Whole-farm Organic Management of BMSB and Endemic Pentatomids through Behavior-based Habitat Manipulation

A multi-state project funded by the
Organic Research and Extension Initiative

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Project Objectives

1. Habitat manipulation – identify and evaluate trap crops
2. Identify whole-farm movement patterns and behaviors.
3. Natural enemy identity and impact in organic systems.
4. Evaluate organic management tactics
5. Develop extension materials.

Objective 1: Trap Crops

2013:

- Evaluated 4 potential organic trap crops: sunflower, millet, sorghum, and okra
- Tested across 4 states: MD, NJ, PA, and WV
- Sunflower and sorghum were the most attractive to BMSB
- Sunflower most attractive to native stink bugs
- Attraction varied throughout the season


Sunflower

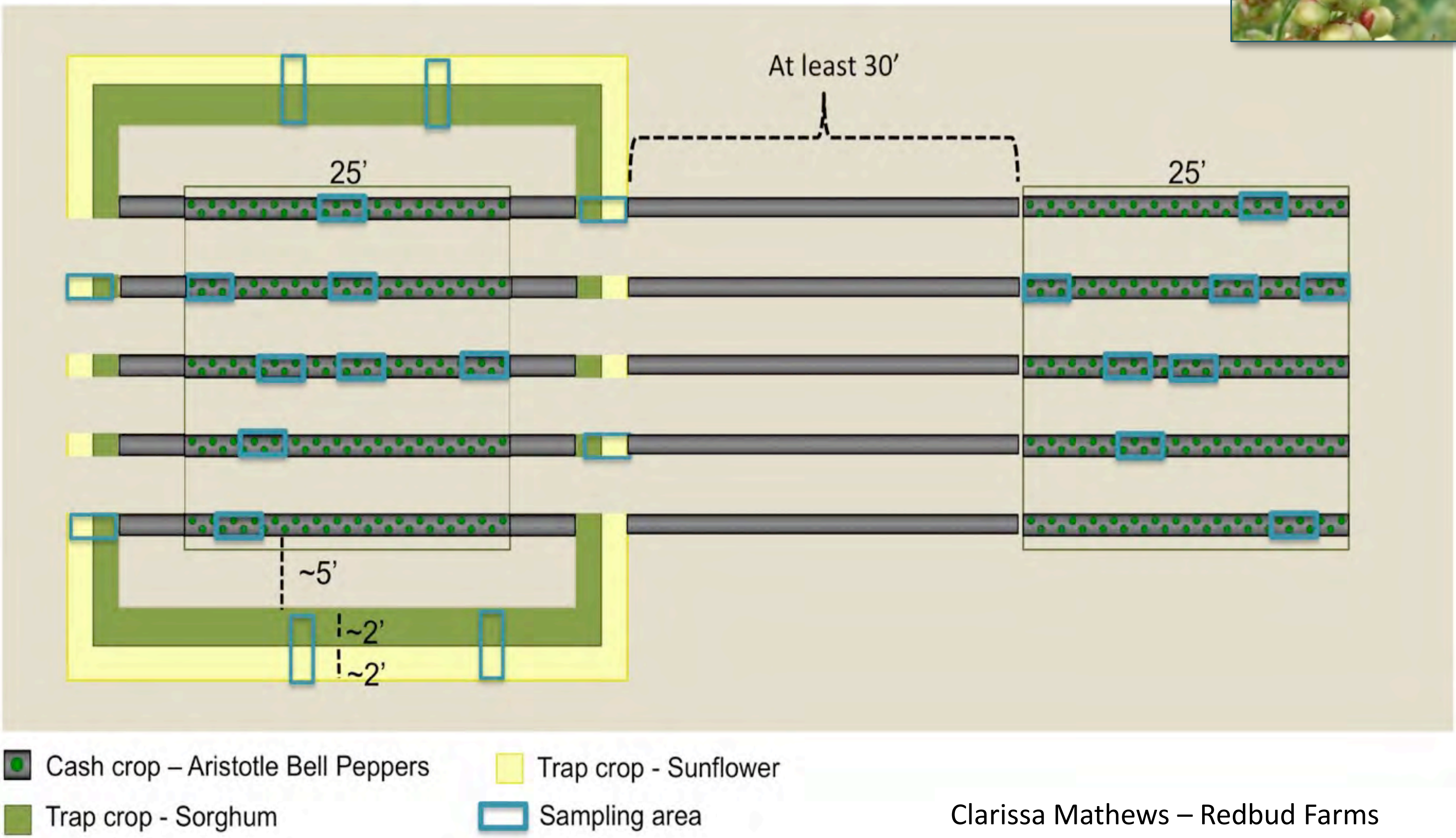

Millet


Sorghum


Okra

Nielsen et al. Env. Entomol. *accepted*

2014 & 2015 Trap Crop



Clarissa Mathews – Redbud Farms
Brett Blaauw and Anne Nielsen - Rutgers

2014 Multi-State Trap Crop Study

Evaluate sunflower and sorghum trap for bell peppers, 8 states:

PI/Site	State	# Sites	# Reps
Nielsen/RAREC	NJ	1	4
Nielsen/Muth	NJ	1	1
Mathews/Redbud	WV	1	4
Dively/UMD	MD	1	4
Pfeiffer/VATech	VA	1	1
Moore/OCU	TN	1	3
Kotcon/WVU	WV	1	4
Welty/Stratford	OH	1	1
Welty/Bridgeman	OH	1	1
Walgenbach/Sizemore	NC	1	1
Zinati/Rodale	PA	1	4
Totals:	**8**	**11**	**28**

Plot Exterior

Plot Interior

2014 Pepper Damage Assessment

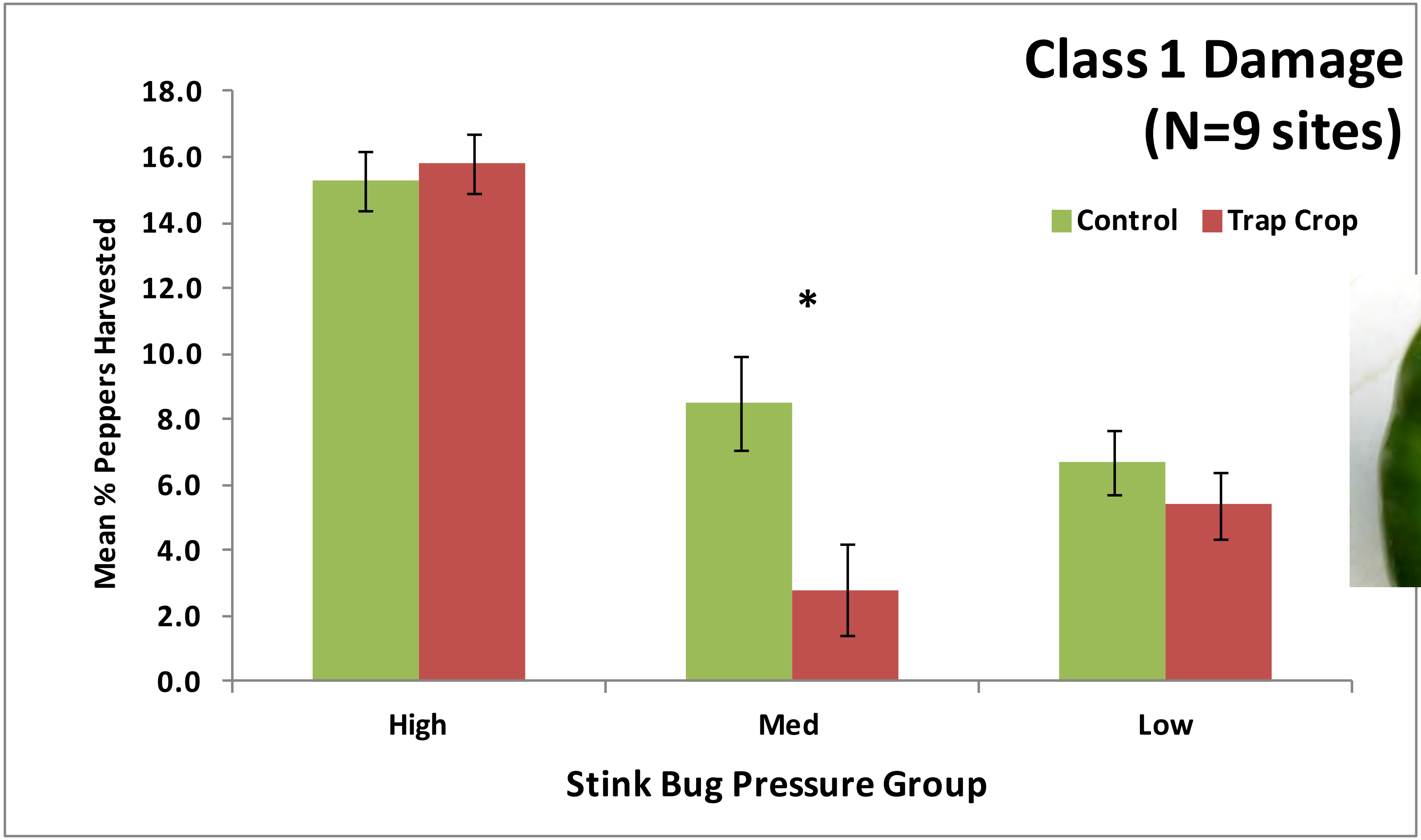
All mature fruit harvested weekly (100 plants/plot), 7 weeks (Jul – Sept)

Rating Class 0 – Undamaged

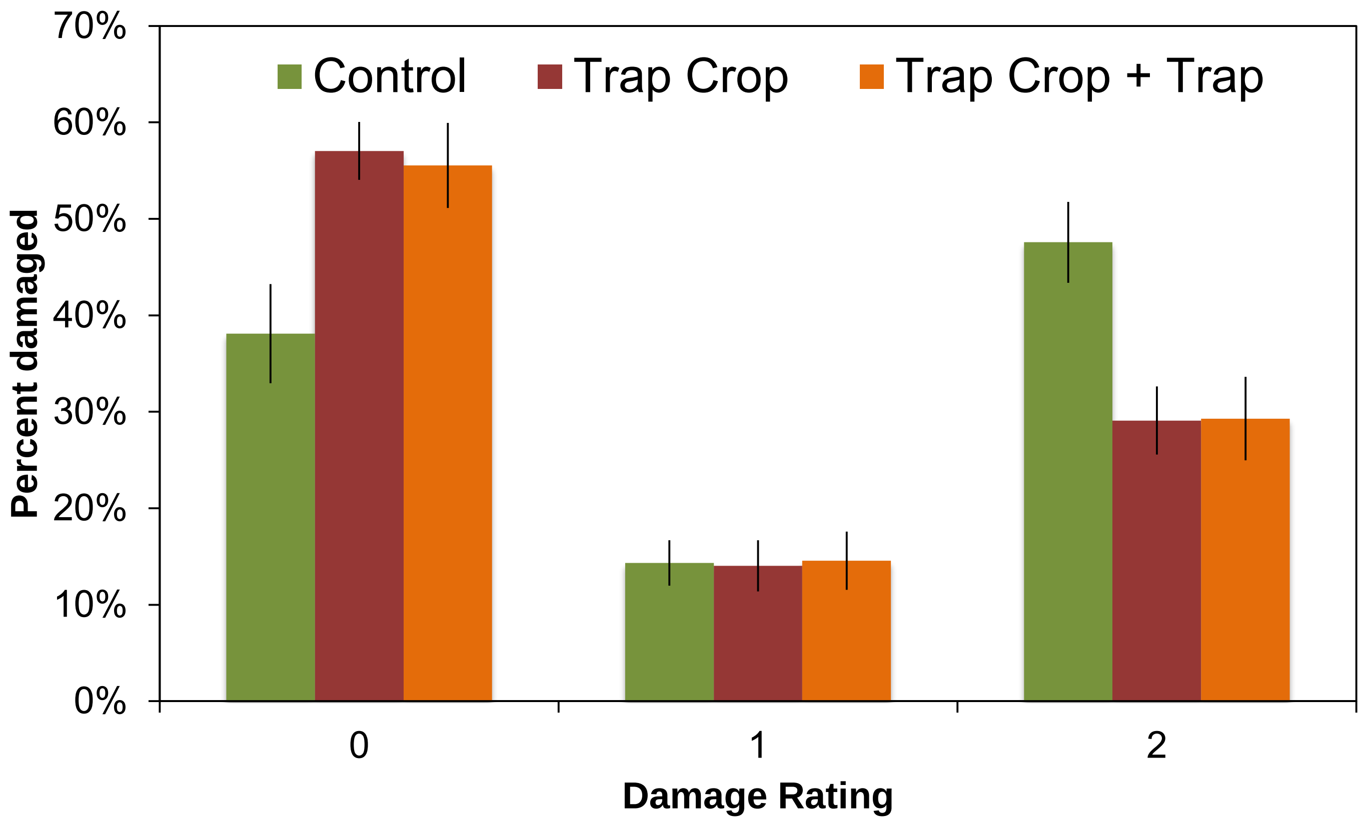
Rating Class 1 – Minor Injury

Rating Class 2 – Major Injury

2014 Trap Crop Results

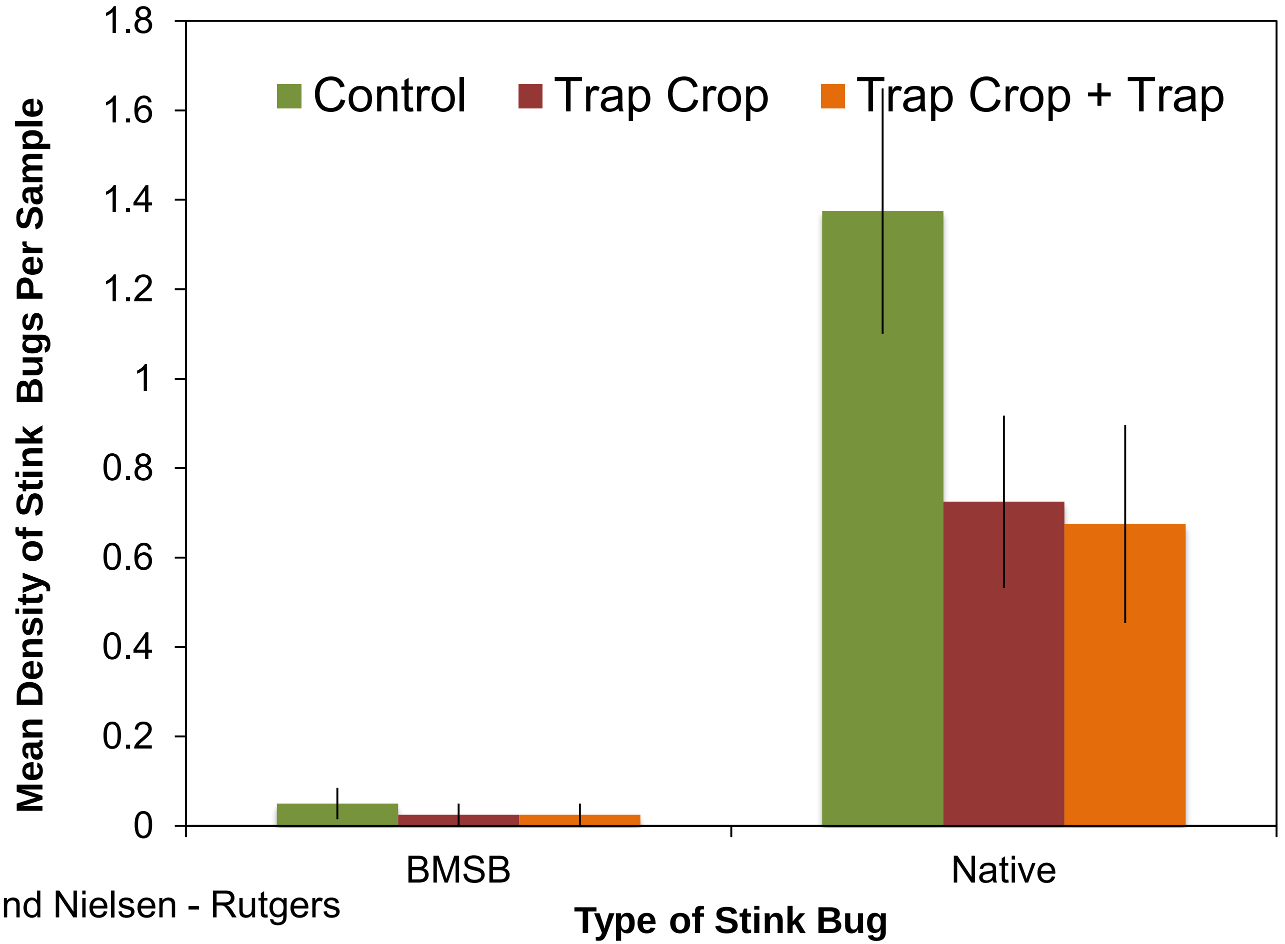


2015 NJ Trap Crop Pepper Damage



Blaauw and Nielsen - Rutgers

2015 NJ Stink Bug Densities on Pepper



Blaauw and Nielsen - Rutgers

Trap Crop Findings

- Sorghum was generally the most attractive trap crop tested for BMSB
  - Sunflower was more attractive earlier in the season with sorghum becoming more attractive in August
- Sunflower is attractive to natural enemies
- Colonization of cash crop was delayed
- Higher damage in peppers occurred under 'high' pressure
- Also attractive to native stink bugs

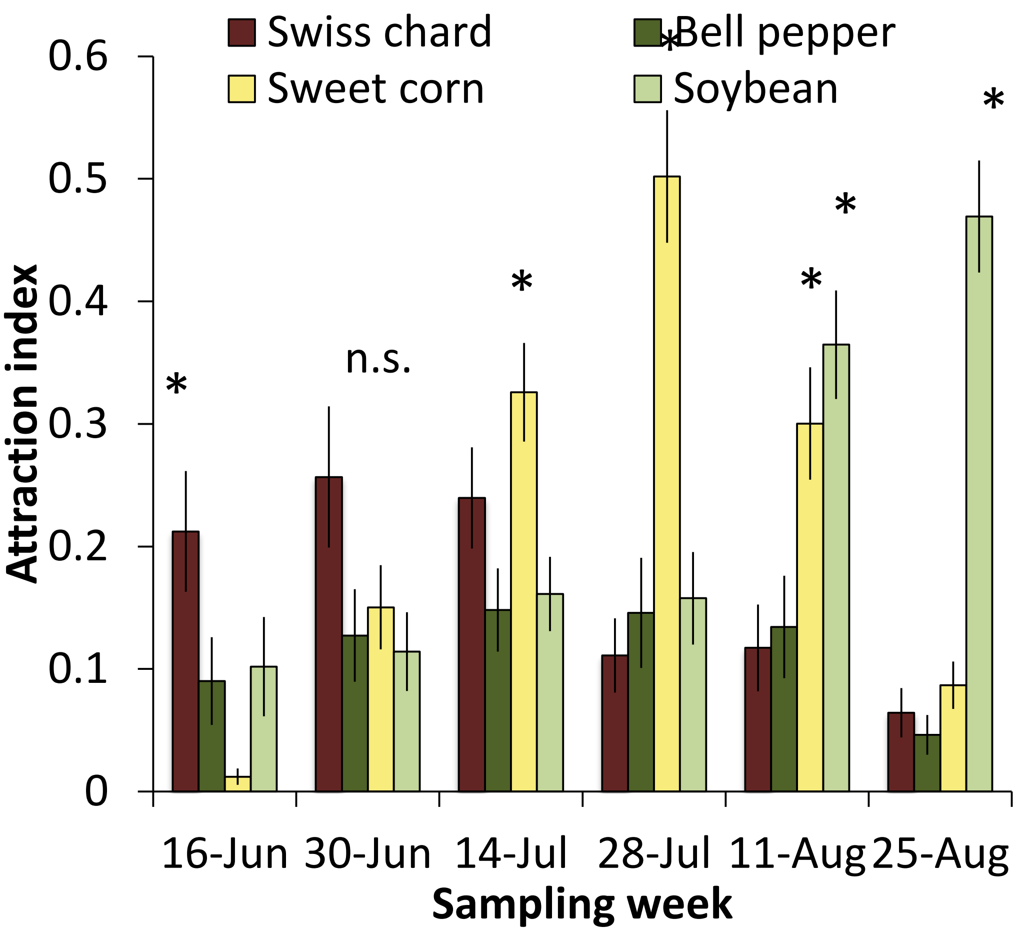
Obj 2: Whole Farm Movement

- Nymphal dispersal behavior
  - Capacity
  - Dispersal between host plants
- Whole-farm sampling
  - Tracking population hot spots
- Overwintering behavior
  - Trapping experiment
  - Citizen Science

Park, Mizell, Leskey, Nielsen, Hamilton, and Matthews

Nymphal Dispersal Capacity

- Nymphs have a strong walking capacity.
- Can disperse 10m in 3 hours
- Nymphs show strong response to the olfactory attractant and traverse large distances to reach source
- Nymphs select host plants
- Based off of phenology
  - Preference for fruiting bodies
  - Identified common odors correlated with attraction

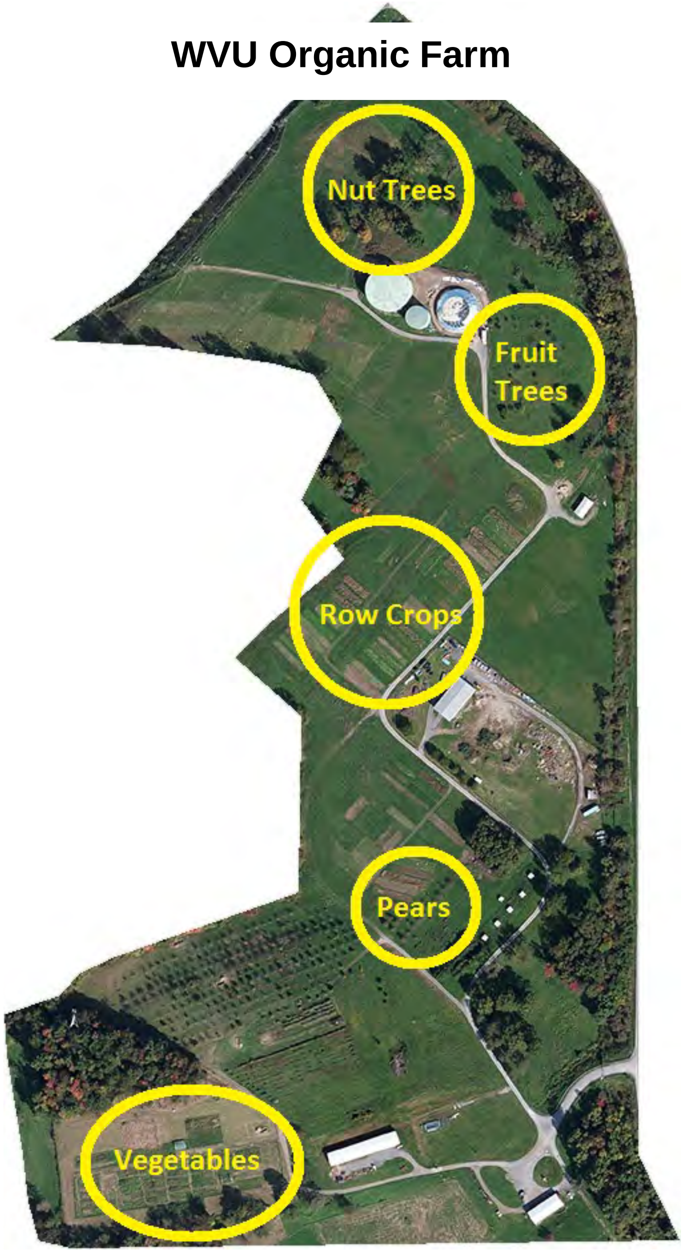


Doo-Hyung Lee and Tracy Leskey – USDA
Blaauw and Nielsen - Rutgers

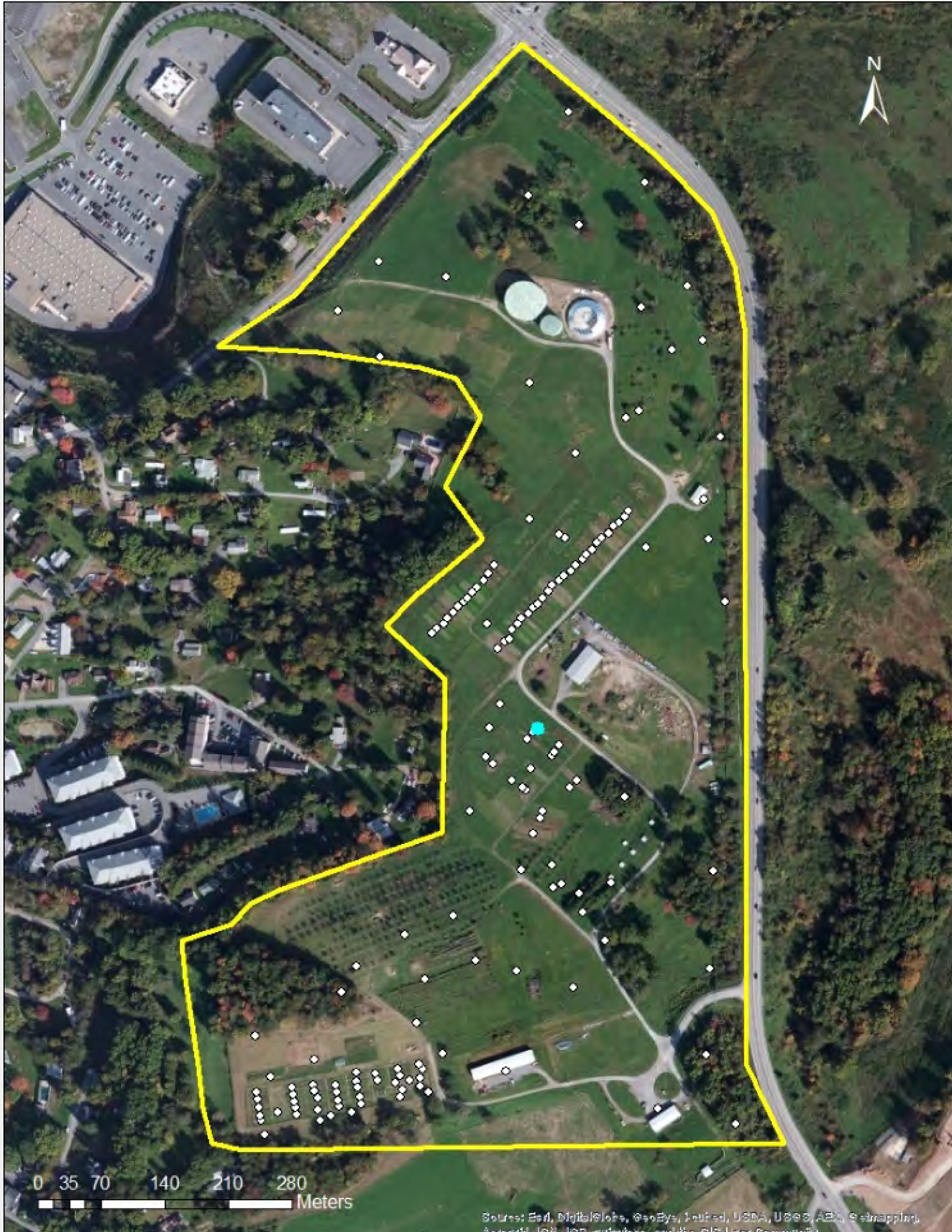
Whole-Farm Movement

- WVU Organic Farm, Morgantown WV (77 acres)
- Redbud Organic Farm, Inwood WV (11 acres)
- Muth Family Farm, Williamstown NJ (108 acres)

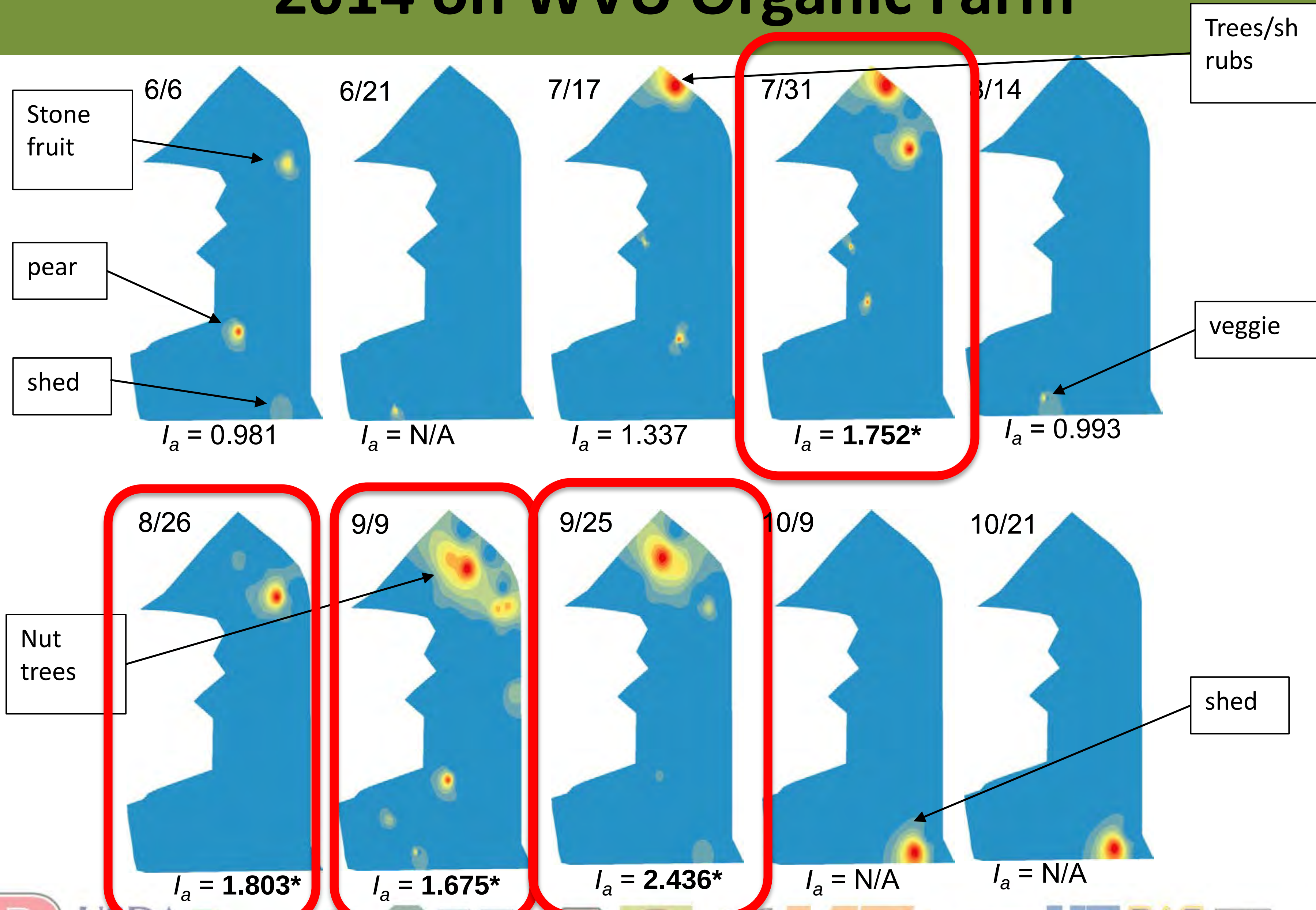
WVU Organic Farm



Jake Goldner and Yong-Lak Park - WVU


N
0 35 70 140 210 280
Meters

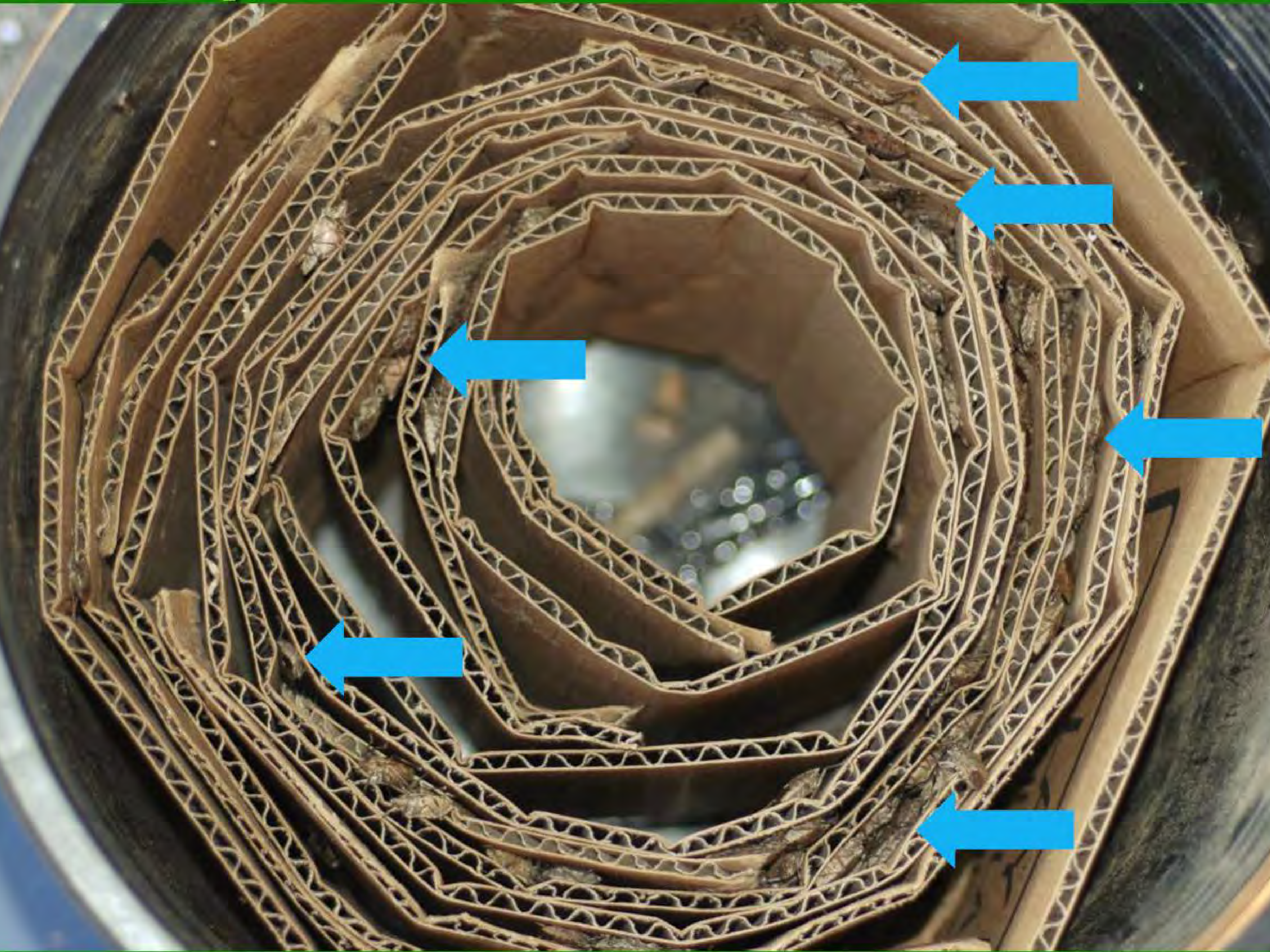
2014 on WVU Organic Farm



*, significant spatial aggregation ($P < 0.05$)

Traps RCBlocked Around Silo Cardinal Directions n = 5 x 4 2 Souths = 2 silos

Russ Mizell - UFL

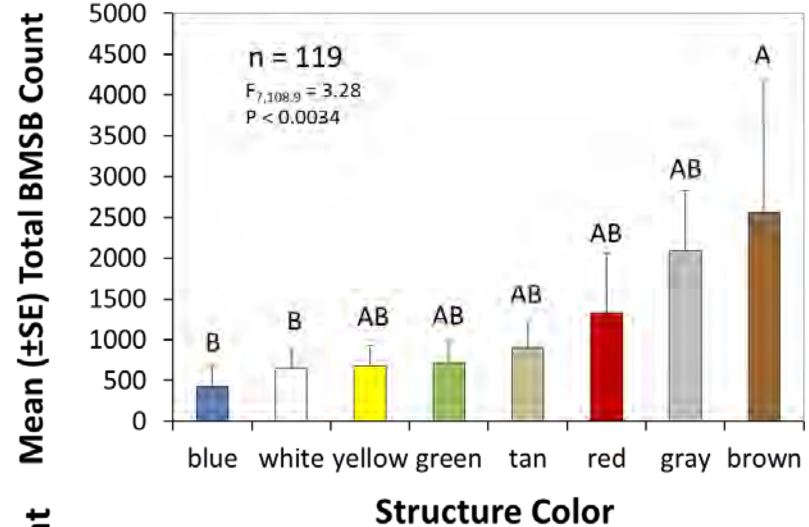


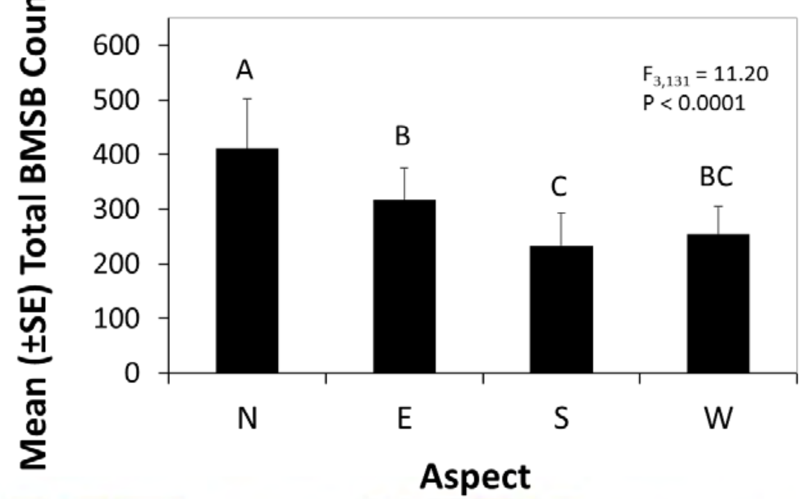
Traps Blocked Around Silo BMSB Counts in 2014, Stat. NS

			Direction			
Color/	North	East	West	South (E	South (W)	Totals
White	93	65	68	43	258	527
Black	51	162	66	66	374	719
Yellow	24	44	31	39	215	353
Silver	125	130	103	8	142	508
Totals	193	301	208	156	989	1846

Great Stink Bug Count

- Crowd-sourcing data collection from volunteers
  - 2013: 162 datasets
  - 2014: 134 datasets
- September 15 – October 15
- Rural or rural-forest landscapes had highest counts

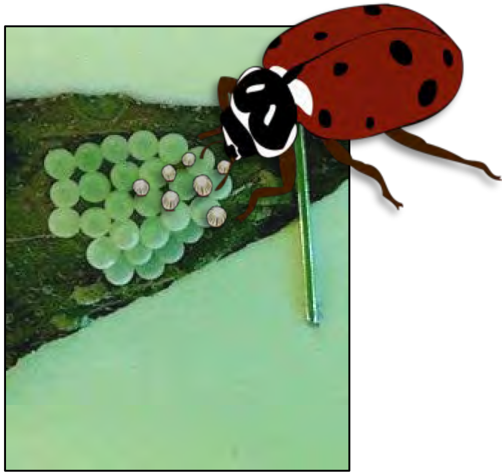




Torri Hancock and Tracy Leskey - USDA

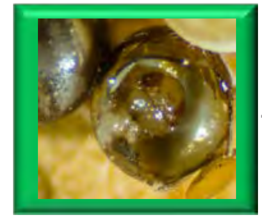
Objective 3: Natural Enemies

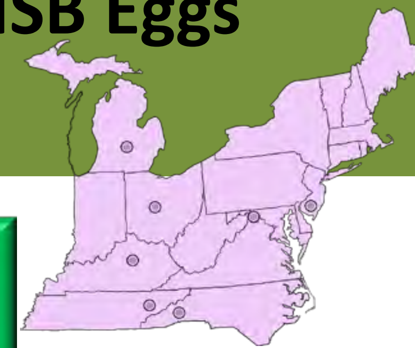
- 8 states observed fate of sentinel BMSB eggs
  - Two sites per state
  - Two week intervals from June through August
- Selected egg masses under video surveillance
- Laboratory trials
  - Identify stage-specific predation
  - Identify type of damage caused
- Gut content analysis
- Supporting natural enemy populations

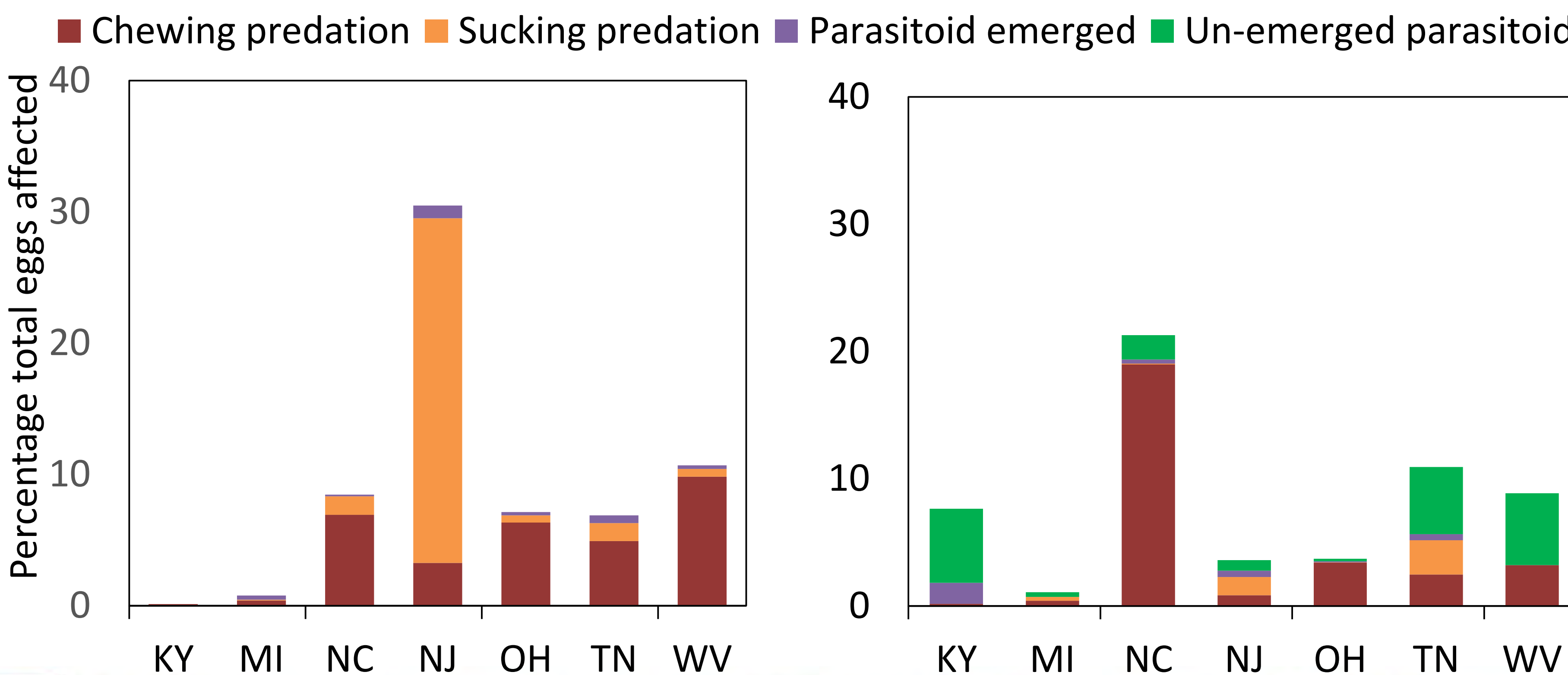


Nielsen, Pote, Park, Pfeiffer, Hooks, Hoelmer, Bessin, Walgenbach, Welty, Rogers, and Grieshop

Predation and Parasitism of Sentinel BMSB Eggs in Seven States

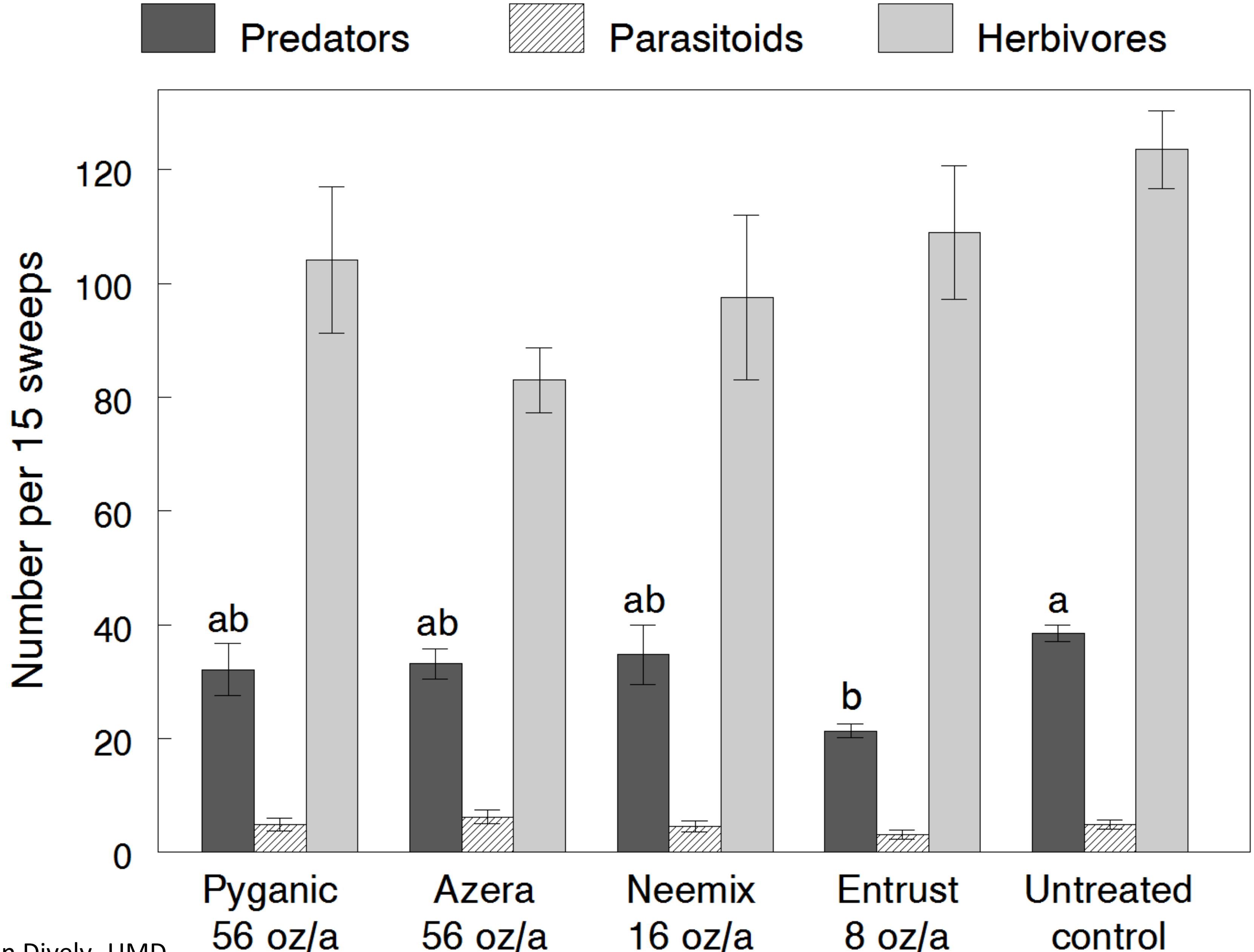






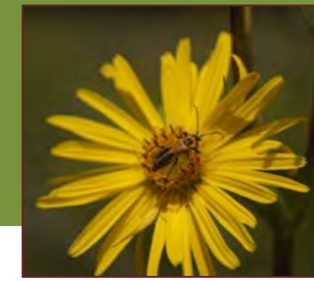
Who Are the Predators?

- Activity is largely at night
- Orthopterans caused high predation and spent a lot of time on the egg masses
- In cages, damsel bugs, wheel bugs, *Orius* sp. cause high predation of multiple life stages
- Minimal predation in the field by lady beetles

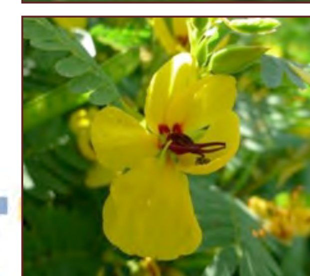


Galen Dively- UMD

Insectary Plantings

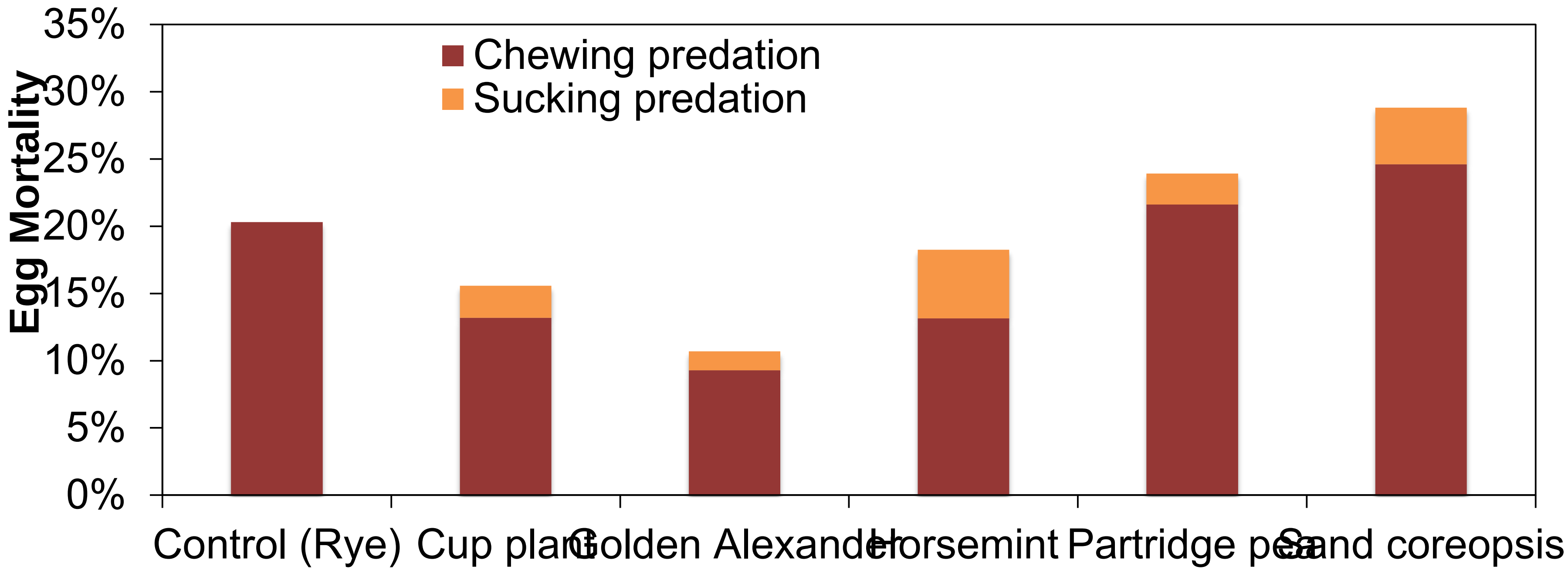


- Identify natural enemies and impact
    - Cup plant, *Silphium perfoliatum*
    - Golden Alexanders, *Zizea aurea*
    - Horsemint, *Monarda punctata*
    - Sand coreopsis, Coreopsis lanceolata
    - Partridge pea, *Chamaecrista fasciculata*
- Determine biological control with partridge pea companion plantings in corn



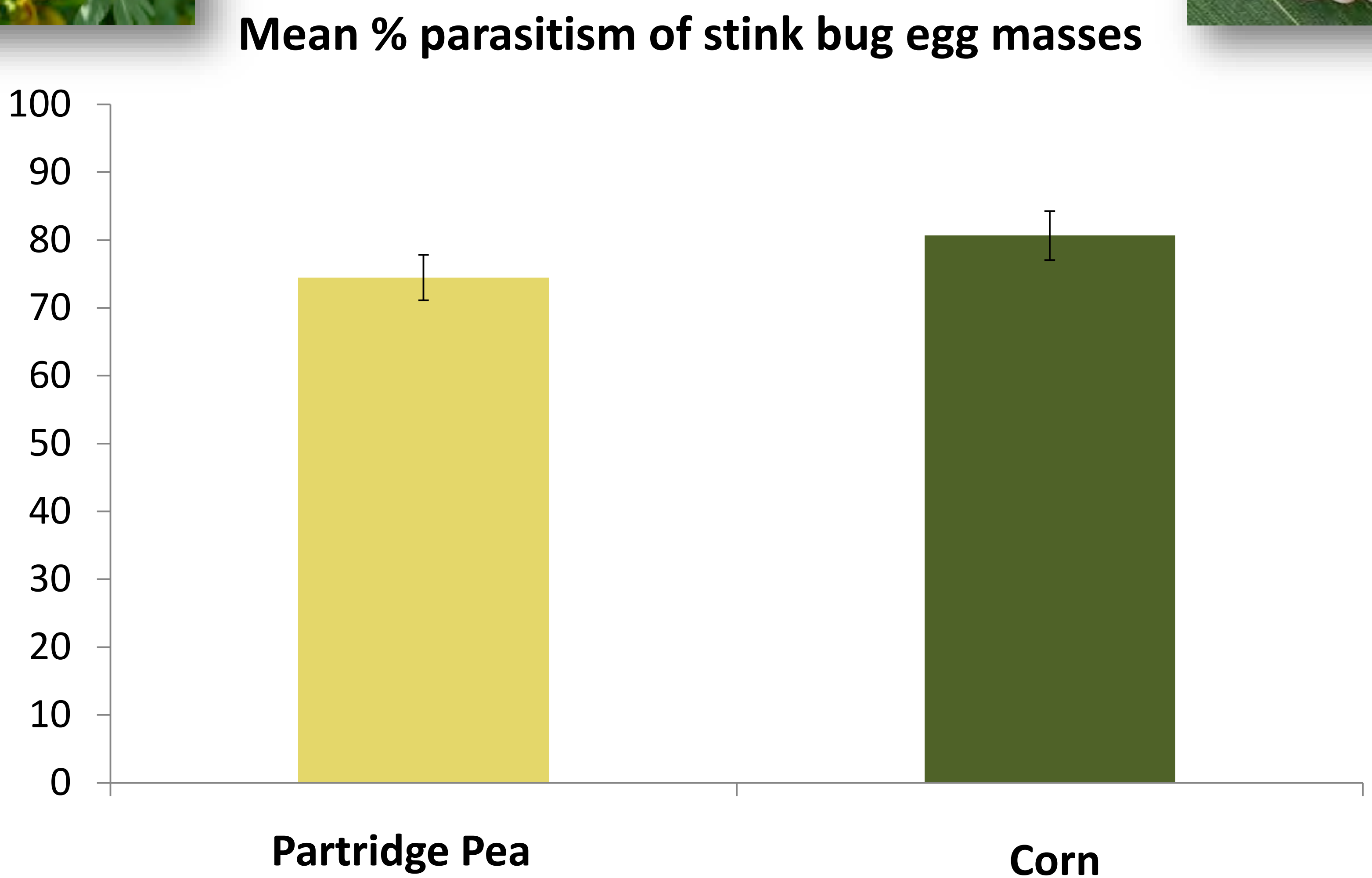
Brett Blaauw – Rutgers
Cerruti Hooks and Lauren Hunt - UMD

Wildflowers to Support Natural Enemies of BMSB

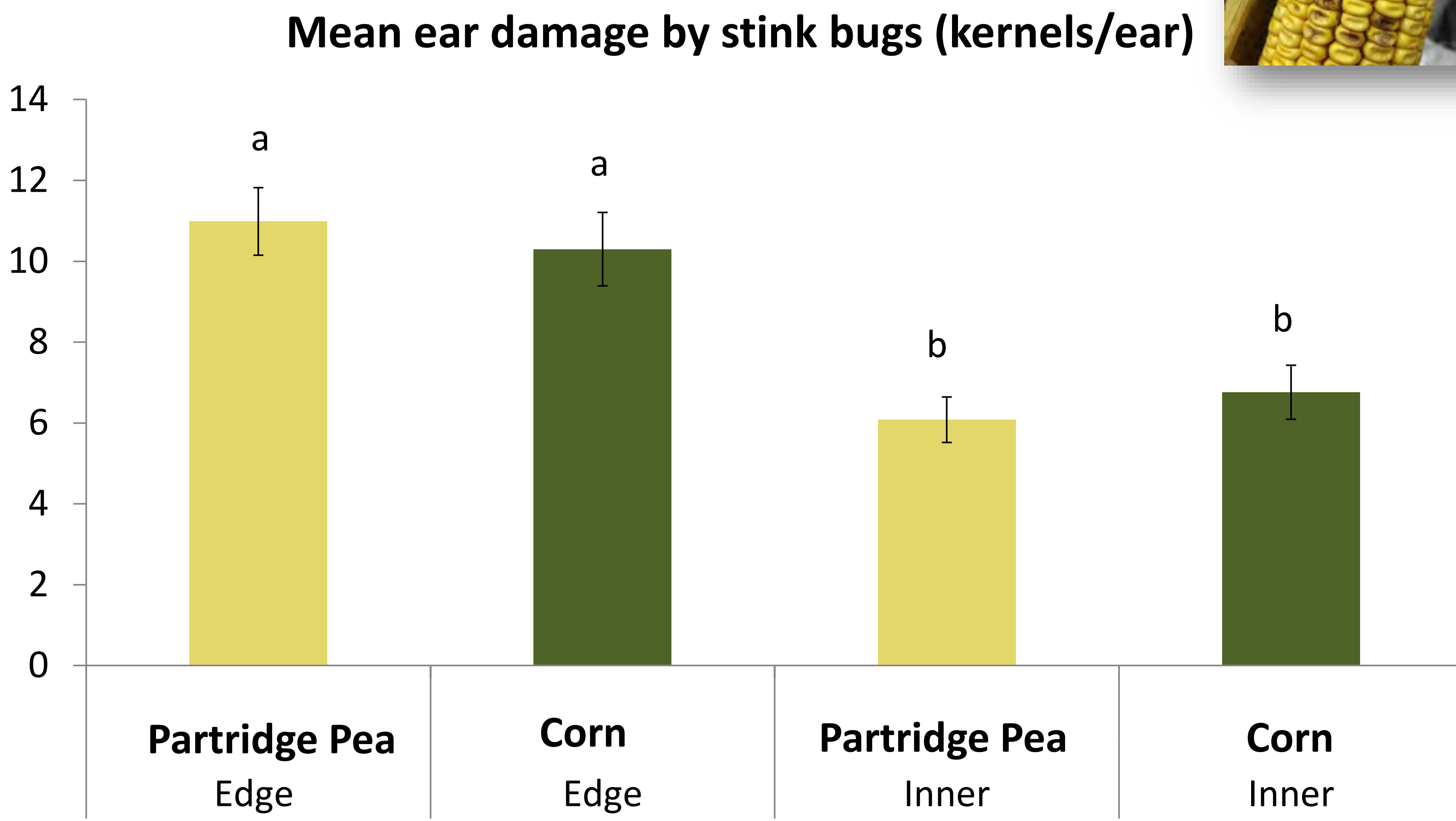


- Flowers support higher numbers of natural enemies
  - No difference in chewing predation of egg masses
  - Higher sucking predation
  - Most egg removal likely due to opportunistic orthopterans

Target Pest Control



Corn Ear Damage



Biological Control Summary

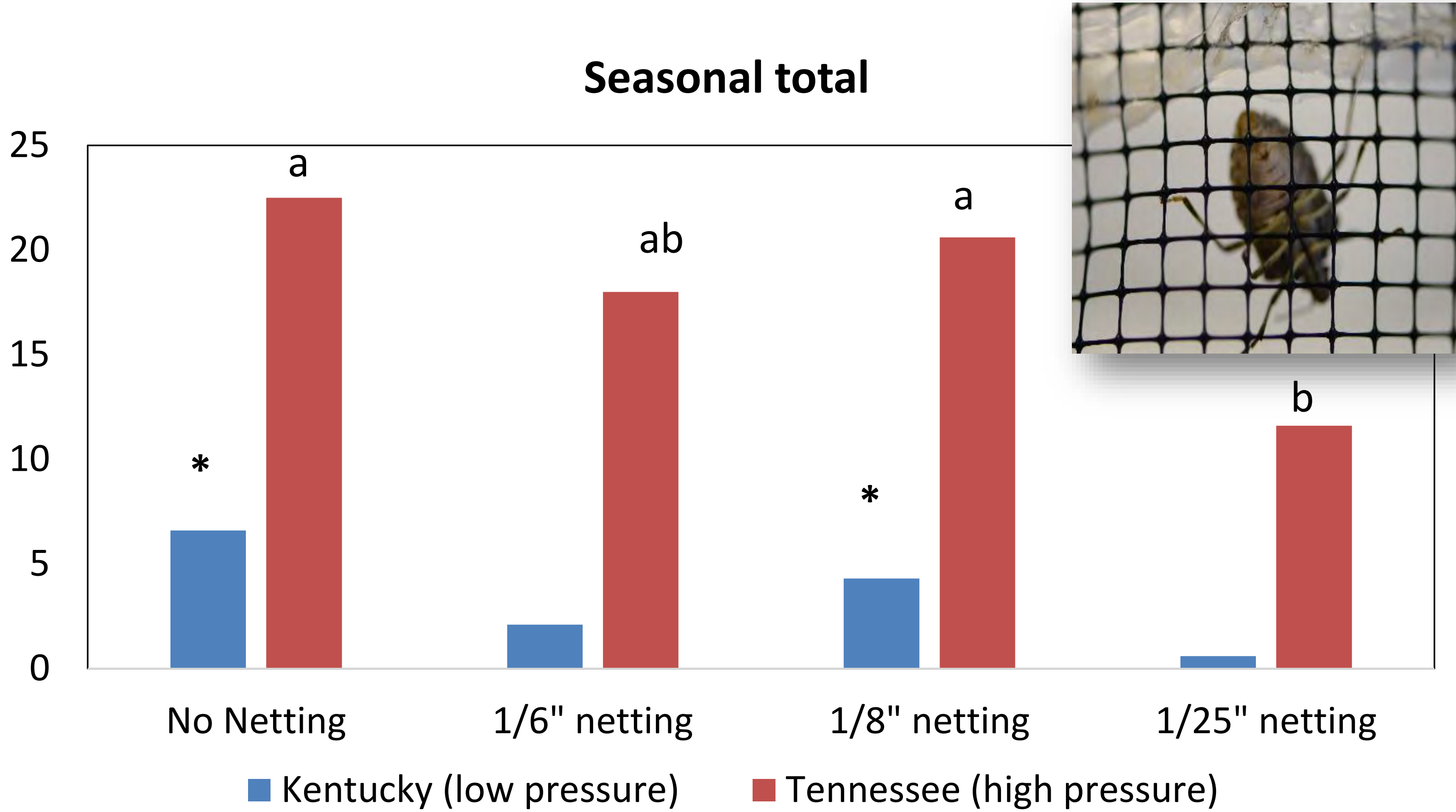
- Egg mass predation is higher in organic systems than conventional
- Most predators are generalists or opportunists
  - Sucking predators, orthopterans
- Can be increased through habitat manipulation
  - Until *T. japaonicus* is widespread, focus should be on plants that increase predator community
    - Horsemint (*Monarda* sp) and Coreopsis
  - Insecticides like Entrust decrease NE populations
- Parasitism is increasing

Objective 4: Evaluate Barrier Fabrics for BMSB and Endemic Stink Bug Management

- Investigated efficacy of barrier fabrics
- Treatments:
    - Fine mesh
    - 1/8” mesh
    - 1/6” mesh
    - No screen
- Scouted pepper plants weekly for:
    - BMSB and native stink bugs
    - Natural enemies
- Peppers were harvested and assessed for damage
    - TN (high pressure)
    - KY (low pressure)

Rogers, Moore, and Bessin

Percentage Stink Bug Damage to Peppers in Screened and Unscreened Plots



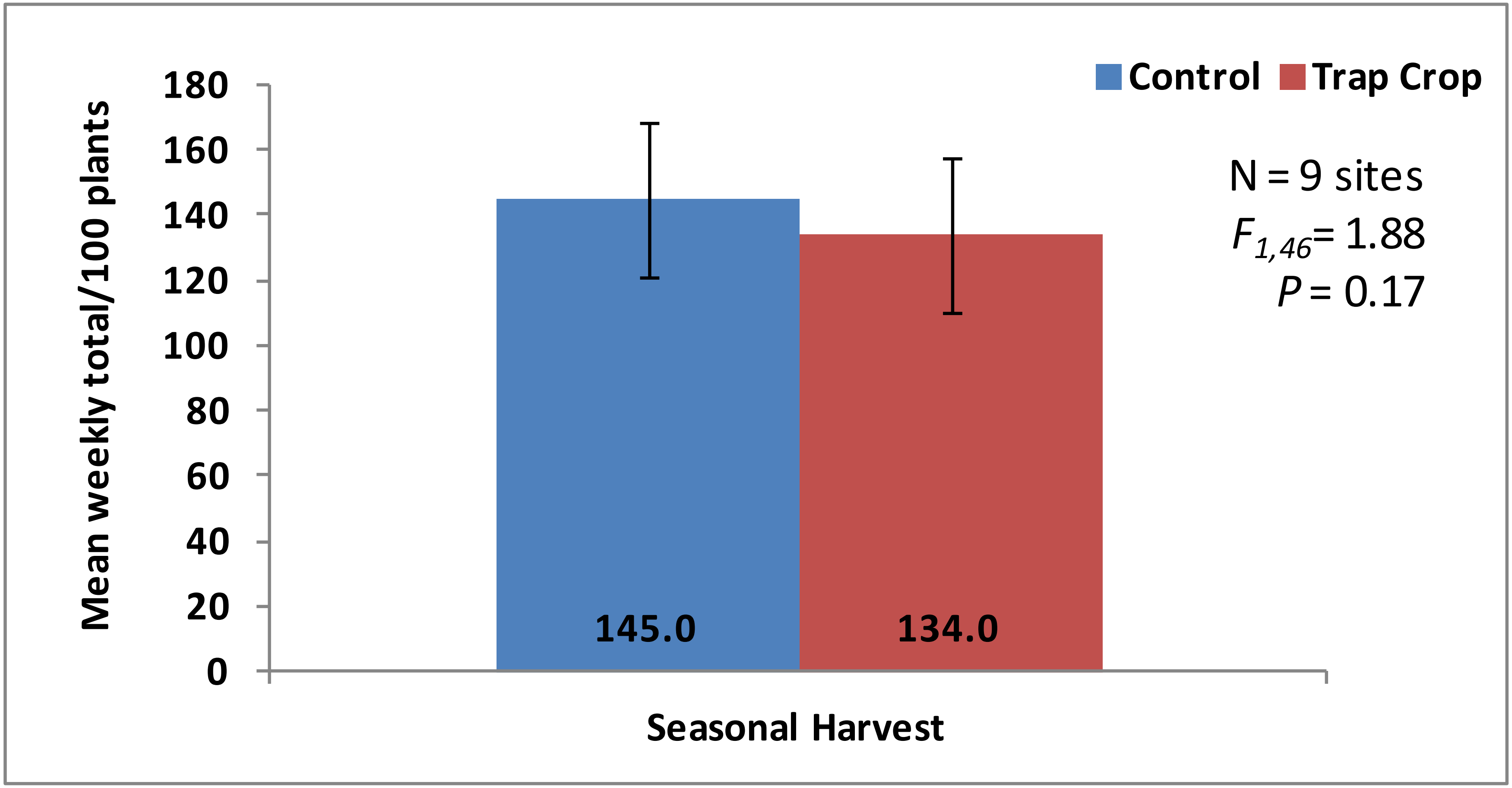
Is Organic Management Feasible?

- Yes, *under moderate pressure*!
- Understand hot spots on the farm
  - Key early season host plants
  - Crops that are preferred hosts by all life stages
- Manipulate the habitat surrounding these areas
  - Support natural enemies
  - Trap crop using sunflower and sorghum
  - Re-design trap crop layout
- Under intense BMSB pressure the finest mesh netting provides protection from stink bug injury
- Remove overwintering populations on-farm

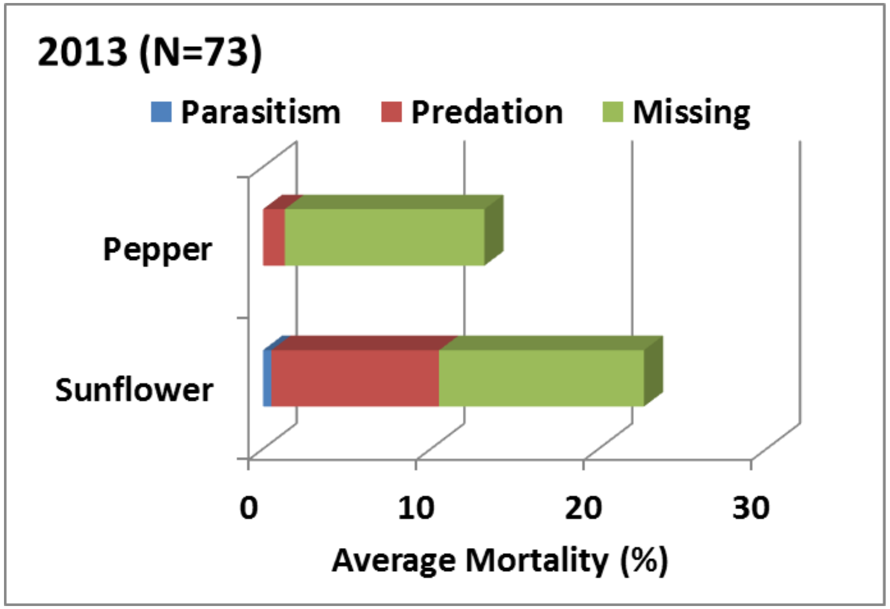
For more information, please visit our project website:

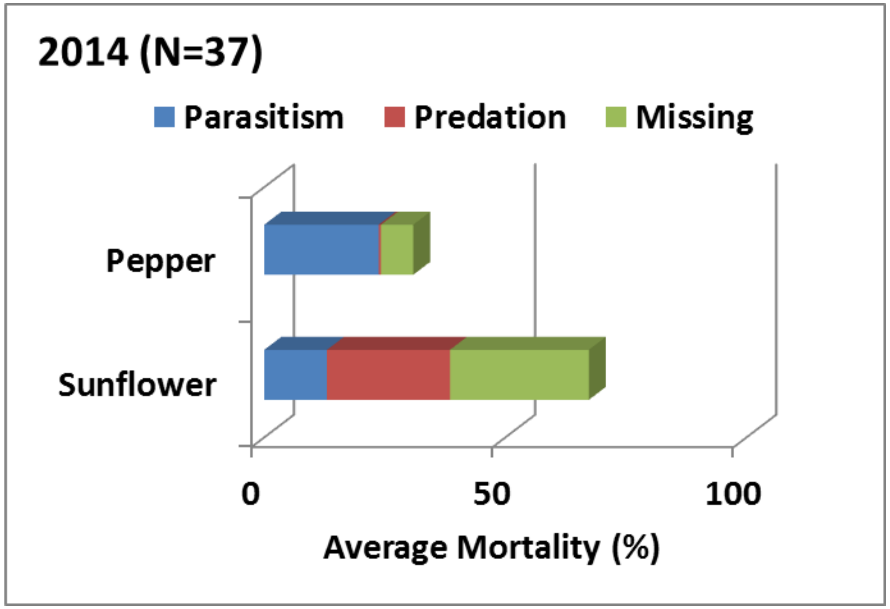
http://eorganic.info/brown-marmorated-stink-bug-organic

2014 Pepper Yields



Biological Control: Stink Bug Eggs



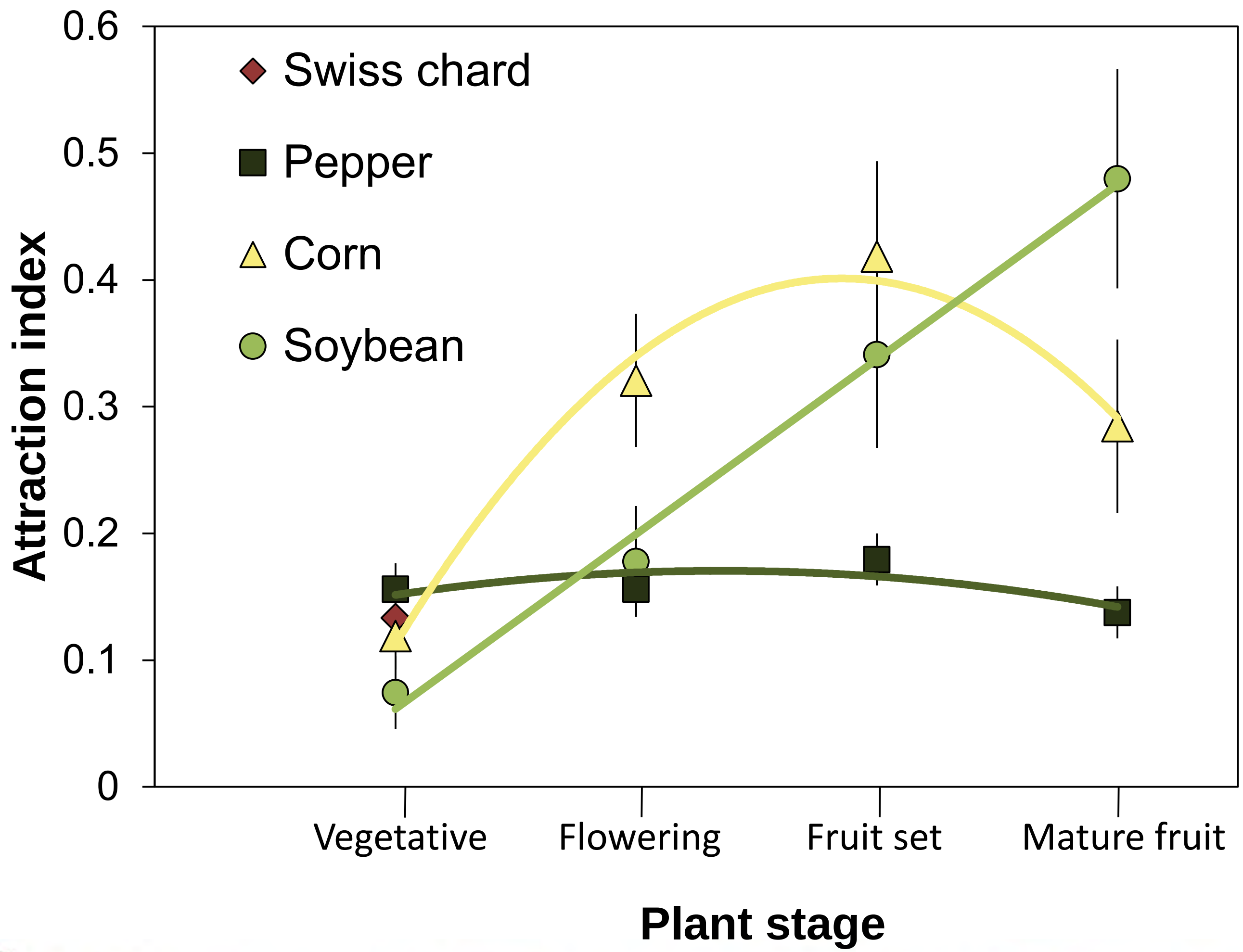


C. Matthews and R. Morrison

Spatial Analysis: SADIE

- **S**patial **A**nalysis by **D**istance **I**ndic**E**s (Perry et al. 1999).
- Calculates effort to make all values uniform
- Yields aggregation index (I_a)
  - $I_a < 1 \rightarrow$ Uniform
  - $I_a > 1 \rightarrow$ Aggregated
  - $I_a = 1 \rightarrow$ Random
- Associated *P*-value for I_a

Host Attractiveness may be Dependent on Plant Phenology



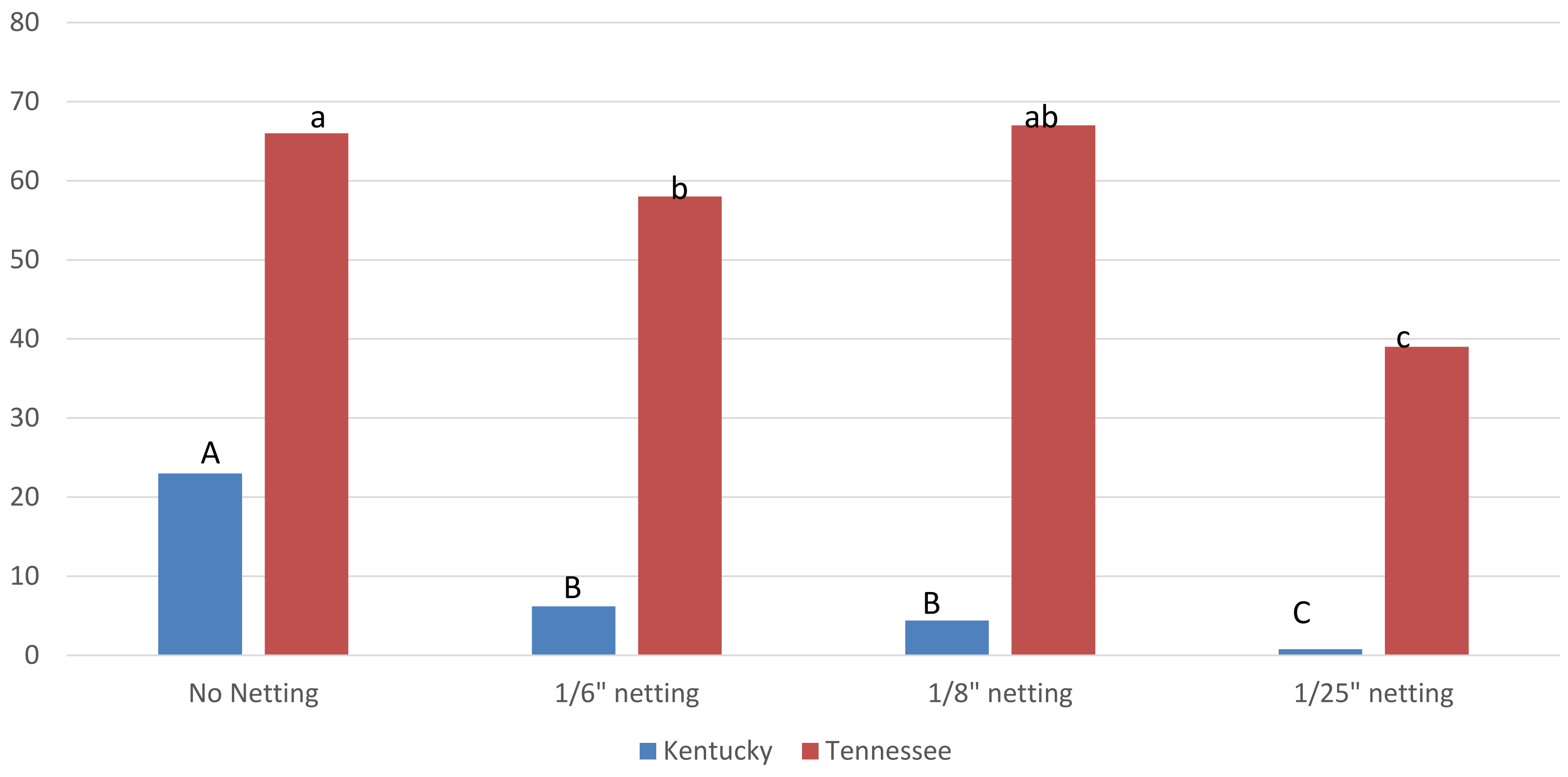
$r^2 = 0.29$
P=0.001

$r^2 = 0.32$
P=0.001

$r^2 = 0.04$
P=0.21

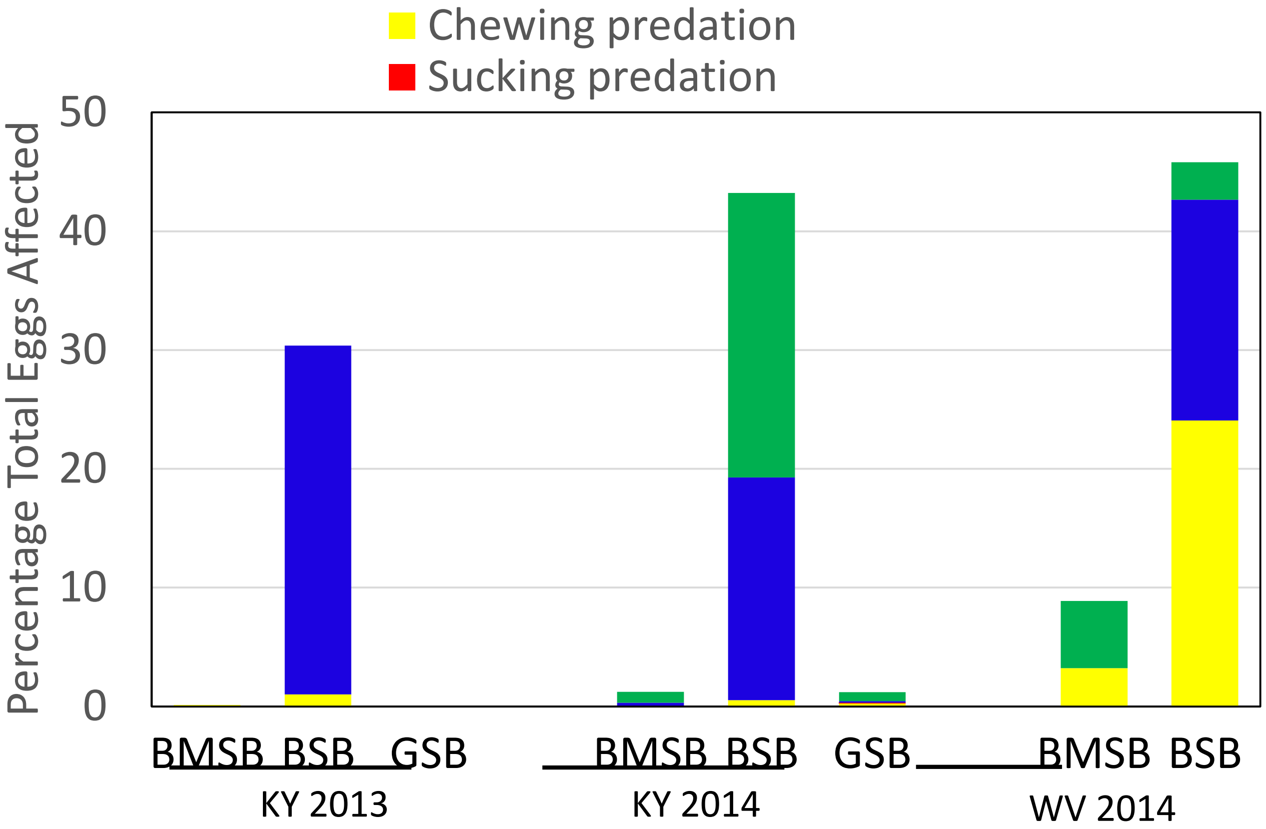



Beneficial insects on yellow sticky cards in screened and unscreened plots of peppers

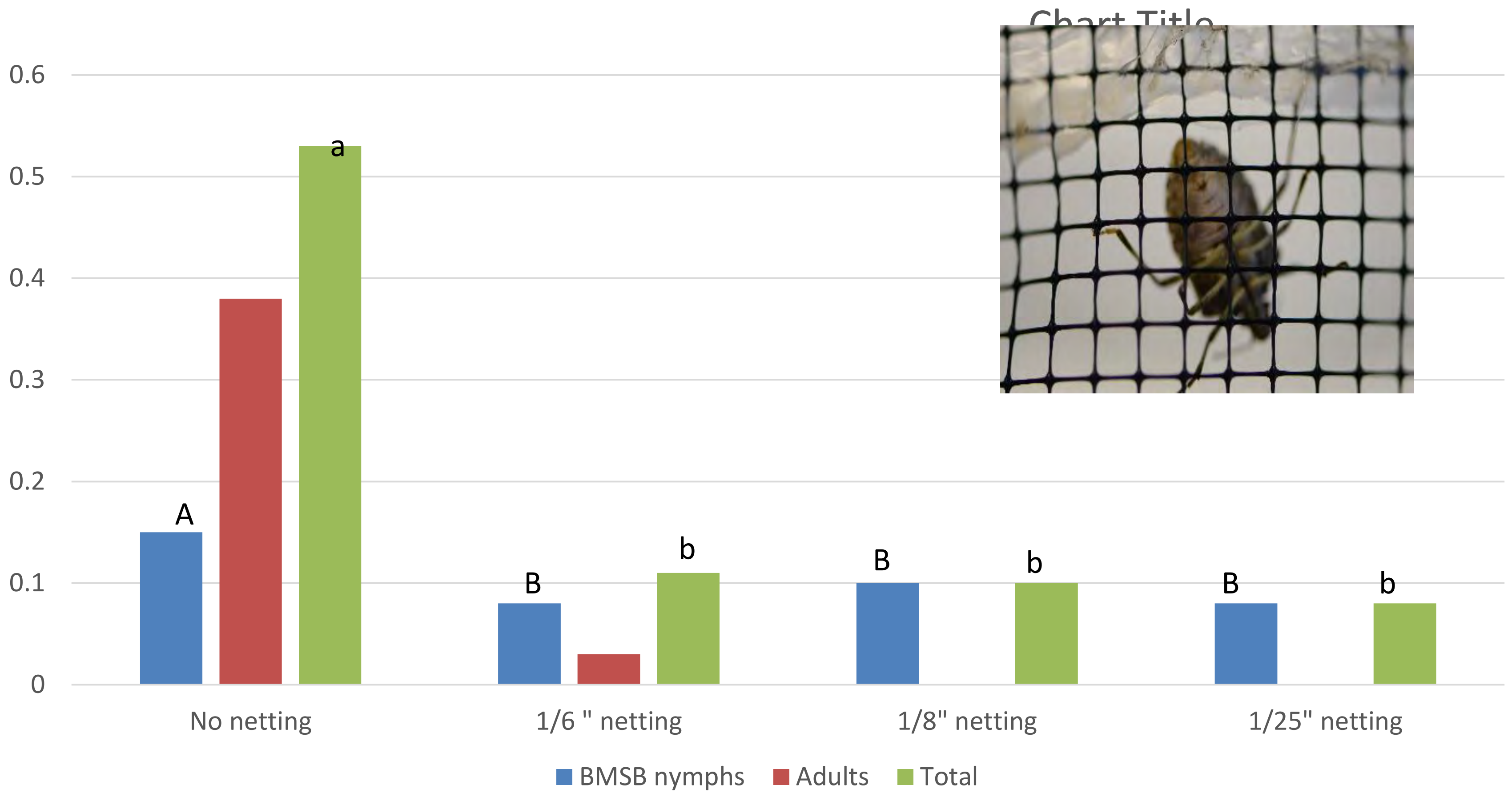


* In 2014, aphids were a problem under the 1/25" netting in two plots in Kentucky.

Sentinel Native Brown (*Euchistus servus*) and Green (*Acrosternum hilare*) stink bug vs BMSB egg predation and parasitism



BMSB in screened and unscreened plots of peppers, Tennessee 2013 and 2014



Percentage of marketable fruit from screened and unscreened plots, 2013 and 2014 combined