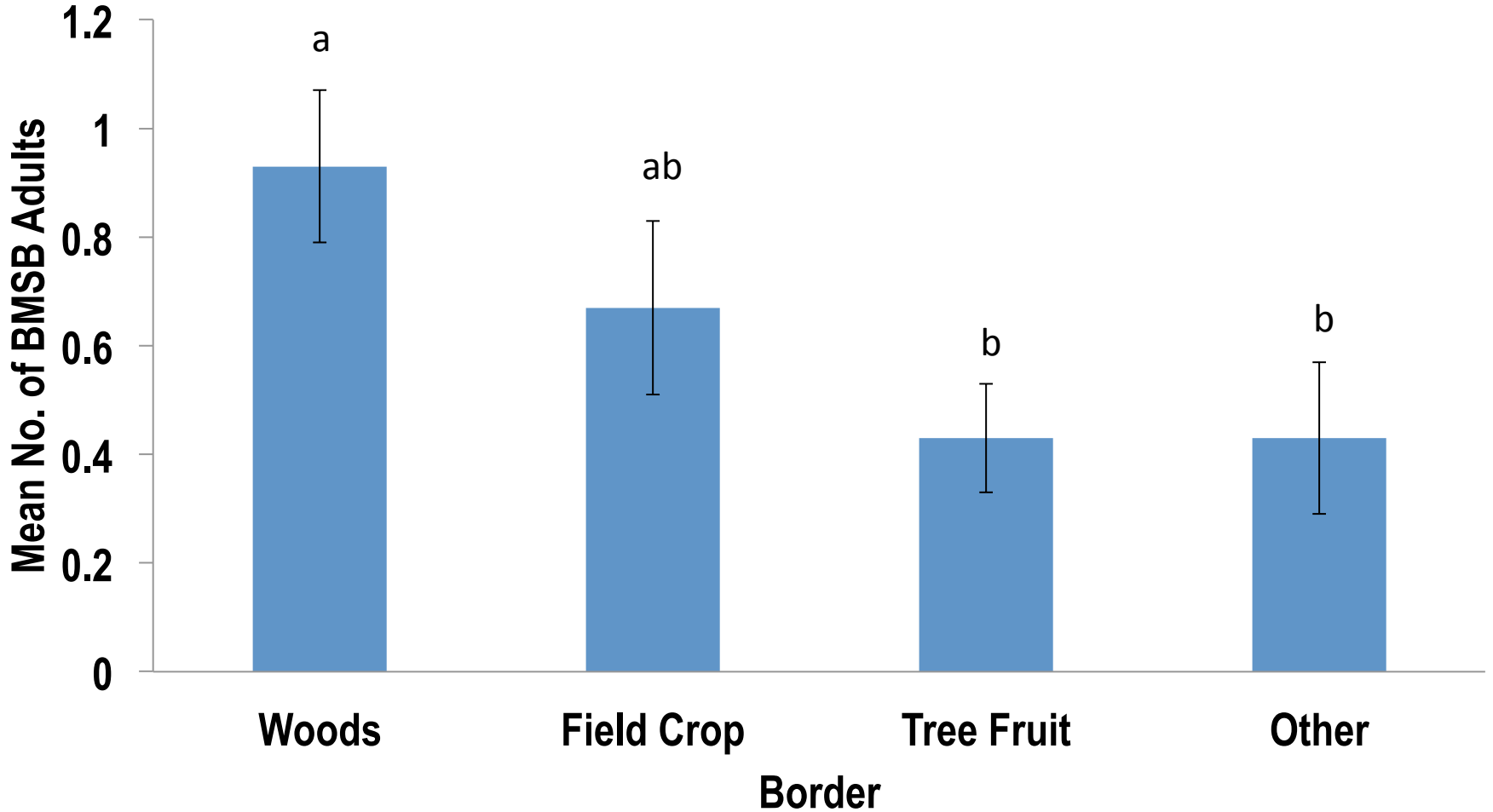
Border Types

- Woods
- Neighboring Tree Fruit Blocks
- Field/row crops (corn or soybean)
- Other

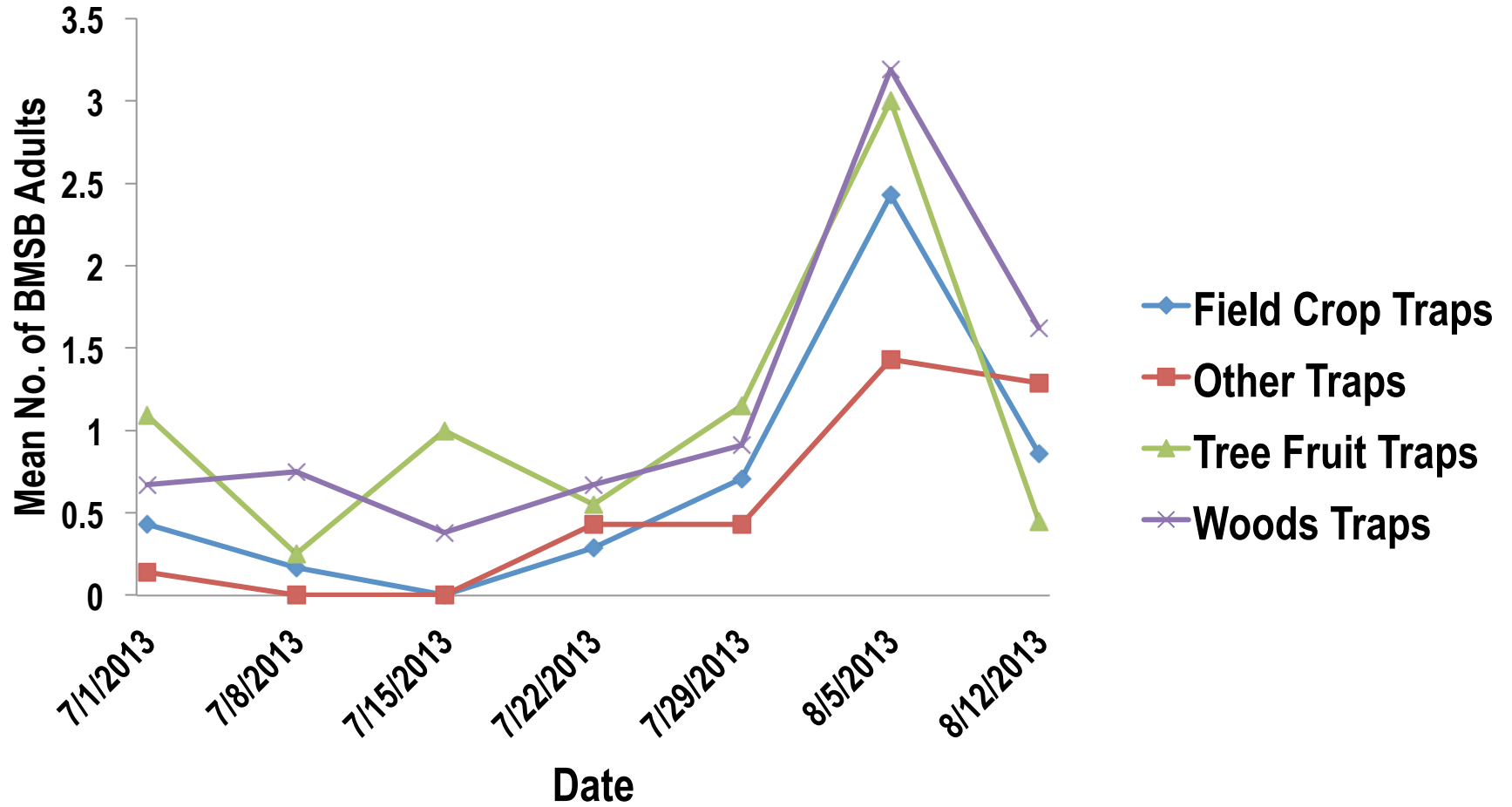
Early Season



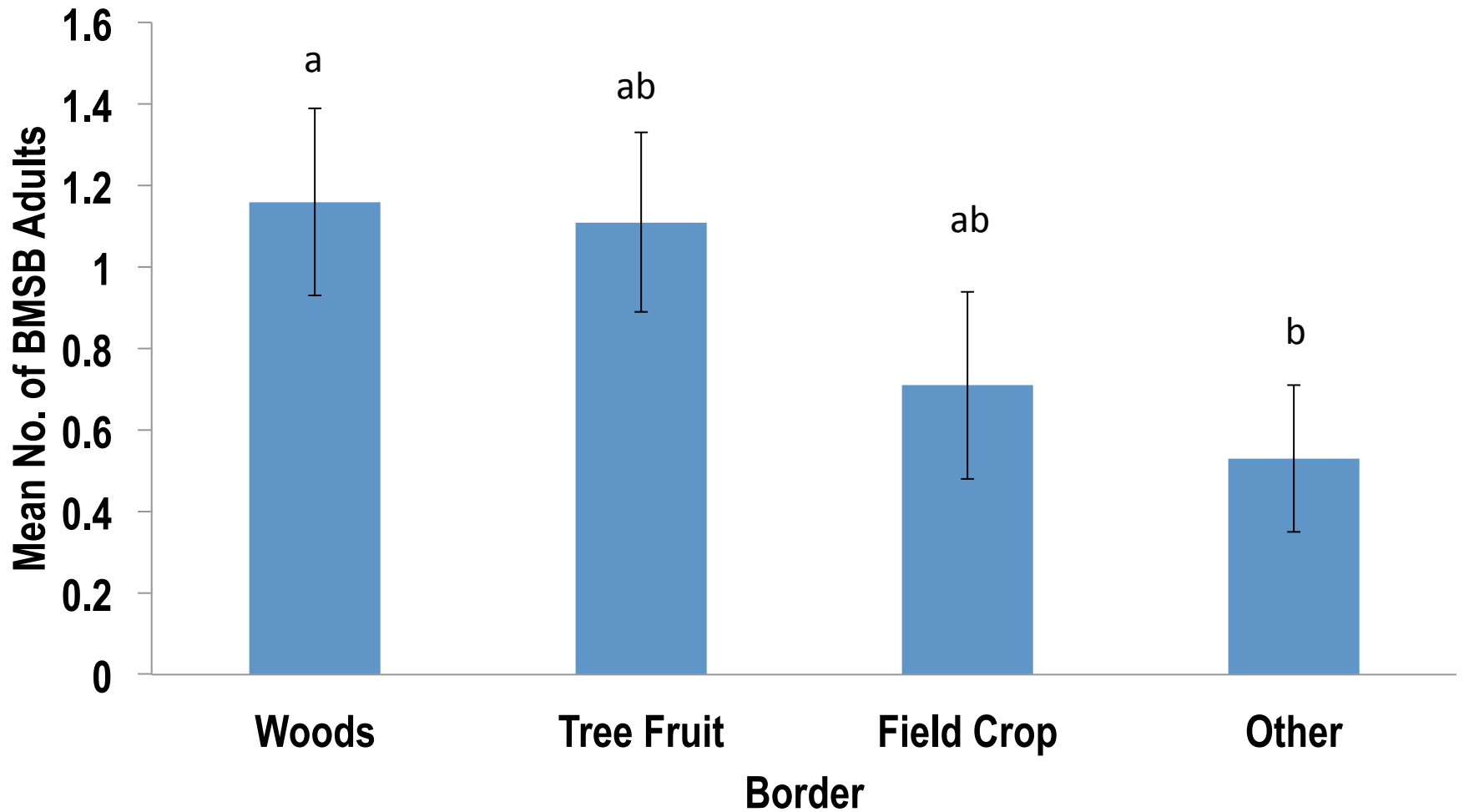
Early Season



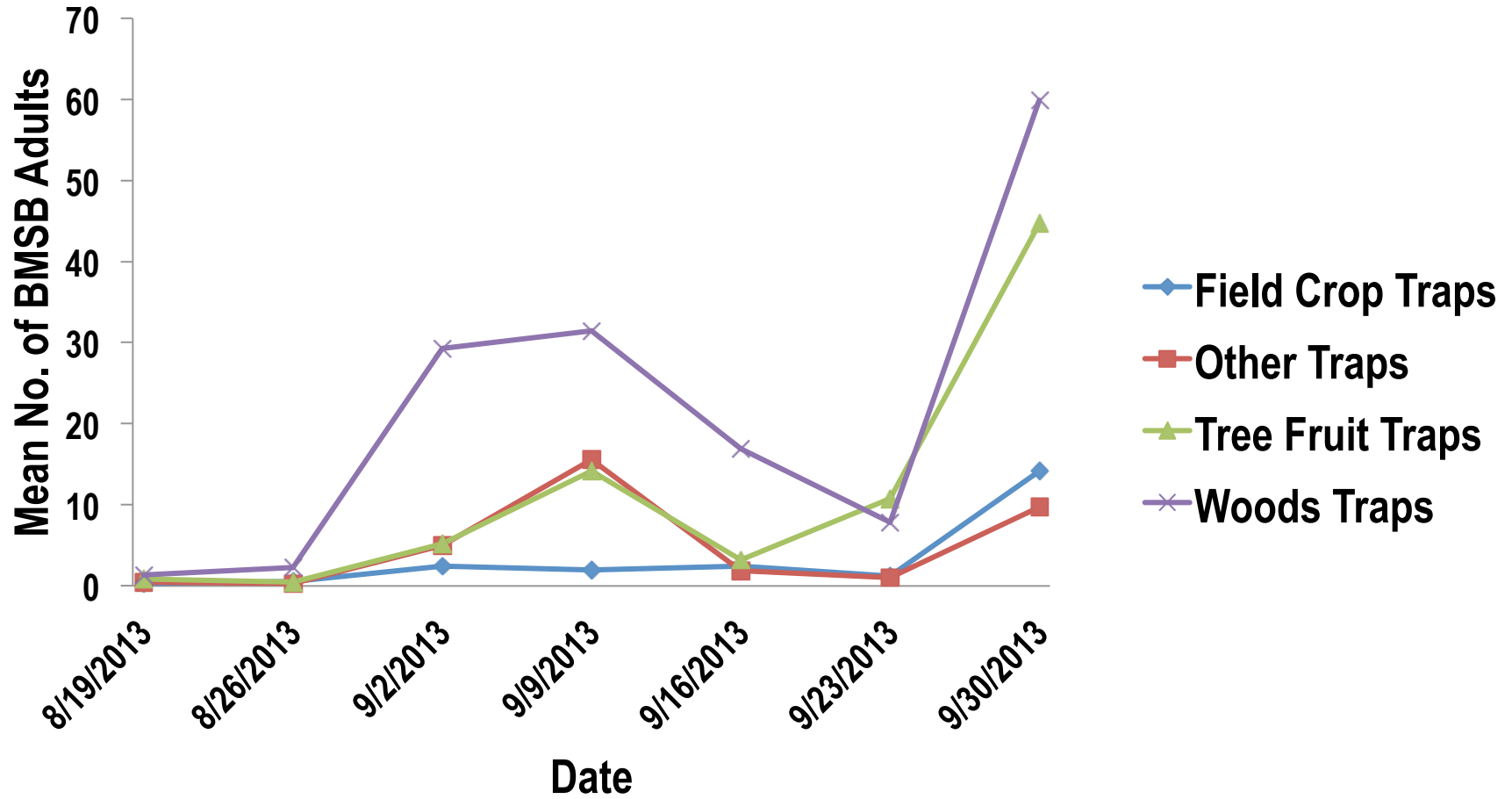
Mid-Season



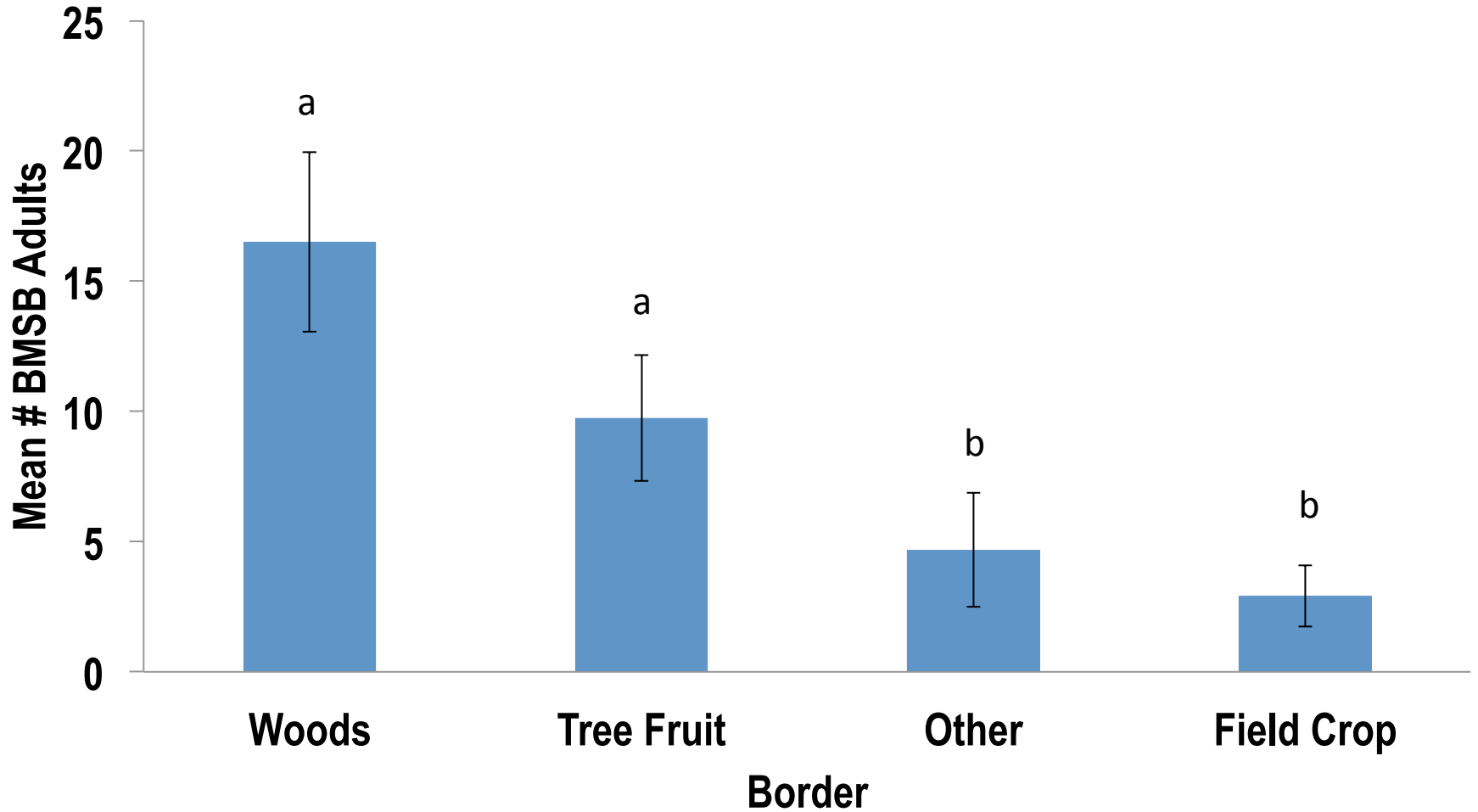
Mid-Season



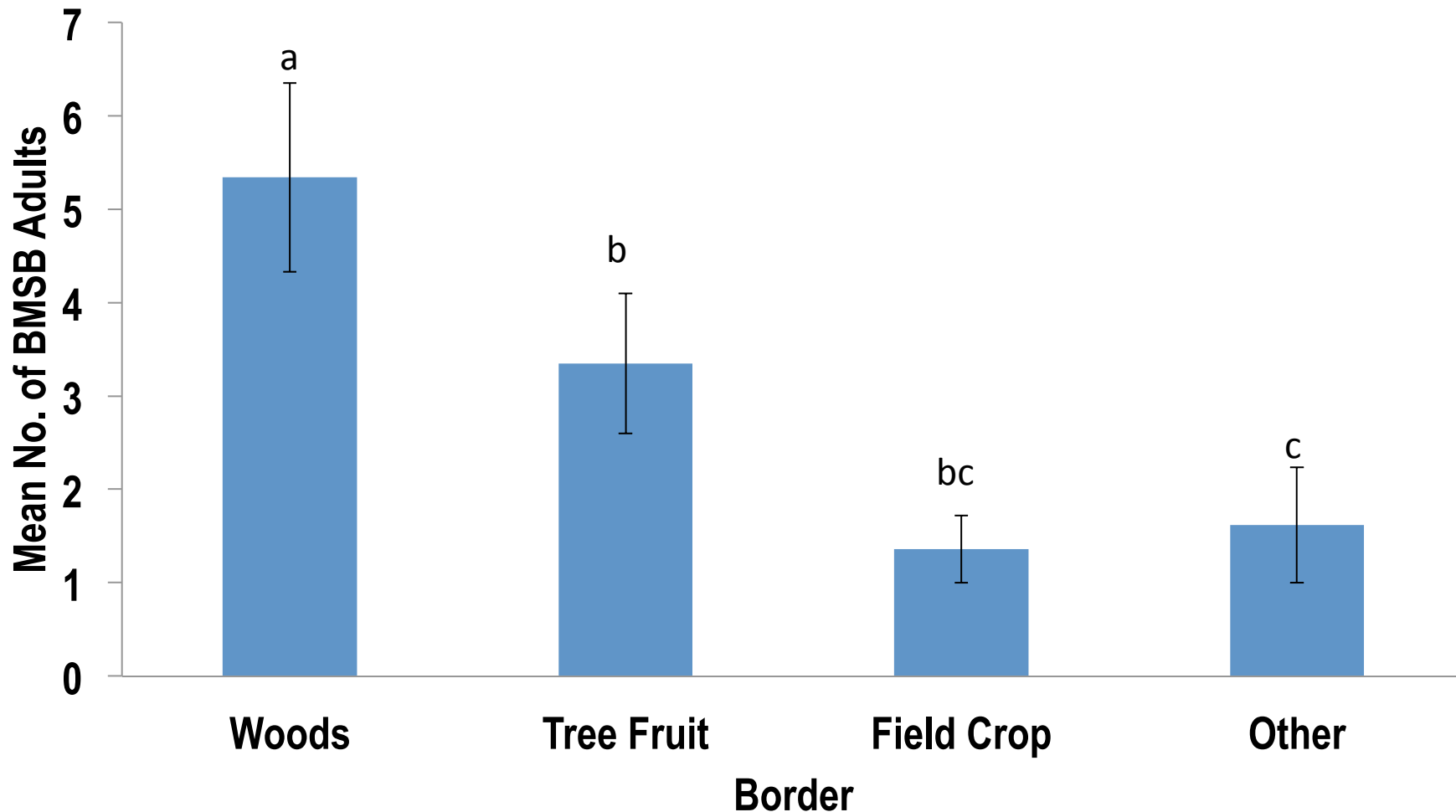
Late Season



Late Season



Season-Long Captures in Traps With Different Bordering Habitats



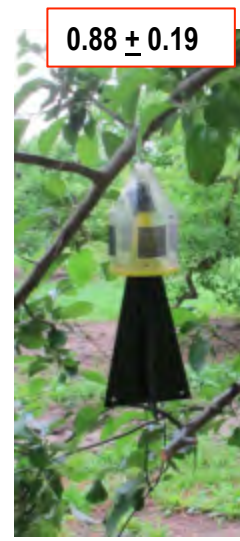
Development of a Trap-Based Treatment Threshold for BMSB in Apple



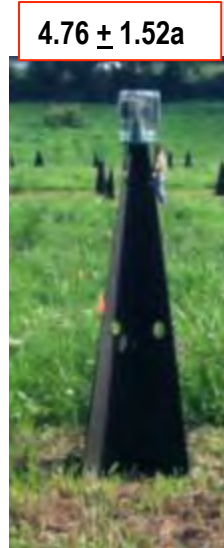
- Visual Stimulus
 - Black pyramid trap
- Olfactory Stimulus
 - BMSB Pheromone + MDT
- Capture Mechanism
 - Tapered pyramid to inverted funnel jar with DDVP toxicant strip
- Deployment Strategy
 - Traps placed in perimeter row of orchard

Year 1: Season-Long Trap Type Studies

Orchard 1

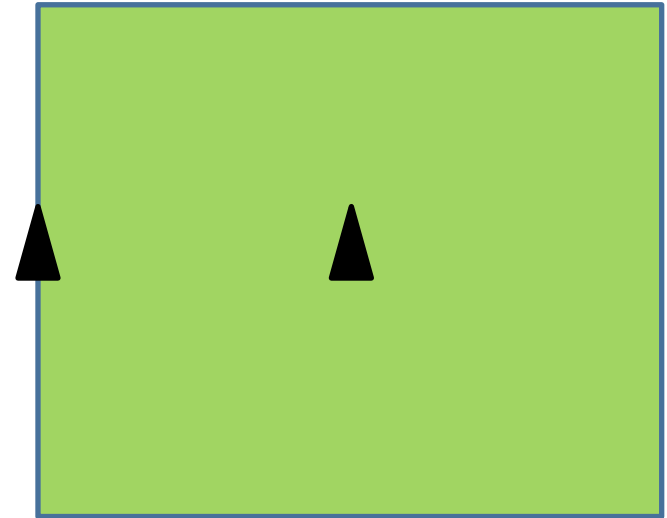


Orchard 2



Can we use trap captures to guide management decisions?

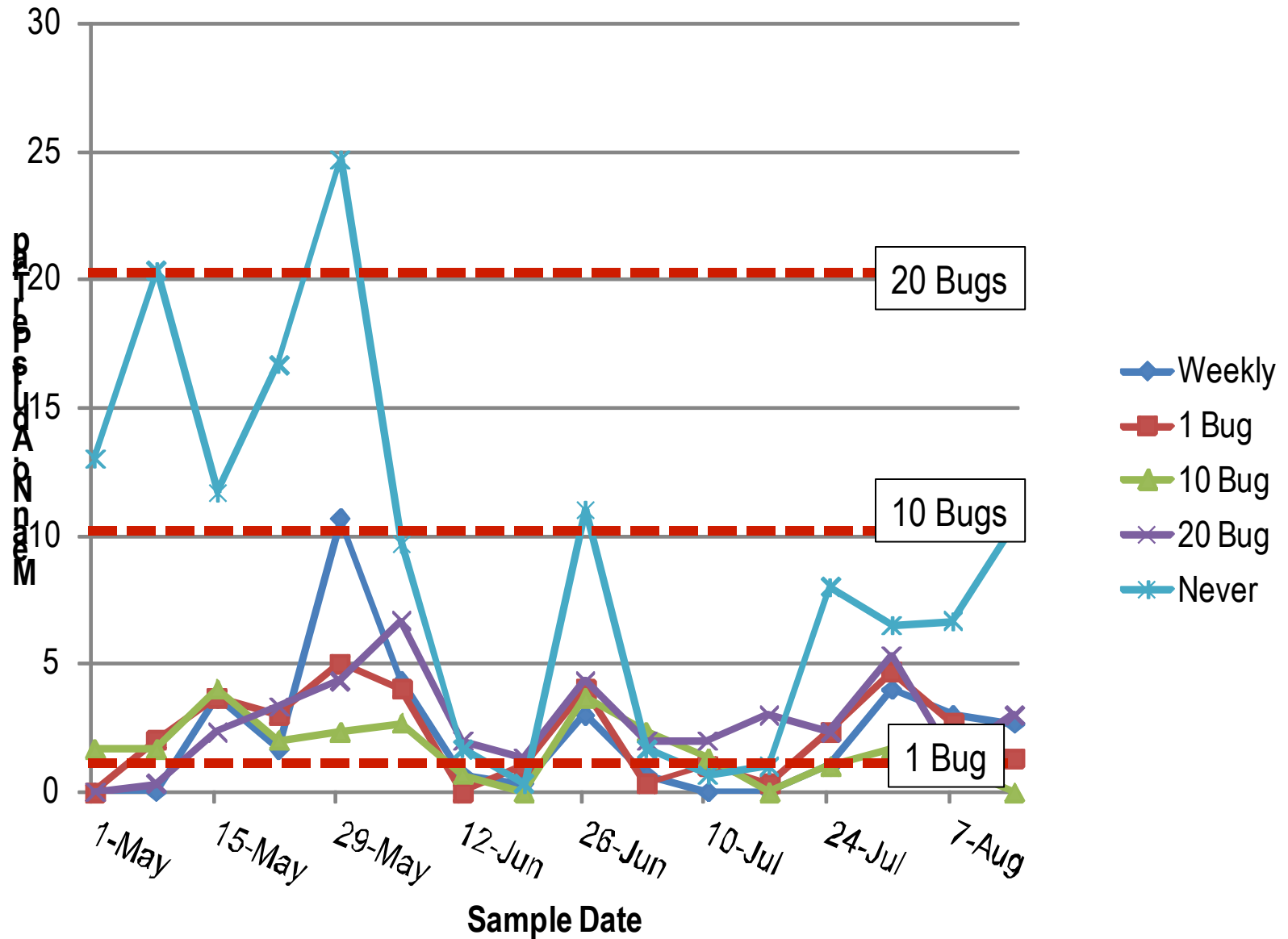
- 15 apple blocks and five treatments.
- Each block was monitored with baited traps; one deployed at the border and one at the center. Traps checked weekly.
- When captures of adults in either trap reached a treatment threshold, the block was treated with BMSB material (ARM).
- Block treated again 7-d later. Threshold was then reset.
- Twice-monthly fruit samples



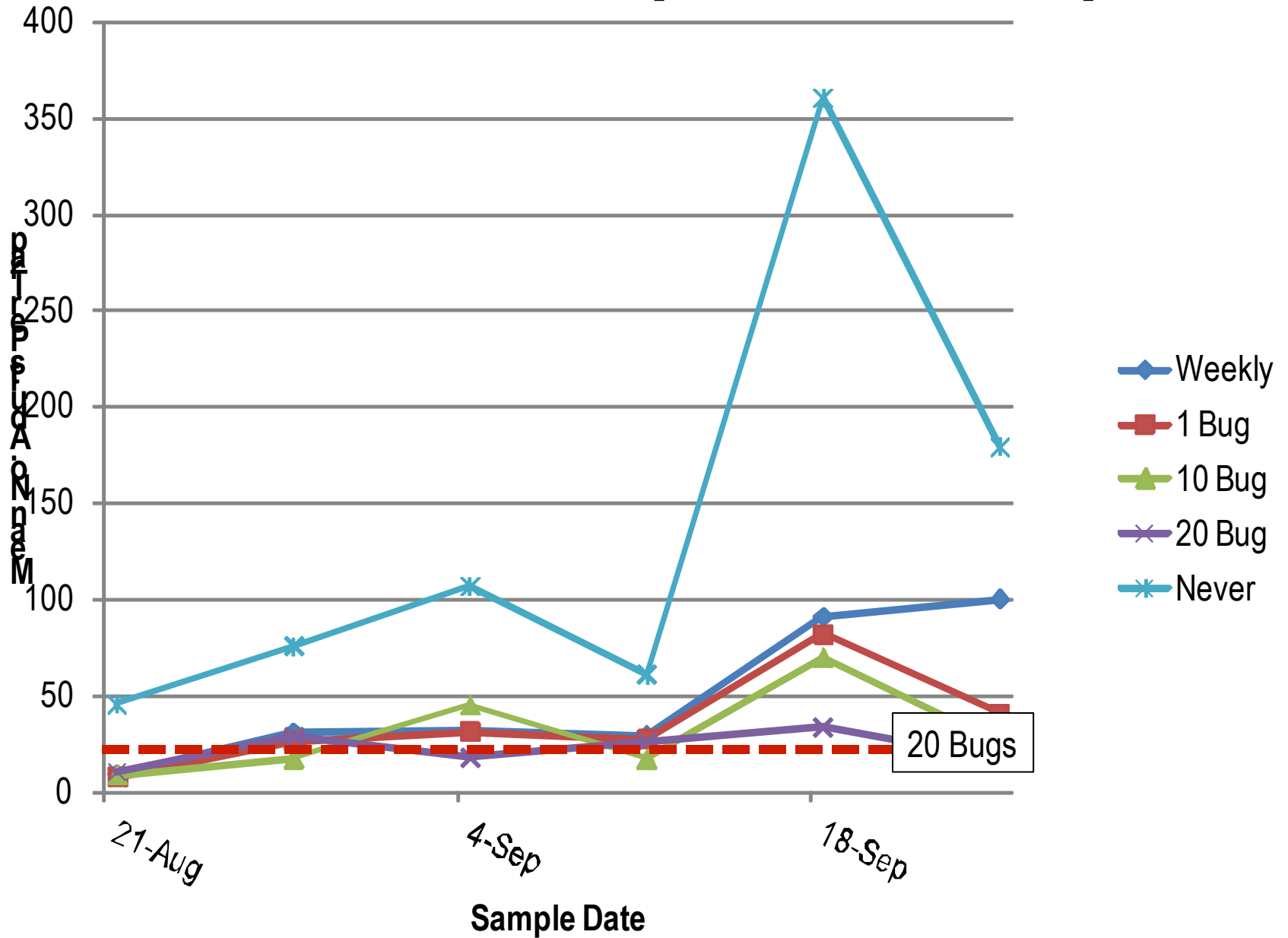
Treatment Regimes

- Sprays Triggered at:
- 1) 1 Adult / Trap
 - 2) 10 Adults / Trap
 - 3) 20 Adults / Trap
 - 4) Treated Every 7 d
 - 5) No Spray (Control)

Early and Mid-Season Captures in Traps



Late-Season Captures in Traps



Impact on Number of Insecticide Applications Made Against BMSB Season-Long

Treatment Threshold	Mean No. ARM Sprays Per Block	% Reduction in Applications
Weekly ARM	21.0 ± 0.0	_____
1 Adult/Trap	19.0 ± 1.0	10%
10 Adults/Trap	12.7 ± 0.7	40%
20 Adults/Trap	10.3 ± 0.3	50%
Control	0.0 ± 0.0	100%

Mean number of sprays reduced substantially using trap-based treatment threshold.

Injury at Harvest Using Trap-Based Treatment Thresholds for Managing BMSB

Treatment Threshold	Mean No. ARM Sprays Per Block	% Injury (Whole Plot Sample)	Severity (Mean # Injury Sites Per Fruit)
Weekly ARM	21.0 ± 0.0	12.9 ± 4.4 a	2.3 ± 0.9 a
1 Adult/Trap	19.0 ± 1.0	9.0 ± 2.6 a	2.3 ± 0.1 a
10 Adults/Trap	12.7 ± 0.7	7.9 ± 2.6 a	2.5 ± 0.9 a
20 Adults/Trap	10.3 ± 0.3	38.8 ± 8.1 b	3.4 ± 0.6 a
Control	0.0 ± 0.0	47.8 ± 5.4 b	5.1 ± 2.1 a

Tentative Conclusions

- Black pyramid trap is a good baseline trap.
- Must use combination lures and kill strip.
- Risk to crops and likelihood of detection greatest near wood lots.



Acknowledgements



- **BMSB SCRI CAP Team and Leskey Lab**
- **USDA NIFA Specialty Crops Research Initiative Award # 2011-51181-30937**
- **USDA-ARS**
- **USDA-APHIS**

