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Davis College  
of Agriculture,  
Natural  
Resources  
and Design

## Managing Bad Stink Bugs with Good Stink Bugs

*eOrganic Webinar*



**Yong-Lak Park**  
**West Virginia University**

## Outline of Presentation



### Stink Bugs

**Plant feeder vs. Predator**

**Brown marmorated stink bug  
(BMSB)**

**Spined soldier bug**



### Stink Bug Control Using Stink Bug

**BMSB vs. soldier bugs**

### Obstacles to overcome

**Prey preference of soldier bugs**

**Mass rearing of soldier bugs**

## Stink Bug



**Shield bug**

**True bug**



## Stink Bug

hemelytra

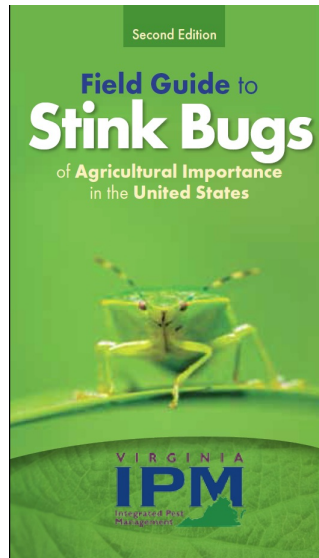


Piercing & sucking mouth

## Stink Bugs: Exotics



## Stink Bug Field Guide



[https://pubs.ext.vt.edu/444/444-356/444-356\\_pdf.pdf](https://pubs.ext.vt.edu/444/444-356/444-356_pdf.pdf)

## Which Ones are Good Stink Bugs?



## Family: Pentatomidae (stink bug)

### Other subfamilies

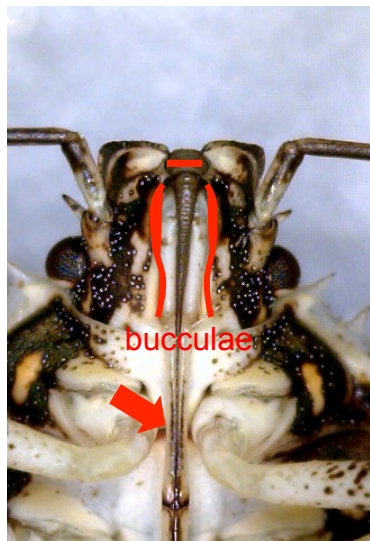


### Asopinae

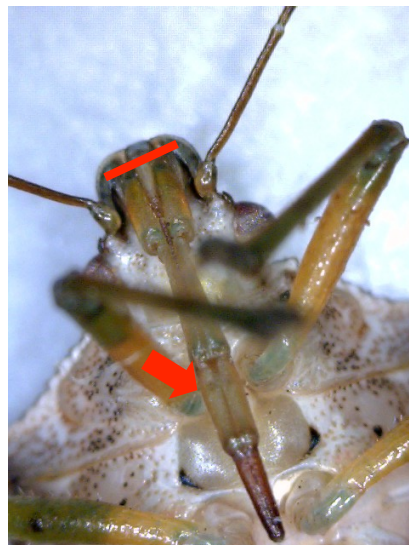


## Stink Bugs

### Plant feeder

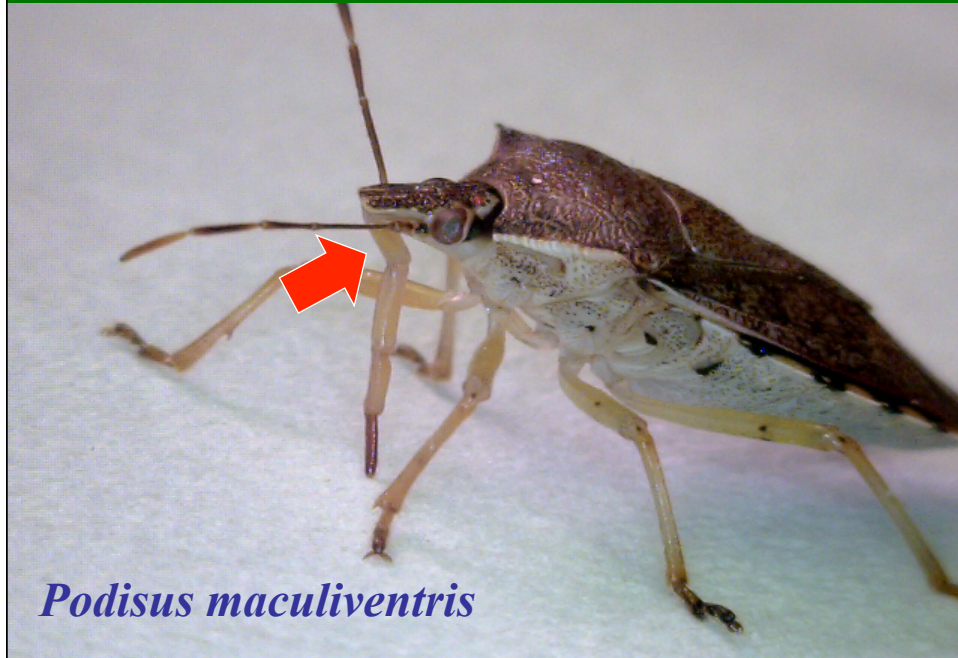


### Predator





## Predatory Stink Bug



## Example Predatory Stink Bugs



twospotted stink bug  
*Perillus bioculatus*



anchor stink bug  
*Stiretrus anchorago*



spined soldier bug  
*Podisus maculiventris*

# Brown Marmorated Stink Bug

*Halyomorpha halys* (Hemiptera: Pentatomidae)  
= also known as *H. mista* in Asian countries



marble



<http://www.stopbmsb.org>

## BMSB Webinar



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### Brown Marmorated Stink Bugs: Invasion, Biology, Monitoring and Management Webinar

Organic Agriculture January 05, 2014 | [Print](#)

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Brown Marmorated Stink Bugs Webinar

- Potential Trap Crops - Green amaranth (*Amaranthus spp.*) and sunflower
- Trap crops baited with Rescue® trap surrounding cash crop
- Sampled weekly for stink bugs and natural enemies



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#### About the Webinar

Brown Marmorated Stink Bug is a highly pervasive pest that can cause severe losses for both conventional and organic growers in a wide variety of crops. This webinar will cover background information on BMSB biology and population ecology including identification and distribution. It will include a preliminary discussion of management tactics that are amenable to organic production systems including organic insecticides and biological control; however, this webinar will be primarily about the biology of the insect and future webinars will discuss management in more detail. A recently funded USDA OREI project led by Rutgers University is currently investigating the application of core organic management options developed through an enhanced

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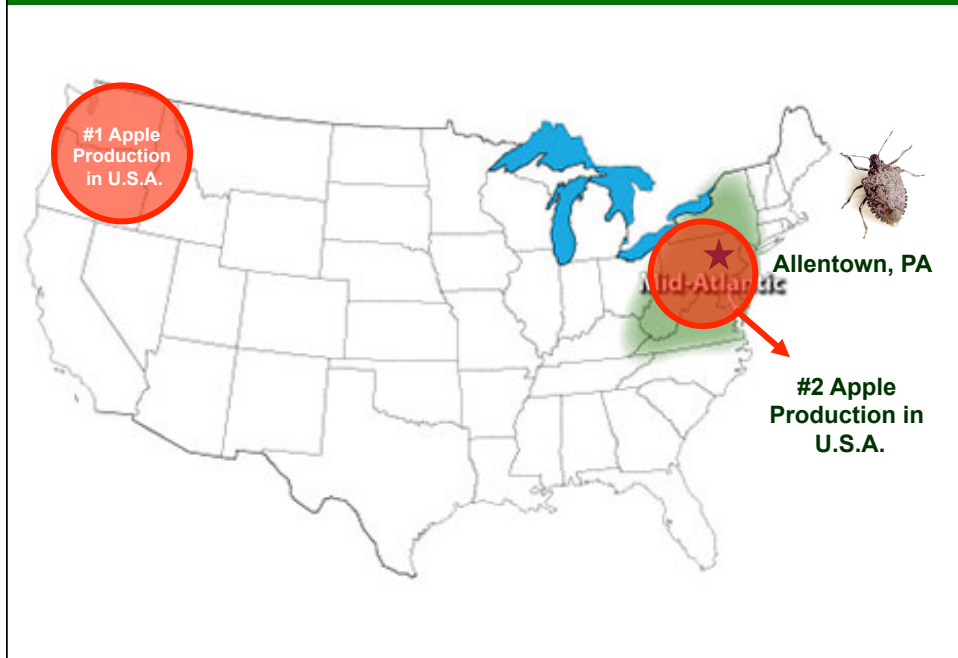
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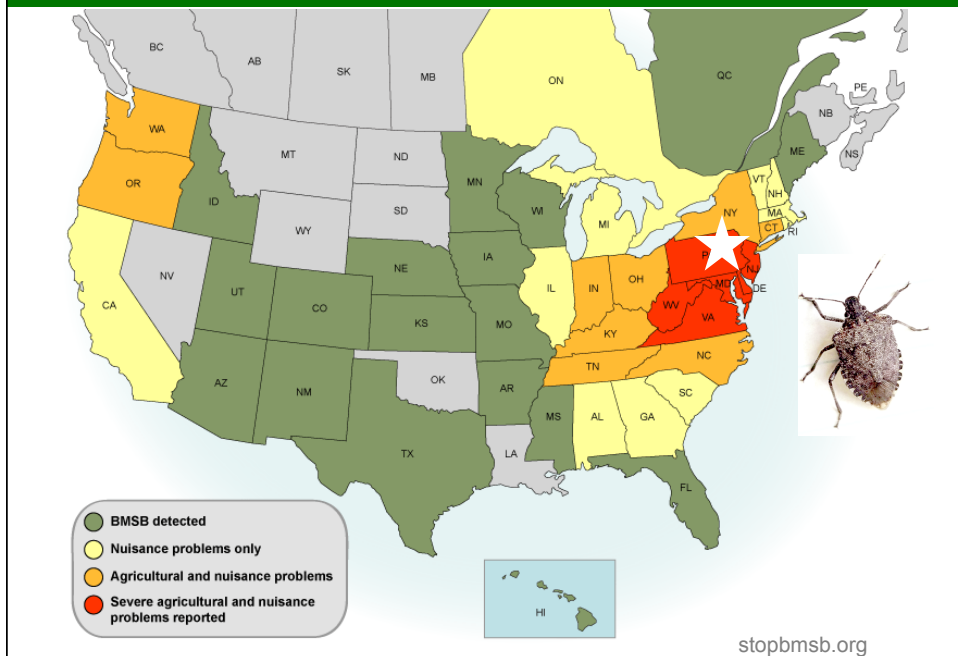
January 22

Managing Bad Stink Bugs Using Good Stink Bugs

## Invasion to Production Agriculture



## Current Distribution in North America





## Two Important BMSB Characteristics

### #1 Highly mobile



#### Strong flier

**> 5 km per day (adult)**

Wiman et al. 2004. J. Pest Sci.

#### Strong walker

**3 m per 30 min. (nymph)**

Lee et al. 2004. J. Ins. Behav.

#### Amazing hitchhiker

**Using railroad and vehicles**

Wallner et al. 2004. PLoS One

## Major U.S. Highways



## Hitchhiking



## Hitchhiking







## Two Important BMSB Characteristics

**#1 Highly mobile**

**#2 Wide host range**

**> 200 plants listed,  
including**



**Fruits,  
Vegetables,  
Field crops,  
Herbs,  
Ornamentals, and  
Trees**



## Fruit Damage



Photo source: <http://www.hgic.umd.edu/content/timelytips.cfm>

## Current BMSB Management

### Heavily rely on insecticides

**Not always successful**

**Re-infestation from outside of treated areas**

**Recover from some insecticides**

**e.g. Pyrethroid**

### Other methods are being developed

**Biological control**

**Classical and augmentative biological control**

**Semiochemicals**

**Aggregation pheromone has been identified**

**Cultural control**

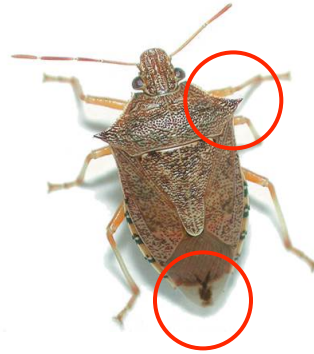
**Trap crops**

## BMSB and Spined Soldier Bug

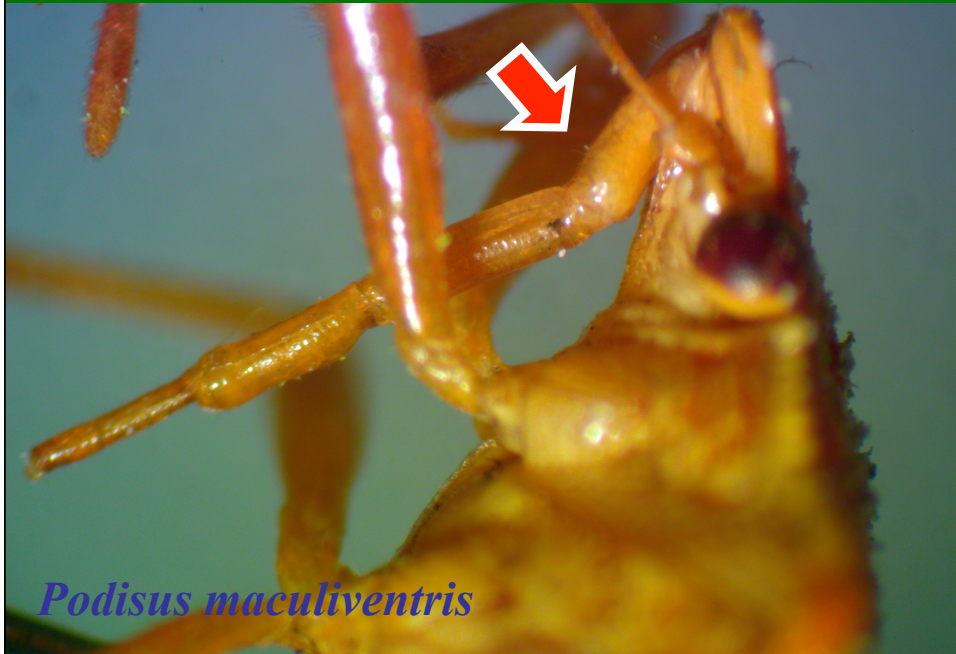
**Brown marmorated  
stink bugs (BMSB)**



**Spined soldier bug**



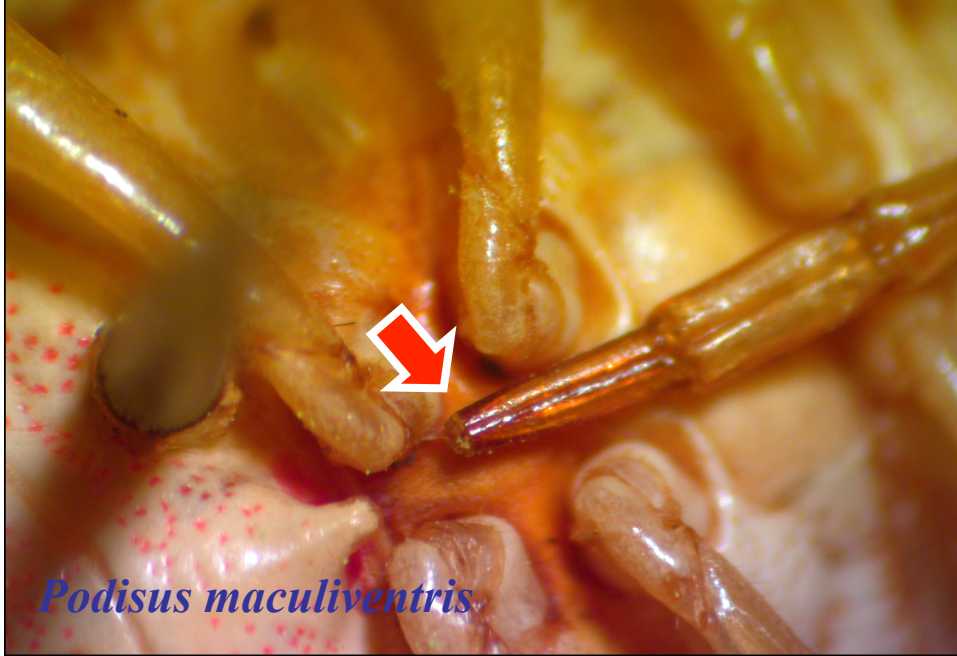
## Spined Solder Bug



*Podisus maculiventris*



## Spined Solder Bug



## Spined Solder Bug

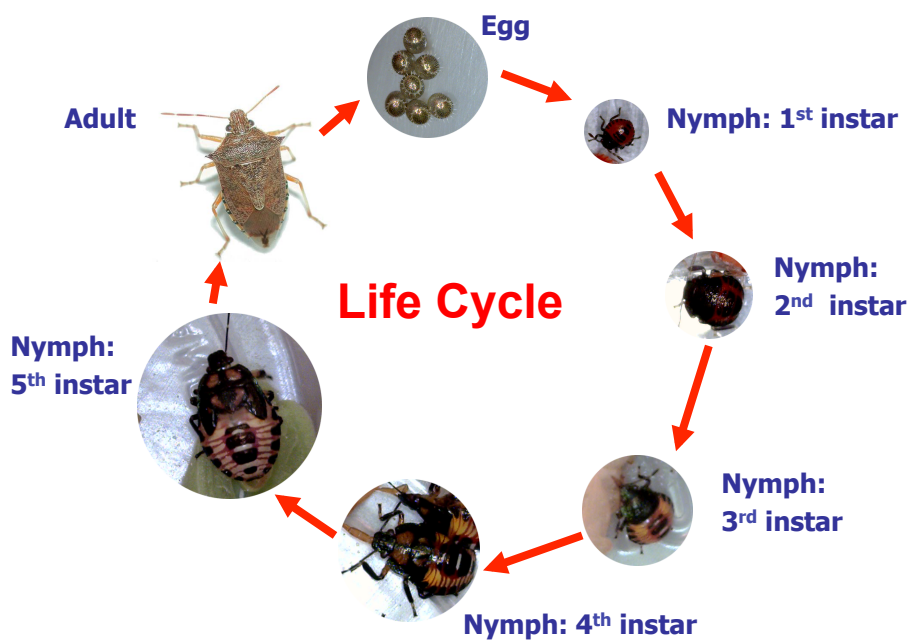




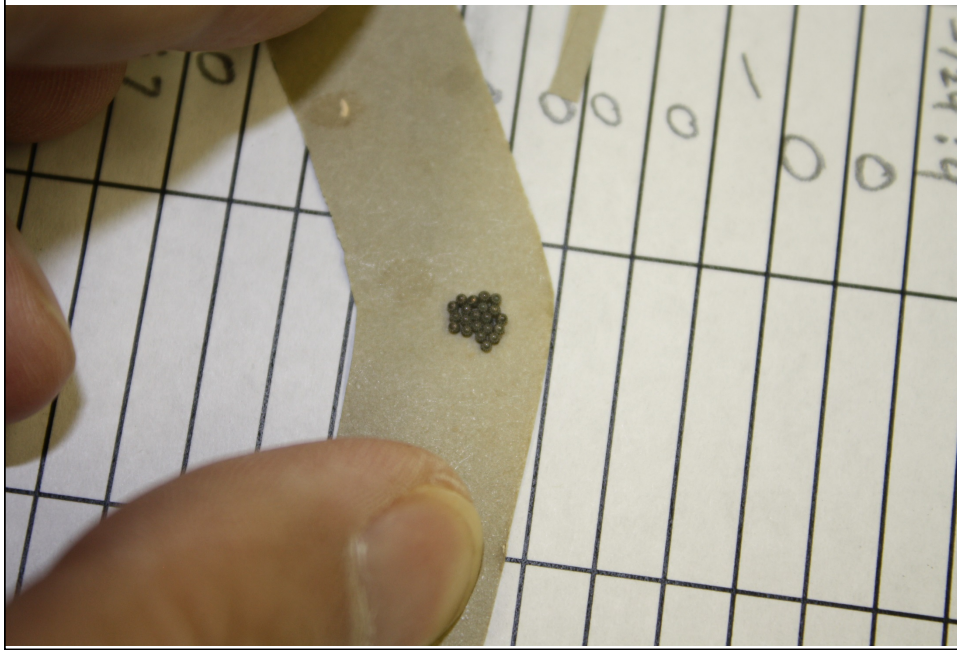
## Spined Solder Bug



## Spined Solder Bug



## Spined Solder Bug Eggs



## Spined Solder Bug Eggs

**Other stink bugs**



**Spined soldier bug**



### Spined Solder Bug Young Nymphs

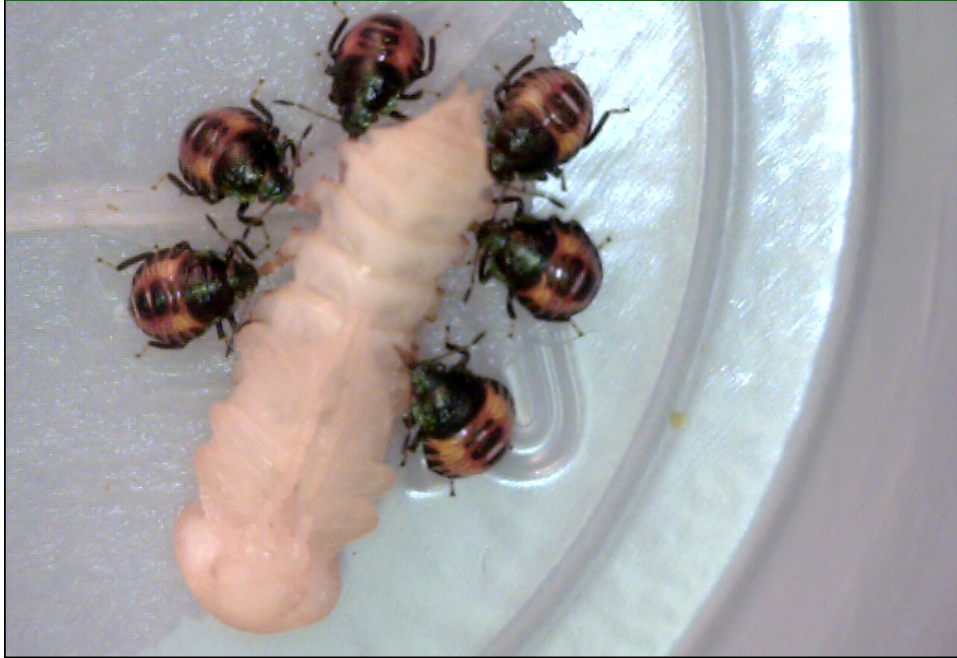


### Spined Solder Bug 1<sup>st</sup> and 2<sup>nd</sup> Instars





**Spined Solder Bug 3<sup>rd</sup> Instars**



**Spined Solder Bug 4<sup>th</sup> Instars**



### Spined Solder Bug 5<sup>th</sup> Instar and Adult



### Spined Solder Bug Adult Male and Female





## Spined Solder Bug



## Soldier Bug Feeding on BMSB Eggs





## Soldier Bug Feeding on BMSB Eggs



## Soldier Bug Feeding on BMSB Eggs



**Soldier Bug Feeding on BMSB 1<sup>st</sup> Instars**

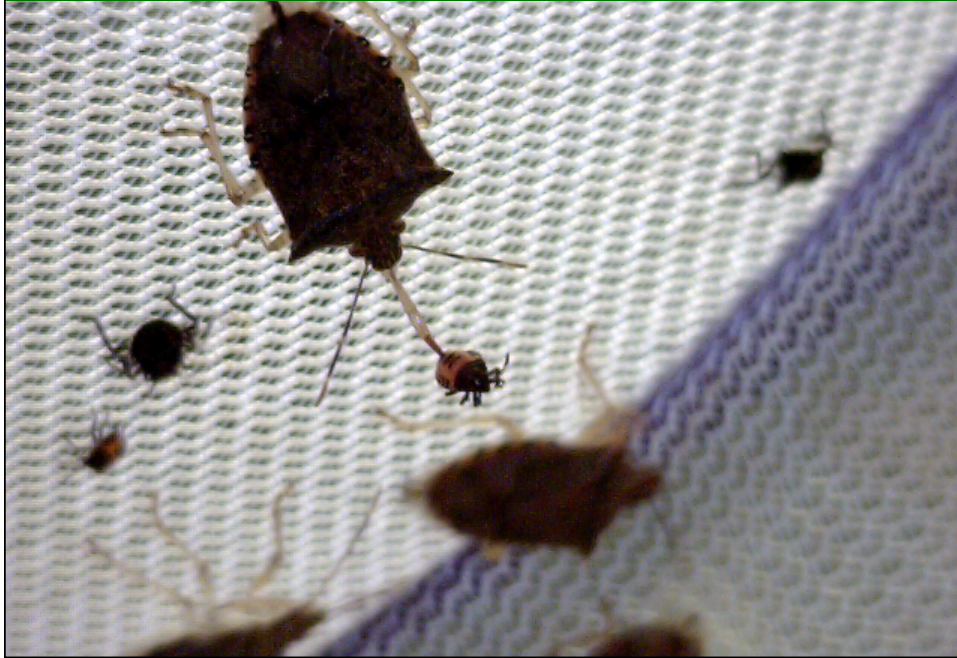


**Soldier Bug Feeding on BMSB 1<sup>st</sup> Instars**





**Soldier Bug Feeding on BMSB 1<sup>st</sup> Instars**



**Soldier Bug Feeding on BMSB 1<sup>st</sup> Instars**





**Soldier Bug Feeding on BMSB 2<sup>nd</sup> Instars**



**Soldier Bug Feeding on BMSB 2<sup>nd</sup> Instars**



### **Soldier Bug Feeding on BMSB 2<sup>nd</sup> Instars**



### **Soldier Bug Feeding on BMSB 5<sup>th</sup> Instars**

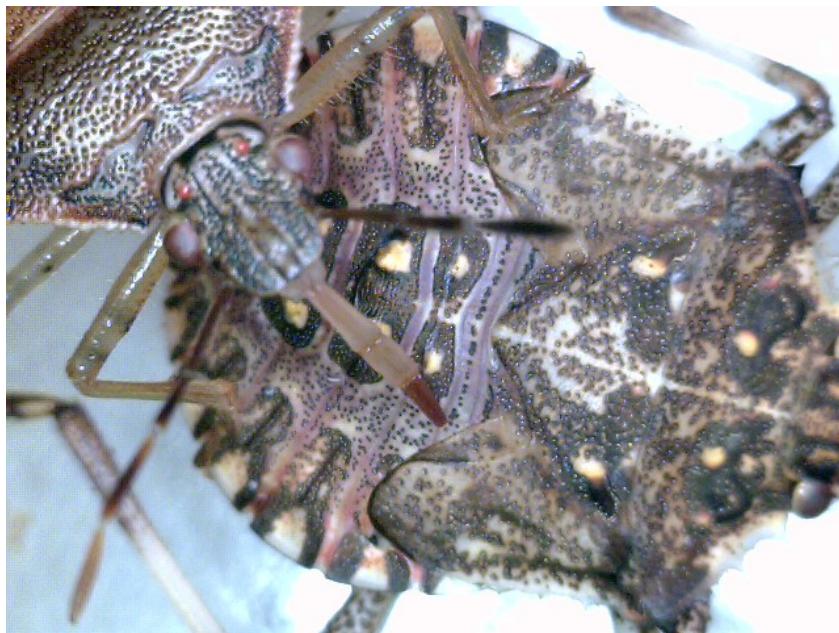




## **Soldier Bug Feeding on BMSB 5<sup>th</sup> Instars**

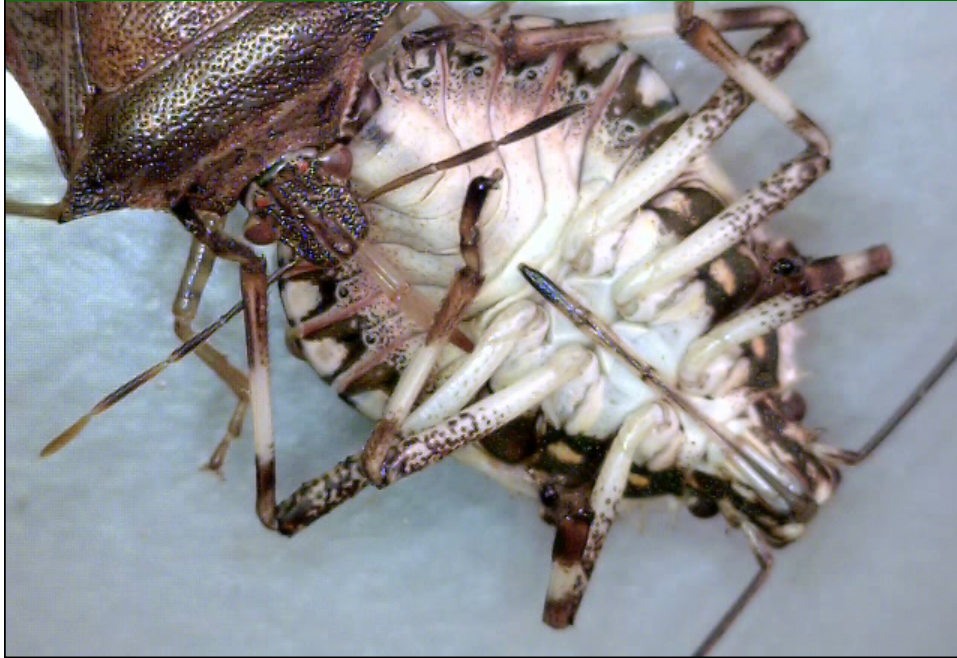


## **Soldier Bug Feeding on BMSB 5<sup>th</sup> Instars**





**Soldier Bug Feeding on BMSB 5<sup>th</sup> Instars**



**Soldier Bug Feeding on BMSB 5<sup>th</sup> Instars**



## Soldier Bug Feeding on BMSB adults



## Solder bugs for BMSB Control?

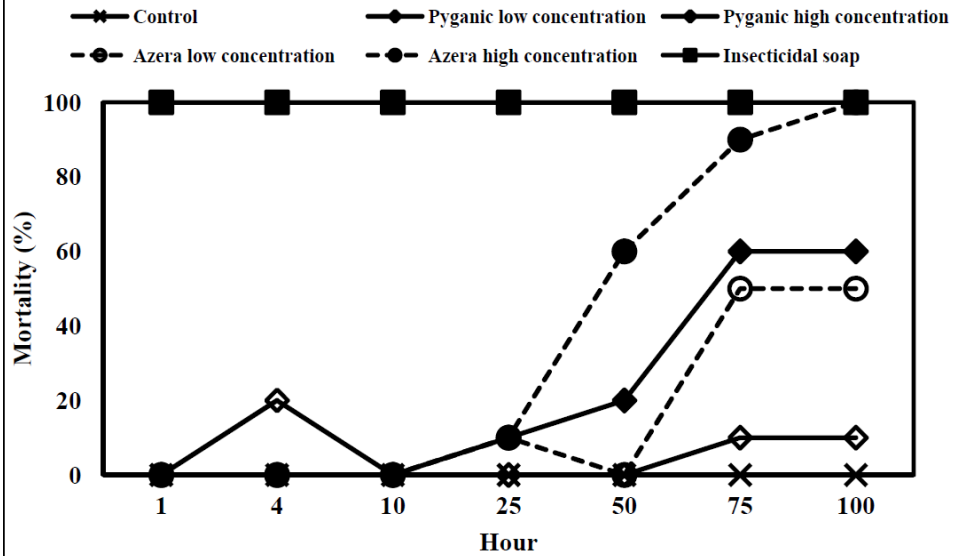
**Table 1:** Amount of weight loss (mean  $\pm$  SEM) of *T. molitor* by *P. maculiventris* feeding and feeding equivalency when the feeding amount by second instar is set as 1.00. Note that first instar is not predacious.

<i>P. maculiventris</i> stage	N	Weight loss of <i>T. molitor</i> per day (g)	Feeding equivalency
2 <sup>nd</sup> instar	30	0.003 $\pm$ 0.001 c*	1.00
3 <sup>rd</sup> instar	30	0.006 $\pm$ 0.002 c	1.83
4 <sup>th</sup> instar	30	0.019 $\pm$ 0.006 b	5.13
5 <sup>th</sup> instar	30	0.035 $\pm$ 0.011 a	9.45
Adult male	15	0.023 $\pm$ 0.010 ab	6.21
Adult female	15	0.021 $\pm$ 0.009 b	5.67

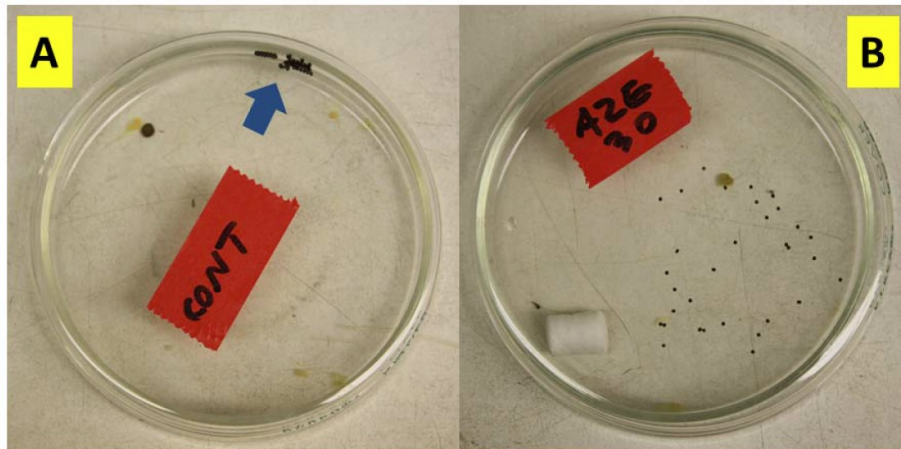
\* Mean weight loss followed by the same letters is not significantly different ( $P > 0.05$ ; Tukey's HSD test).

**Citation:** Gyawaly S, Park YL. Feeding Potential and Prey Acceptance of *Podisus maculiventris* (Hemiptera: Pentatomidae): Implications for Biological Pest Control. J Plant Biol Soil Health. 2013;1(2): 5.

## Solder bugs for BMSB Control?



## Solder bugs for BMSB Control?





## Solder bugs for BMSB control?

Can soldier bugs kill BMSB?

**Yes!**



*Florida Entomologist* 85(1)

March 2002

PREDATION BY *PODISUS MACULIVENTRIS* ON DIFFERENT  
LIFE STAGES OF *NEZARA VIRIDULA*

PATRICK DE CLERCQ<sup>1</sup>, KRIS WYCKHUYS<sup>1</sup>, HARLEY N. DE OLIVEIRA<sup>2</sup> AND JOHANNETTE KLAPWIJK<sup>3</sup>

## Solder bugs for BMSB control?

Can soldier bugs kill BMSB?

**Yes!**

Can soldier bugs effectively control BMSB?

**Limited control for immature BMSB**

Can soldier bugs be a key solution for BMSB control?

**Maybe not!**



**Two obstacles to overcome**

## Soldier bugs for BMSB control?

### Obstacle 1. Not readily available and expensive

SKU: 128

**Our Price: \$143.50**

Item

Quantity

**ADD to CART**

FREE SHIPPING in the contiguous 48 United States.

## Mass Rearing for Five Years @ WVU



## Development Time for Soldier Bugs

Stage	Temp. (°C)	<i>n</i>	Mean ± SE (days)	Median (days)	Survival (%)
Egg to adult	13.2	0	–	–	0.0
	18.4	20	53.5 ± 0.98a	52.305	6.1
	21.7	48	40.4 ± 0.36b	39.557	31.2
	23.7	56	27.6 ± 0.20c	26.982	29.6
	27.2	76	22.7 ± 0.18d	22.042	31.1
	32.7	84	21.5 ± 0.24e	20.814	8.6
	35.2	0	–	–	0.0
	40.6	0	–	–	0.0

<sup>a</sup> Means within a column for each stage followed by the same letter are not significantly different ( $P > 0.05$ ; Tukey's HSD test at 5 % error rate)

<sup>b</sup> No individual survived

## Simulation of Development of Soldier Bugs

**Survivorship**  $S(T) = k \times \exp\{-0.5 \times [\ln(T/T_m)/\rho]^2\}$

**Development distribution**  $f(x) = \frac{100}{1 + \exp[-\alpha(x - \beta)]}$

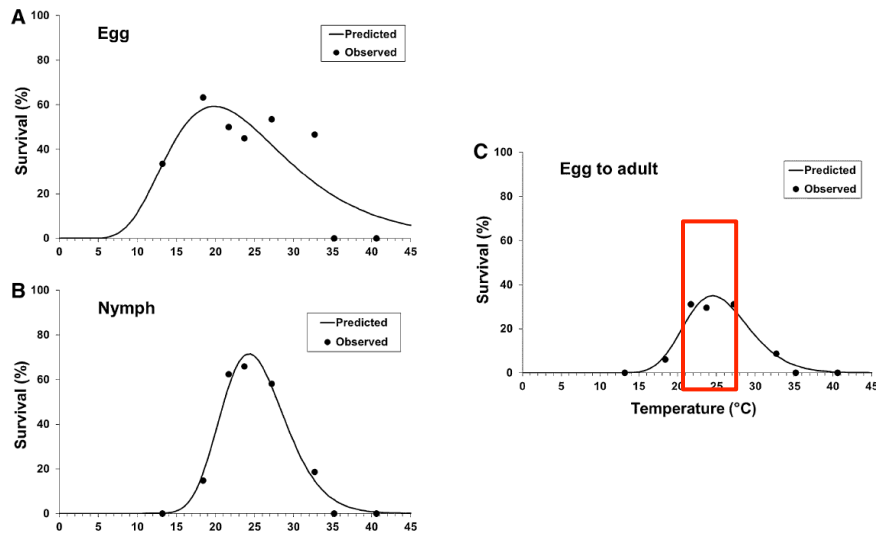
**Rate of development**  $R(T) = n \times T(T - T_b)(T_L - T)^{\frac{1}{m}}$

**Simulation**  $F(t, T) = \frac{N \times S(T)}{1 + \exp\{-\alpha[t \times R(T) - \beta]\}}$

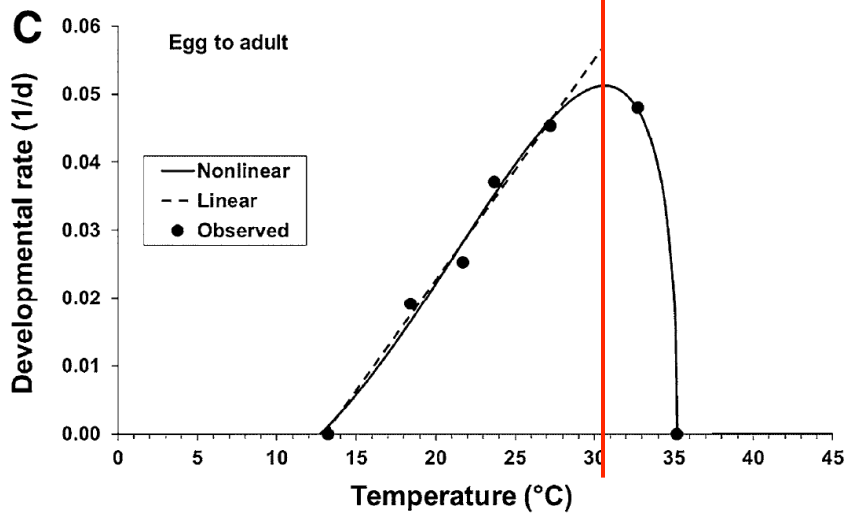
Temperature-dependent development and survival of *Podisus maculiventris* (Hemiptera: Pentatomidae): implications for mass rearing and biological control  
J Pest Sci (2014) 87:331–340



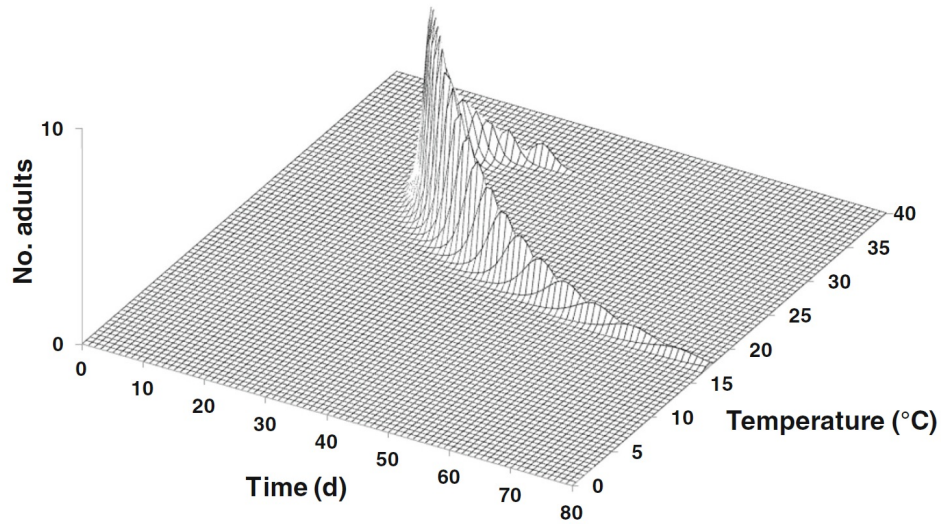
## Temperature-Dependent Survivorship



## Temperature-Dependent Development



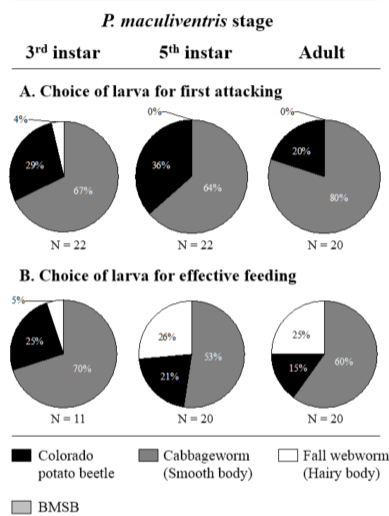
## Simulation of Development



*24.5°C for highest survival and 30.6°C for fastest development*

## Soldier bugs for BMSB control?

### Obstacle 2. They are generalist predators

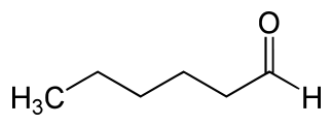


## Attracting Soldier Bugs



## Attracting Soldier Bugs

### Aggregation pheromones



(E)-2-hexanal





## Aggregation Pheromones

Pheromones are commercially available



## Spatial Relocation of Soldier Bugs

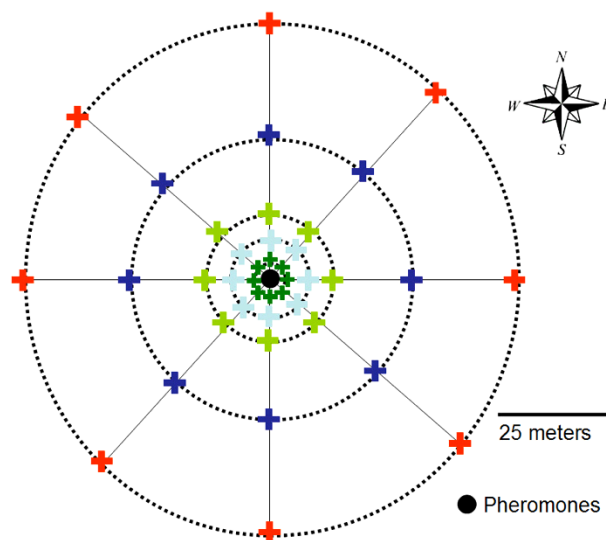
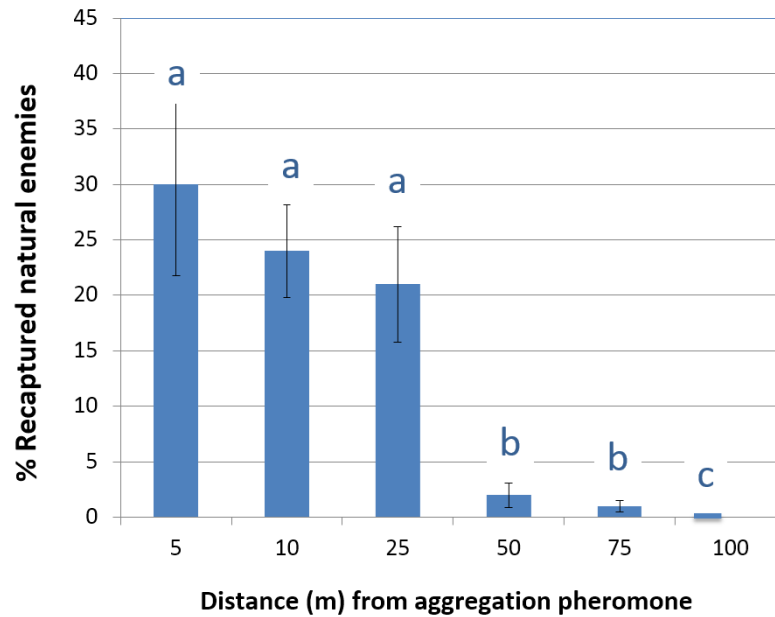


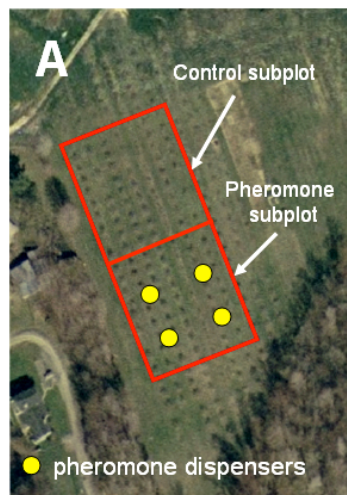
Fig. 1. Spatial layout of natural-enemy releasing locations (⊕).

## Spatial Relocation of Soldier Bugs

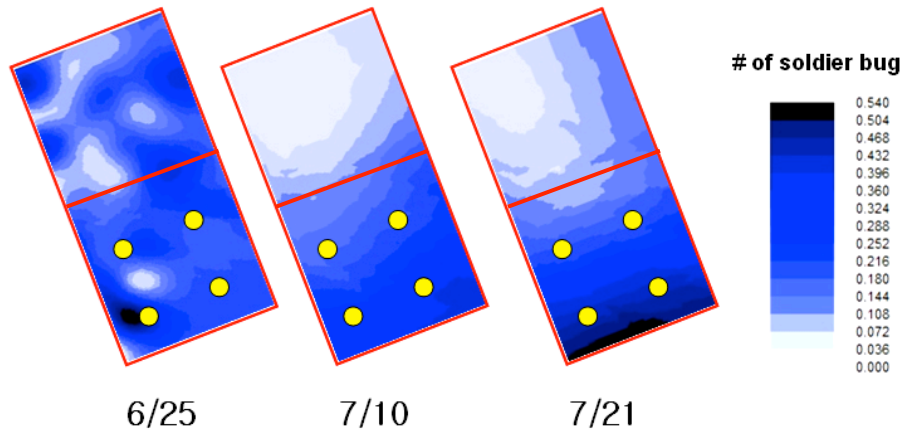


## Spatial Relocation of Soldier Bugs

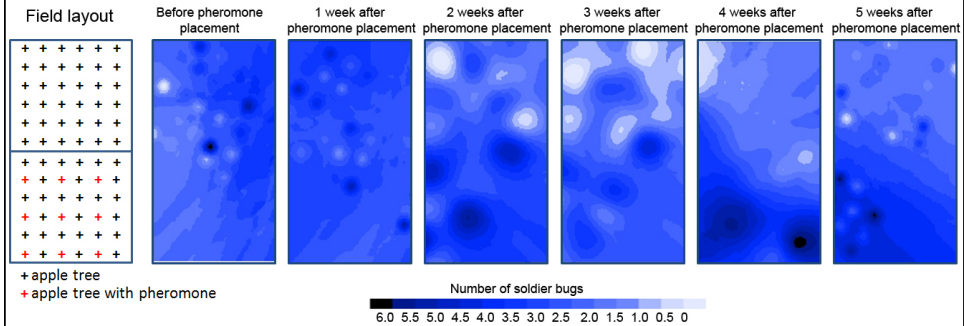
### Using aggregation pheromone



## Spatial Relocation of Soldier Bugs



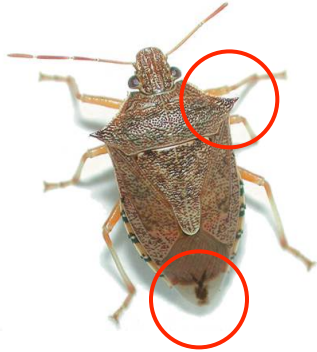
## Spatial Relocation of Soldier Bugs





## Take-Home Message

### Spined soldier bug



*Correct identification*

*Generalist predator*

*Control immature BMSB*

*Attracting using pheromone*

*Pesticide susceptibility*

## Acknowledgement

### Funding Sources

- USDA NIFA OREI
- WV Specialty Crop Block Grant
- State Horticulture Association of PA

# Stink Bugs

