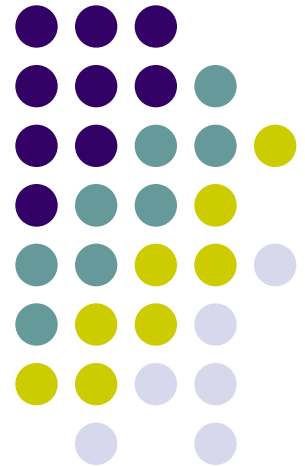


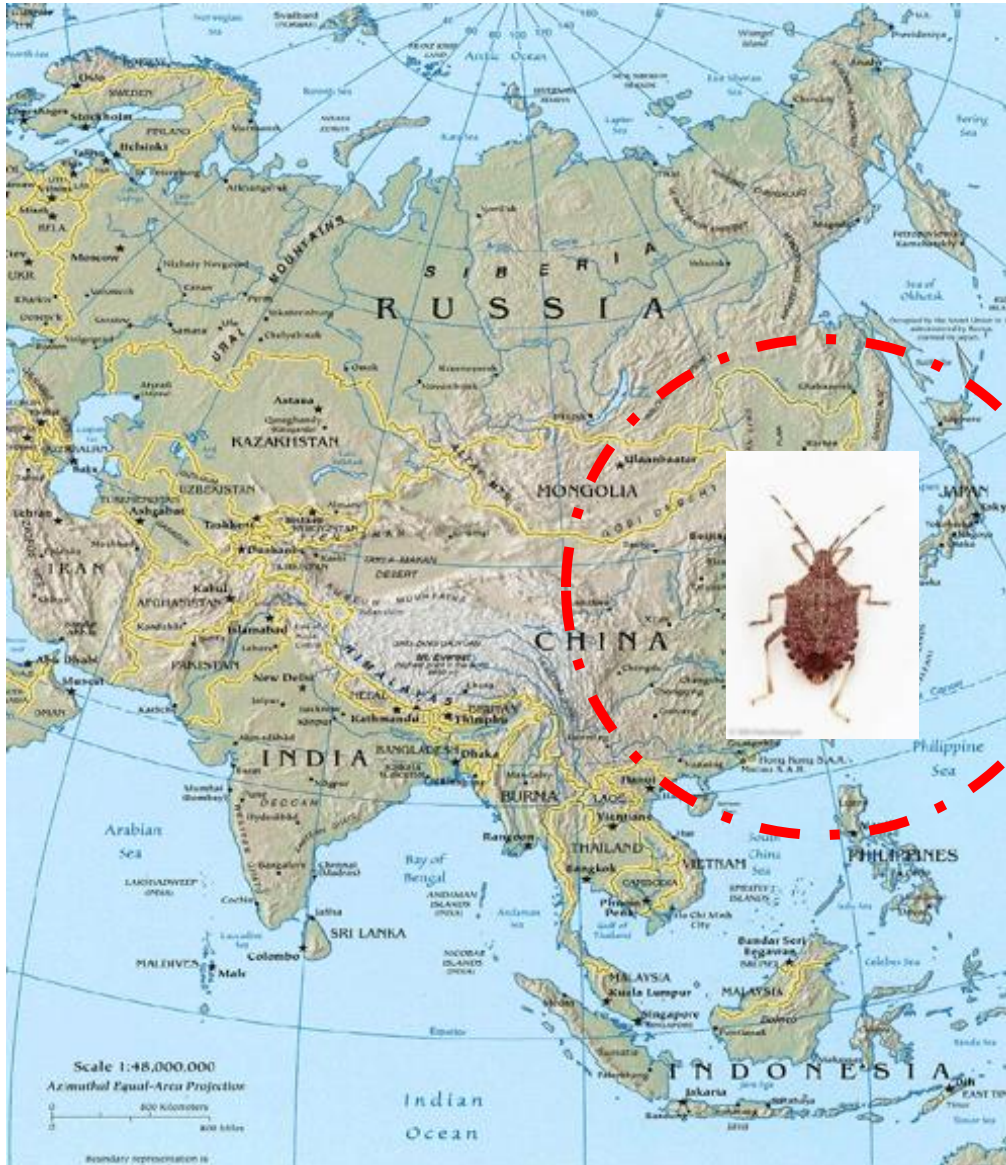
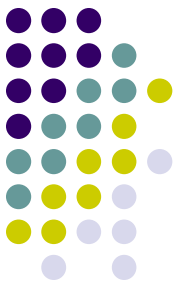
Development of Behaviorally Based Monitoring Tools and Management Strategies for the Brown Marmorated Stink Bug



Tracy C. Leskey
USDA-ARS
Appalachian Fruit Research Station
Kearneysville, WV 25430 USA

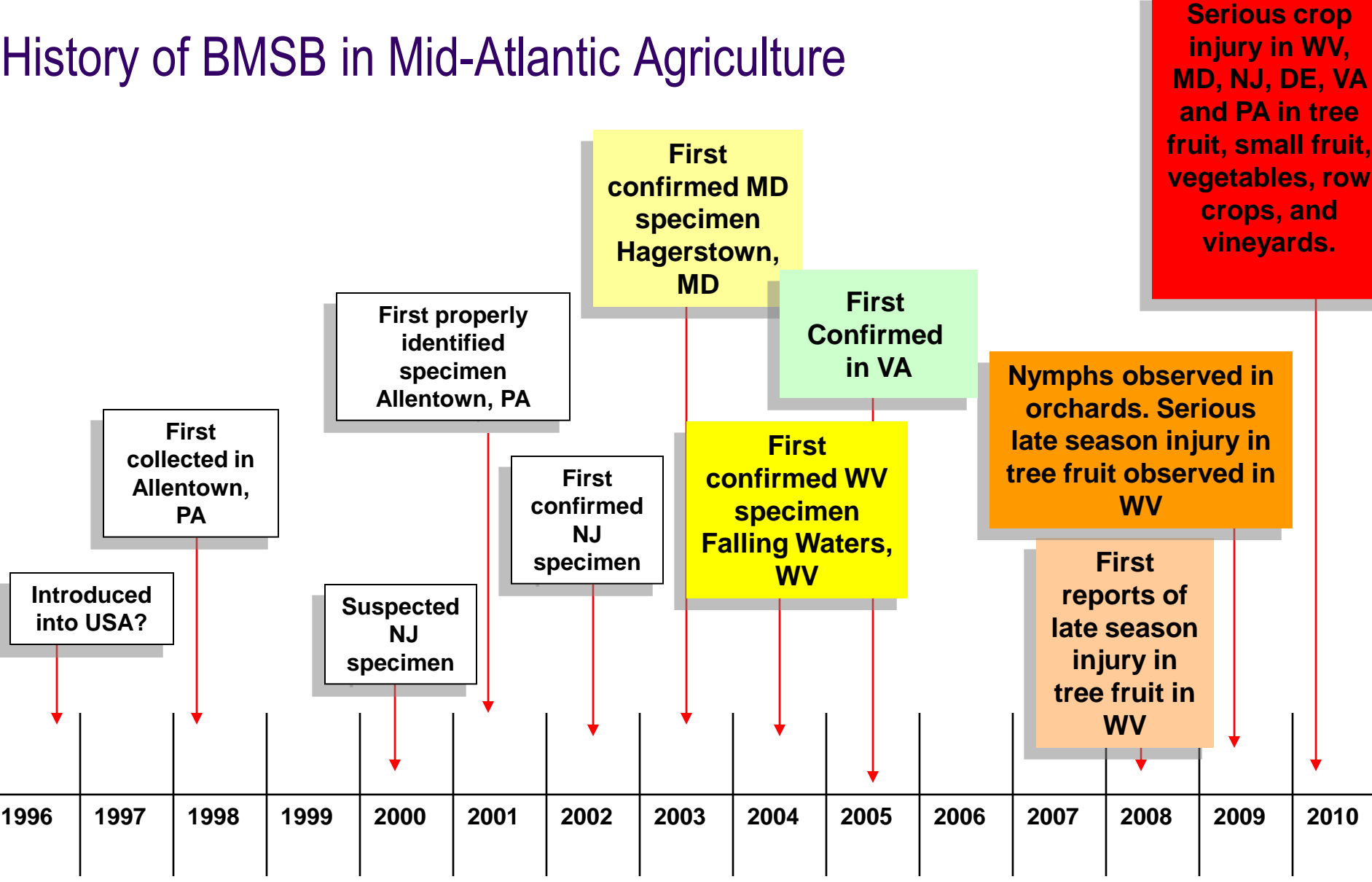


Brown Marmorated Stink Bug is an Invasive Species

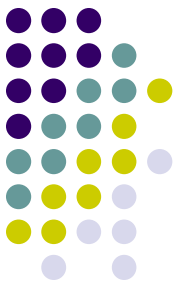


- Native to China, Japan, Korea, and Taiwan.
- Generally considered a minor agricultural and nuisance pest with occasional outbreaks.

History of BMSB in Mid-Atlantic Agriculture



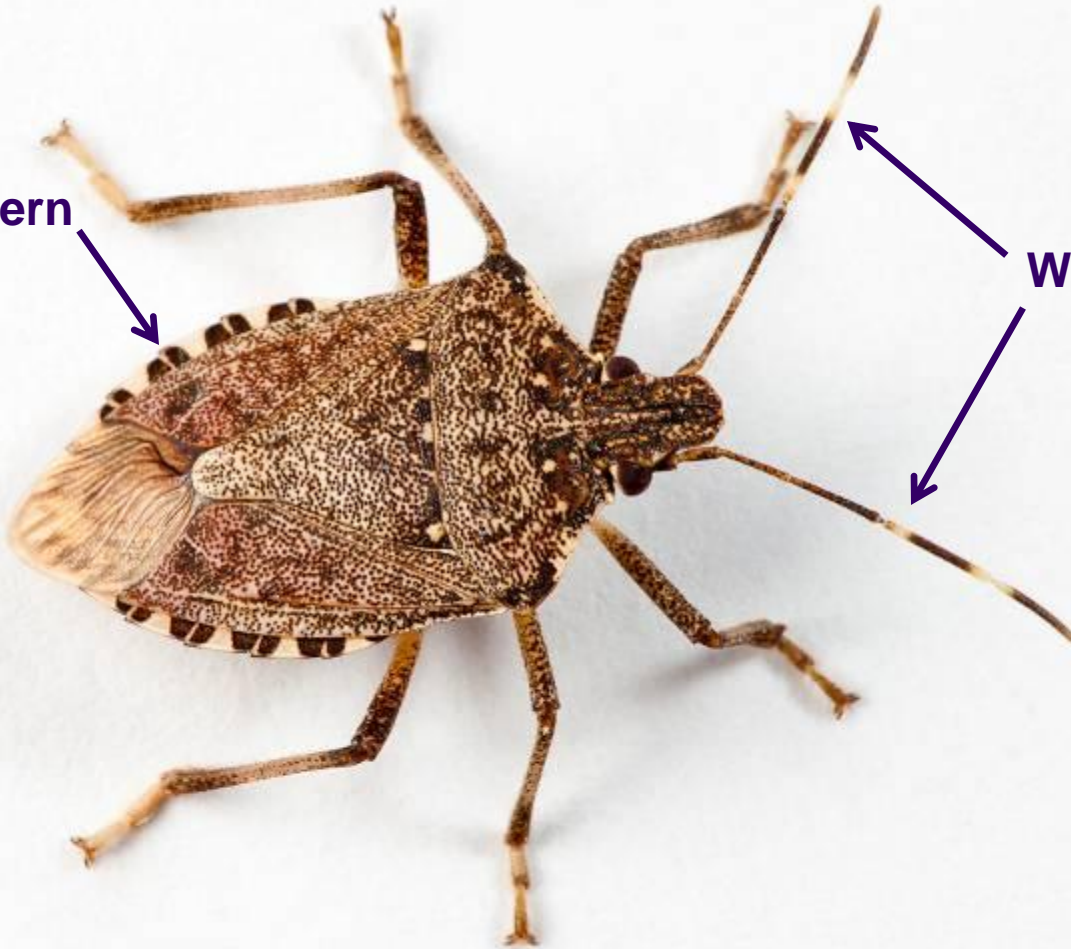
Identification

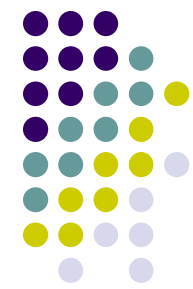


Marbled pattern



White bands





Threat Posed By Brown Marmorated Stink Bug To Commercial Tree Fruit and Other Crops

- Season-long threat to commercial tree fruit. Persistent movement into orchard blocks from other cultivated crops and wild hosts.
- Both adults and nymphs feed on the fruit.
- Reproduction can occur within commercial orchards.



Egg Mass



1st



2nd

3rd

4th

5th

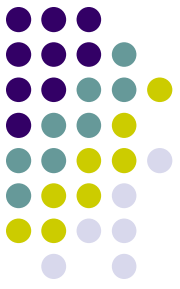


Male

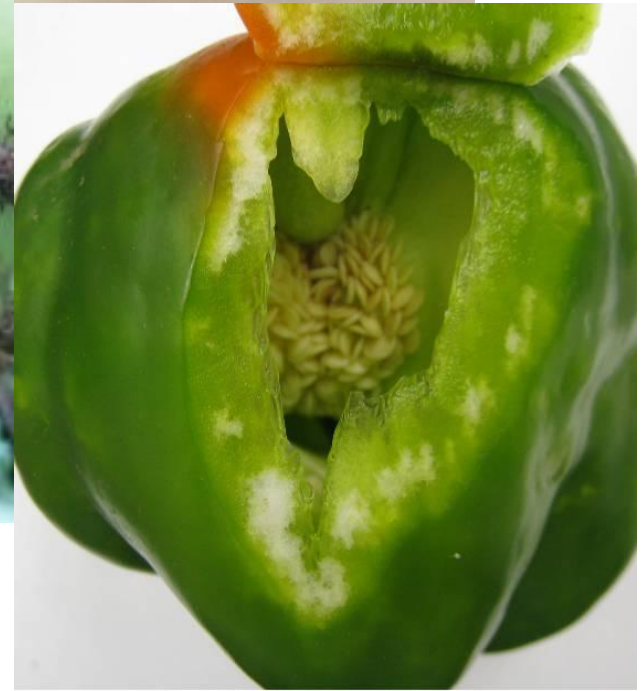
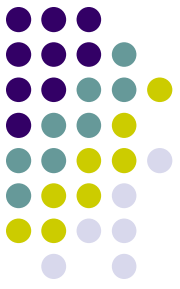


Female

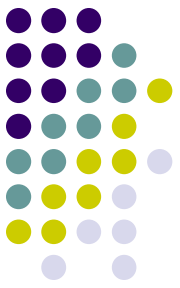
Orchard Crops



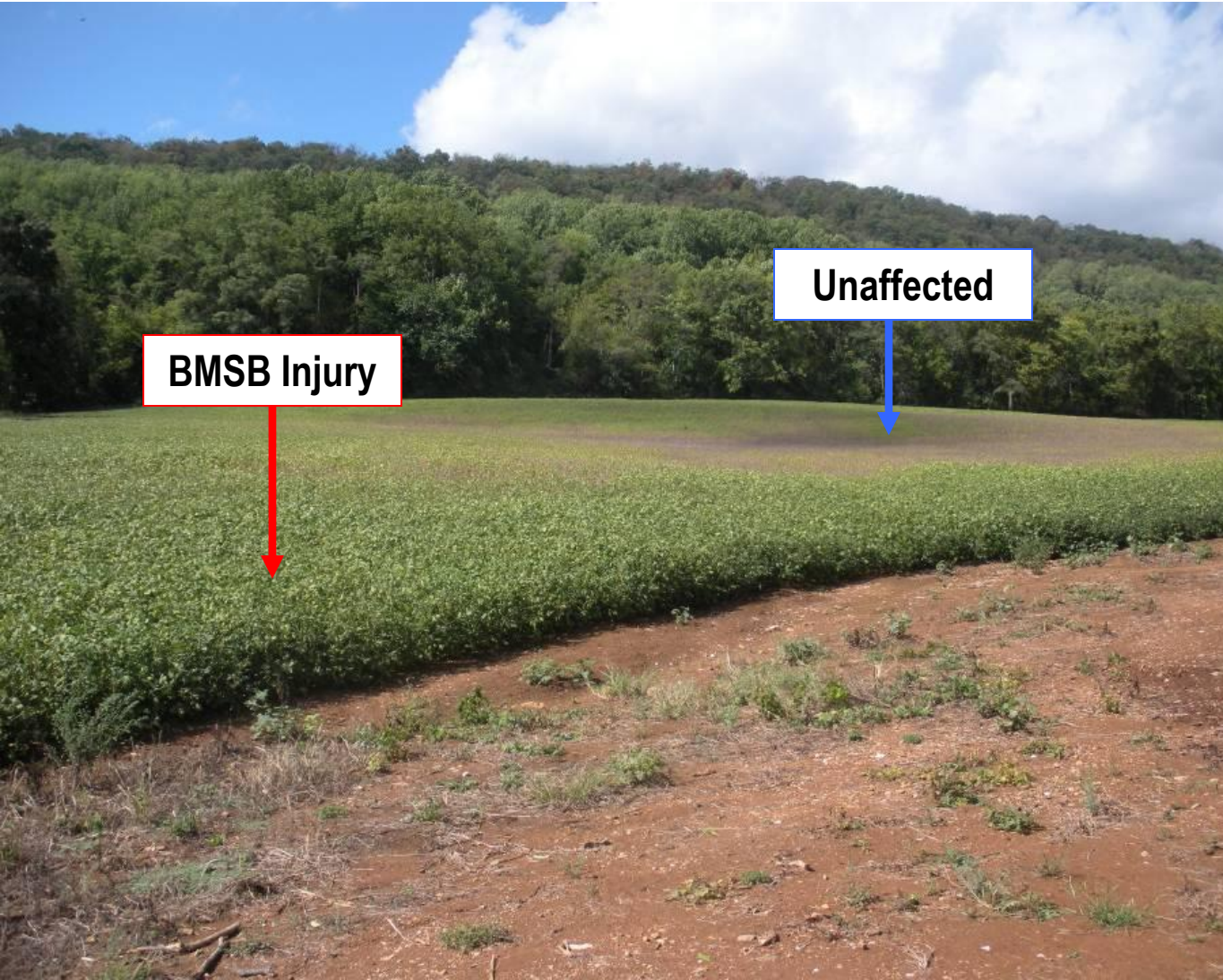
Vegetables



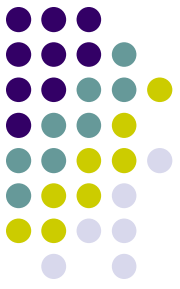
Small Fruit and Grape



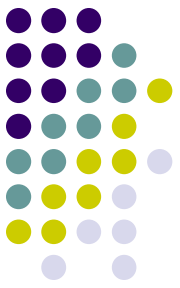
Row Crops



Ornamentals and Nursery Crops



Threat To Commercial Tree Fruit



① EARLY SEASON →

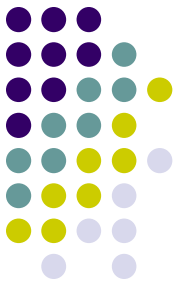


② SEASON LONG →



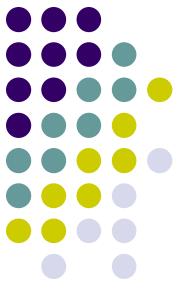
③ LATE SEASON - POST HARVEST →





Development of a Behaviorally Based Monitoring Tools for BMSB

- No established monitoring tool for BMSB.
- Growers need a tool that allows them to detect presence, abundance, and seasonal activity.
- Used to make informed management decisions.



Development of a Behaviorally Based Monitoring Tool for BMSB

- **Visual Cues**
- **Olfactory Cues**
- **Capture Mechanism**
- **Deployment Strategy**



2009-2010 BMSB Response to Visual Stimuli

Black

Green

Yellow

White

Clear



Trunk
Mimic

Foliar
Stimulus

Foliar
Stimulus

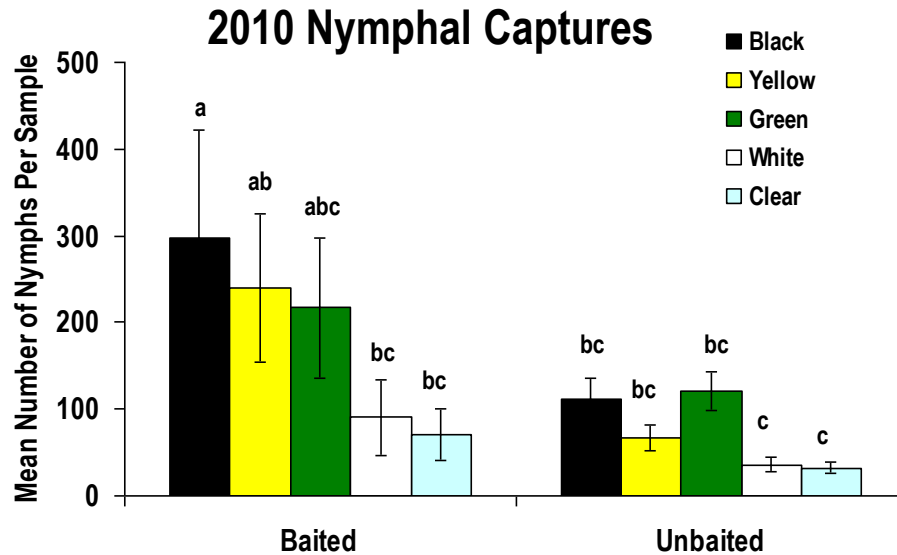
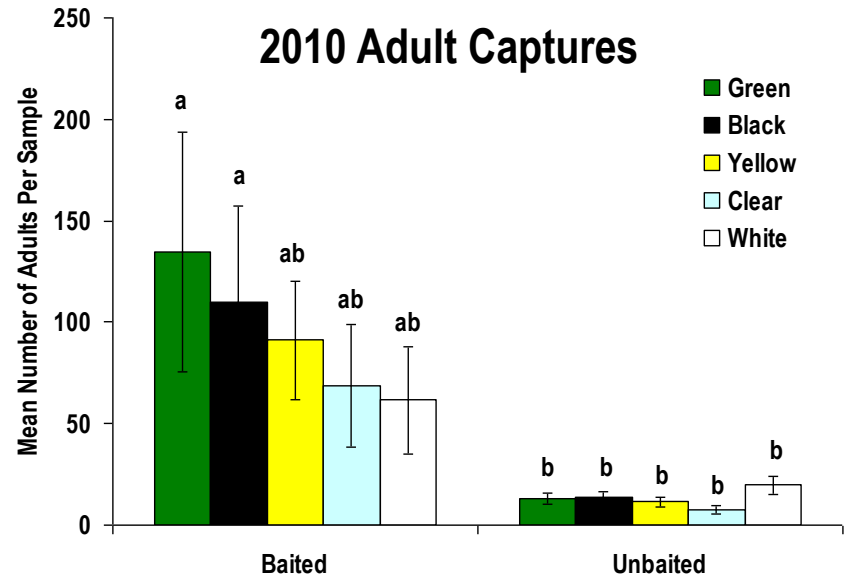
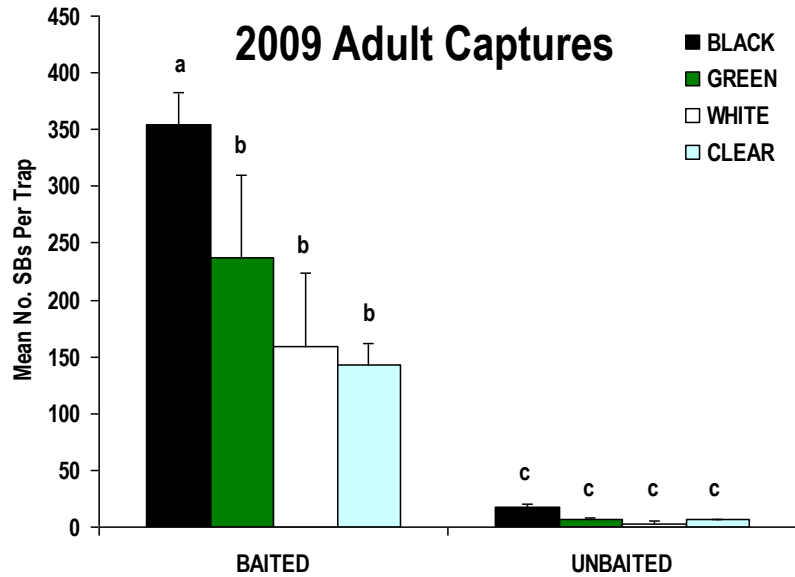
Unapparent
Stimulus

Unapparent
Stimulus

- Responses to visual stimuli associated with trap bases.
- Baited and unbaited traps at the periphery of orchards.
- Lure or bait is a known attractant for BMSB but with limitations. Methyl (2E, 4E, 6Z)-decatrienoate.



Baited Black Pyramid Traps Performed Best



Comparisons of Capture Mechanism and Deployment Strategies

- = ground deployment
- = canopy deployment
- = visual cue



CBC America, Japan

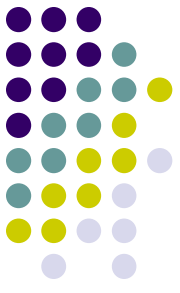


Sankei Chemicals Co., Ltd., Kagoshima, Japan

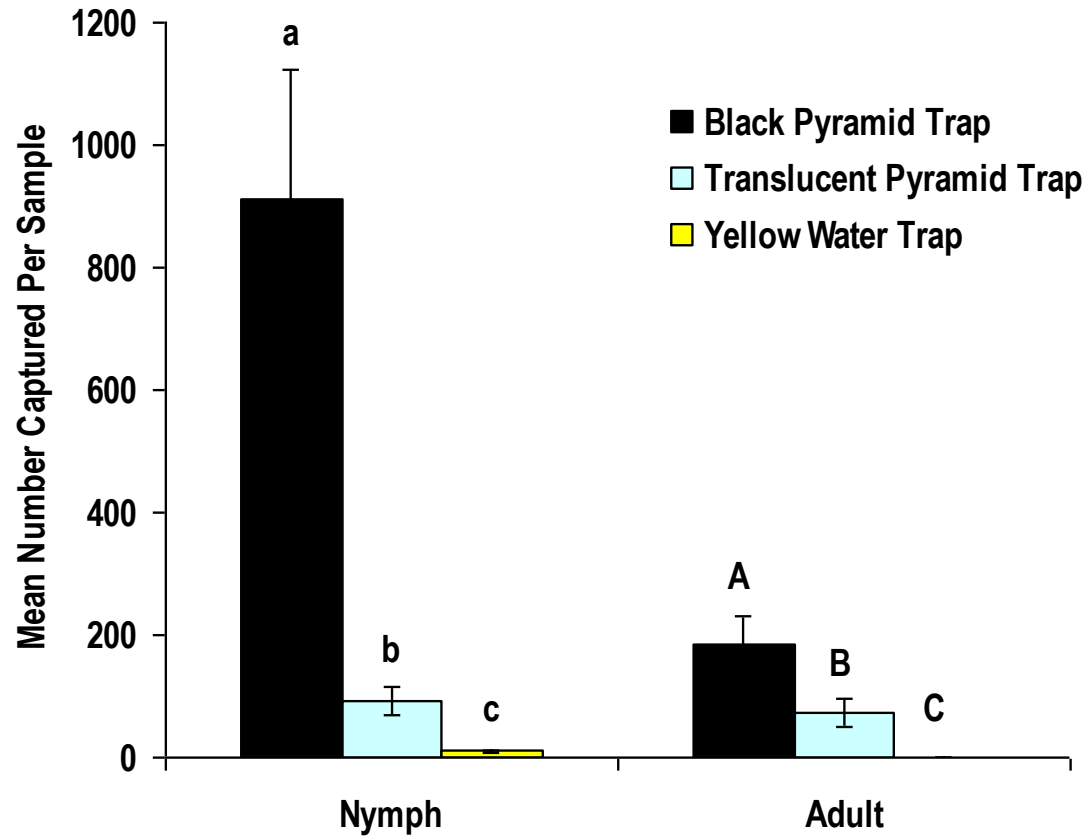


AFRS

- **Comparison with commercially available traps.**
- **Deployed in perimeter row of a pear orchard. Three replicates. Sampled twice weekly from August 2-September 30, 2010.**



Trap Type Results





Monitoring Adult and Nymphal Populations in 2011

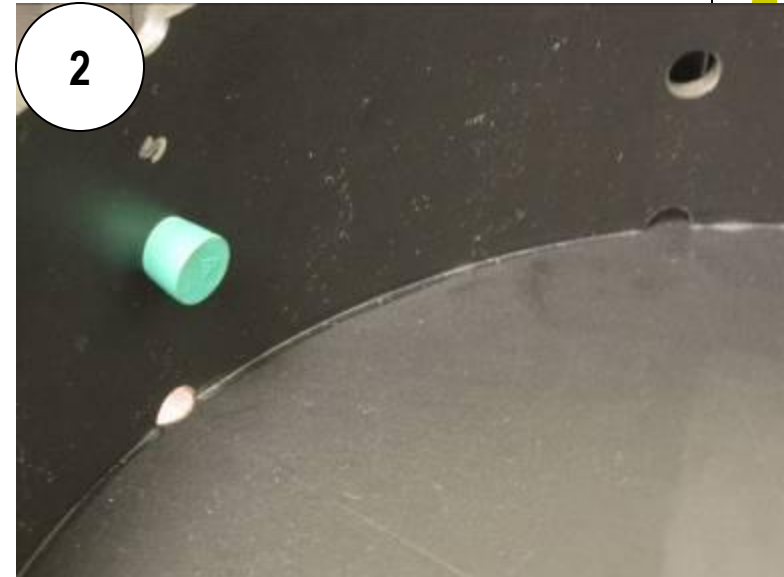
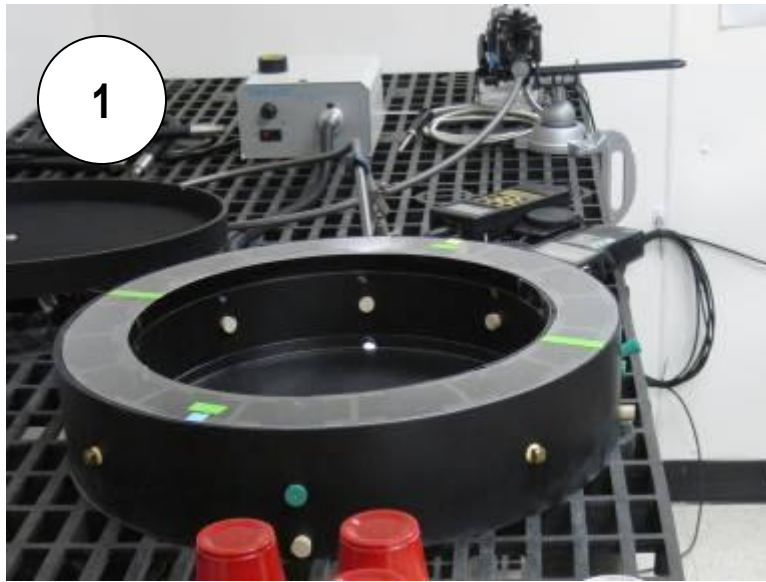
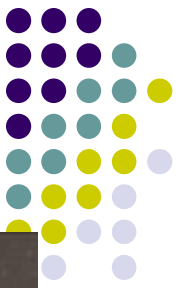
- **Black pyramid traps have been deployed in commercial orchards.**
- **Deployed in border row between trees.**
- **Baited with 66 mg lures of methyl (2E, 4E, 6Z)–decatrienoate. Known attractant with limitations.**
- **Monitoring 10 commercial orchards.**
- **Deployed throughout the mid-Atlantic, New England, Great Lakes / Mid West, and West Coast.**

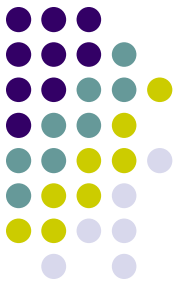


Can We Improve Our Monitoring Traps?



Bioassay Designed to Identify Optimal Wavelengths and Intensities of Light





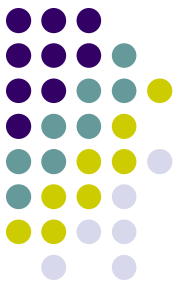
Trial One - Simple Choice Study

Light Intensity

- Release single individuals into center of arena.
- Treatments include sex and light intensity.
- Light Intensity (Indirect Light, Fixed Full Spectrum)

| | |
|-------------------|----------------------------|
| ● 0 Lux (Control) | <i>Darkness</i> |
| ● 100 Lux | <i>Fixed Full Spectrum</i> |
| ● 200 Lux | |
| ● 400 Lux | |
| ● 800 Lux | |
| ● 1600 Lux | |

- Trial duration up to 15 minutes.
 - Treatment Zone
 - Remain in Release Zone

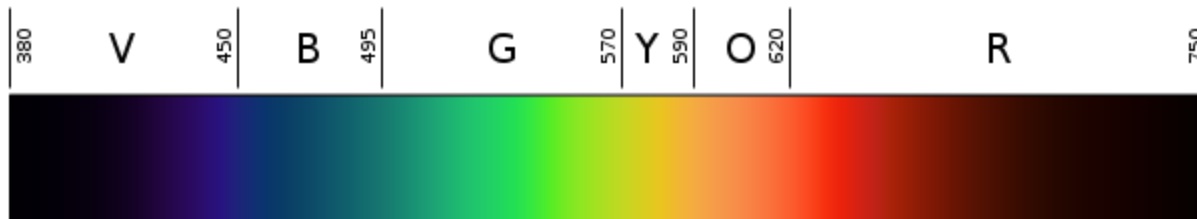


Trial Two -Simple Choice Study

Wavelength

- Release single individuals into center of arena
- Treatments – Wavelength (Indirect Light, Fixed Intensity)

- | |
|--|
| ● Full Spectrum |
| ● 320 nm, Long Pass Filter (Ultraviolet and above) |
| ● 400 nm, Long Pass Filter (Visible Light, Purple and Above) |
| ● 495 nm, Long Pass Filter (Visible Light, Blue and Above) |
| ● 610 nm, Long Pass Filter (Visible Light, Yellow and Above) |
| ● Control |



Identification of Aggregation Pheromone



Tentative Conclusions



- **Dark ground-deployed pyramid trap appears to be visually stimulating. Capture mechanism works well because both nymphs and adults have a tendency to walk up surfaces.**
- **Nymphs attracted to baited traps season-long. Adults more strongly attracted late-season.**
- **Need for a season-long attractant. Identification of true BMSB aggregation pheromone is critical.**
- **Augment trap designs with specific wavelengths and intensities of light to improve overall sensitivity and specificity.**

Challenges in Managing BMSB in Commercial Plantings



- Tremendous season-long pressure from populations moving from wild and other cultivated hosts into cropped areas leading to constant re-infestation of plots.
- Greatest efficacy observed when adults have direct contact with finished wet spray material. Only a small portion of damaging population likely exposed to this material.
- Avoidance behaviors allow them to potentially escape treatments.
- Insecticides labeled as excellent against native SBs not showing same field efficacy against BMSB. Knock down and recovery observed in grower orchards. Other materials were ineffective.

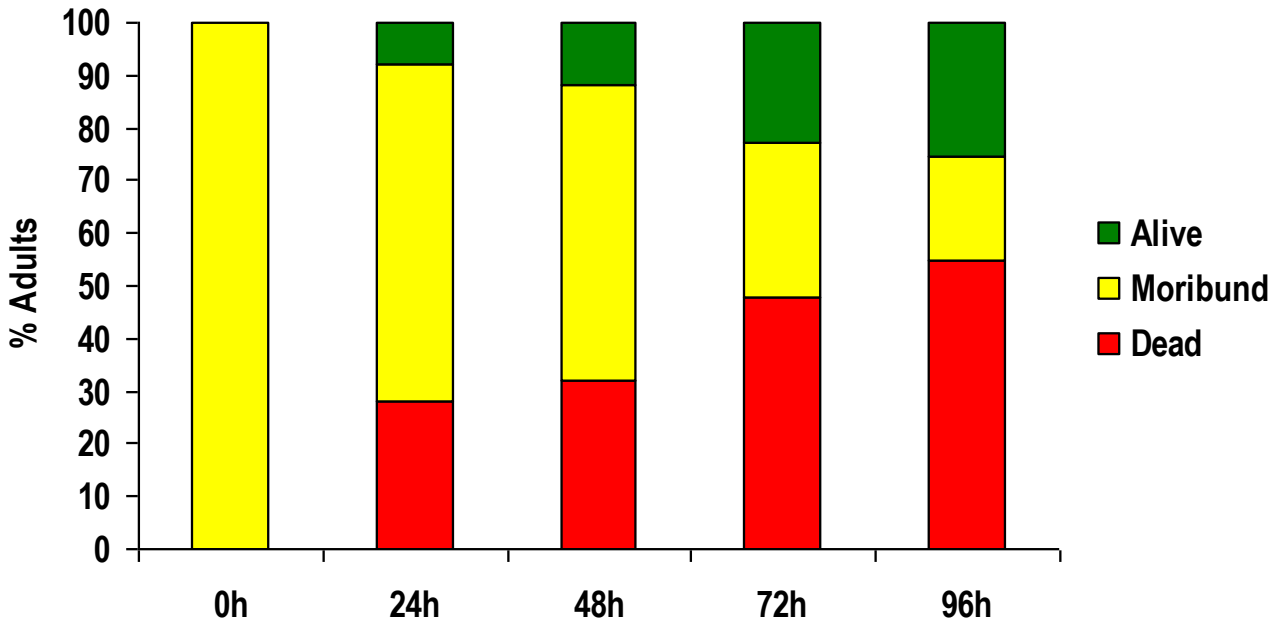
Knock Down and Recovery



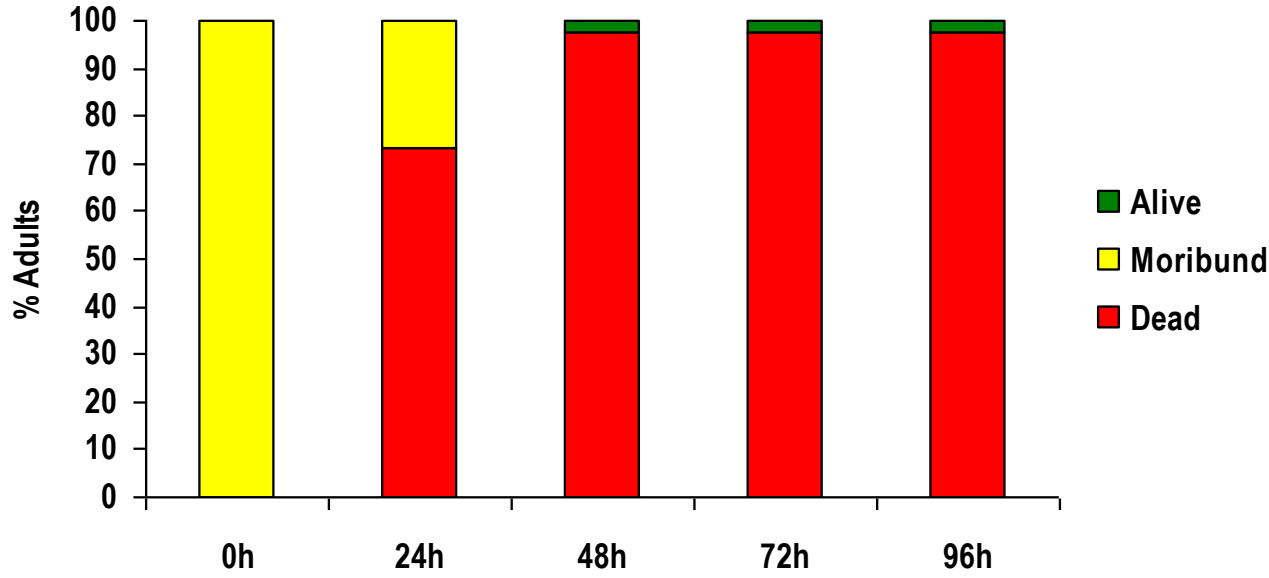
- Treated 1-acre plots with Tombstone or Vydate.
- Recovered bugs from 1x1 meter square plots beneath the canopy of treated trees.
- 8 replicates.
- Followed mortality.

Results

Tombstone
(cyfluthrin)
2.8 oz per acre
4 contiguous rows
(1 acre)
N=75



Vydate
(oxamyl)
3.0 pints per acre
4 contiguous rows
(1 acre)
N=78



Laboratory-Based BMSB Insecticide Evaluations

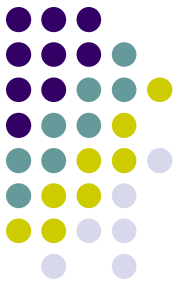
USDA-ARS-AFRS



- Constant (season-long) pressure from outside orchards continuously re-infests plots.
- Immigrating/emigrating adults are unlikely to encounter direct contact with finished (wet) spray material. This population poses the **primary threat** to tree fruit orchards.
- Control of this population depends on sustained effectiveness of residue. Laboratory insecticide trials designed to be biologically relevant and based on control of this primary threat.

BMSB Toxicity Testing

Material and Rate Selections



Pyrethroids

Bifenthrin
Fenpropathrin
Permethrin
Gamma-Cyhalothrin
Beta-Cyfluthrin
Lambda-Cyhalothrin
Zeta Cypermethrin
Cyfluthrin
Esfenvalterate

Organophosphates

Dimethoate
Malathion
Methidathion
Chlorpyrifos
Acephate
Azinphosmethyl
Diazinon
Phosmet

Neonicotinoids

Dinotefuran
Thiamethoxam
Clothianidin
Imidacloprid
Acetamiprid
Thiacloprid

Other Classes

Endosulfan
Zinc Dimethyldithiocarbamate
Tolfenpyrad (SC and EC)
Pyrifluquinazon
Kaolin Clay
Abamectin
Indoxacarb
Spirotetramat
Flonicamid
Cyantraniliprole

Carbamates

Methomyl
Formetanate HCl
Oxamyl
Carbaryl

Biopesticides

MBI-203
MBI-205
MBI-206
Pyganic

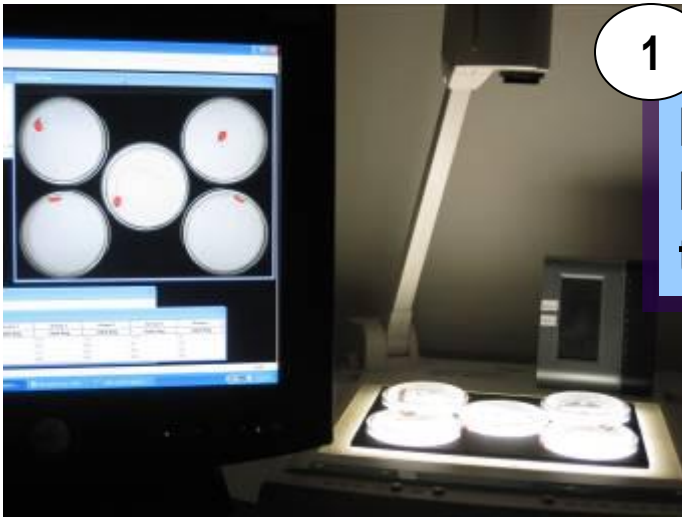
Combination Materials

Chlorpyrifos+
Gamma-Cyhalothrin

Kaolin Clay+
Thiamethoxam

Concentrations of insecticide per unit carrier (water alone) determined based on application of 100 gallons per acre, applied at field volume.

Experimental Trials



1

EthoVision trials for measuring horizontal mobility on insecticide-treated surfaces.

2

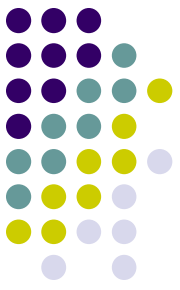
Direct observations of vertical movement capacity following insecticide exposure.



3

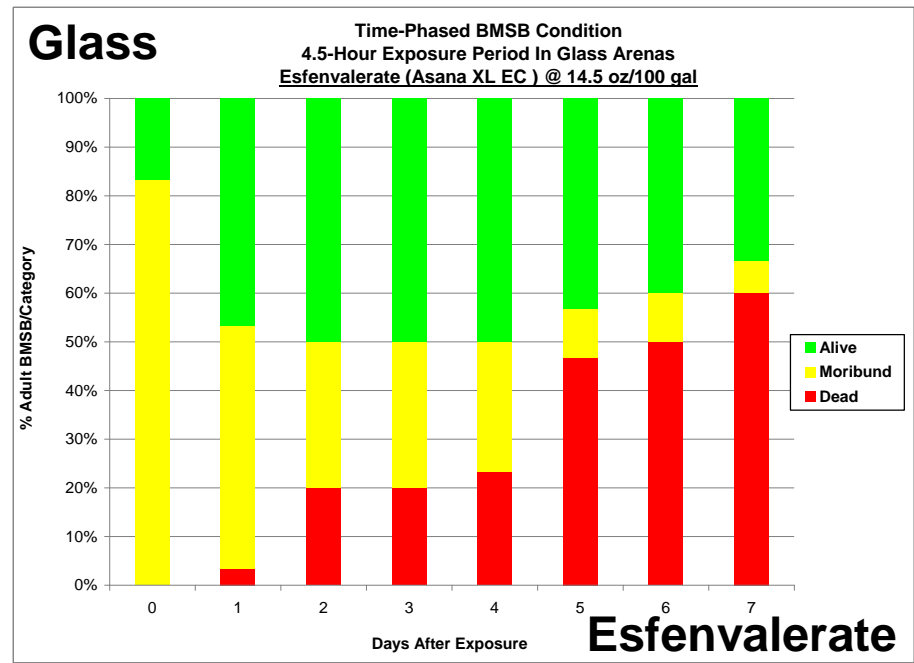
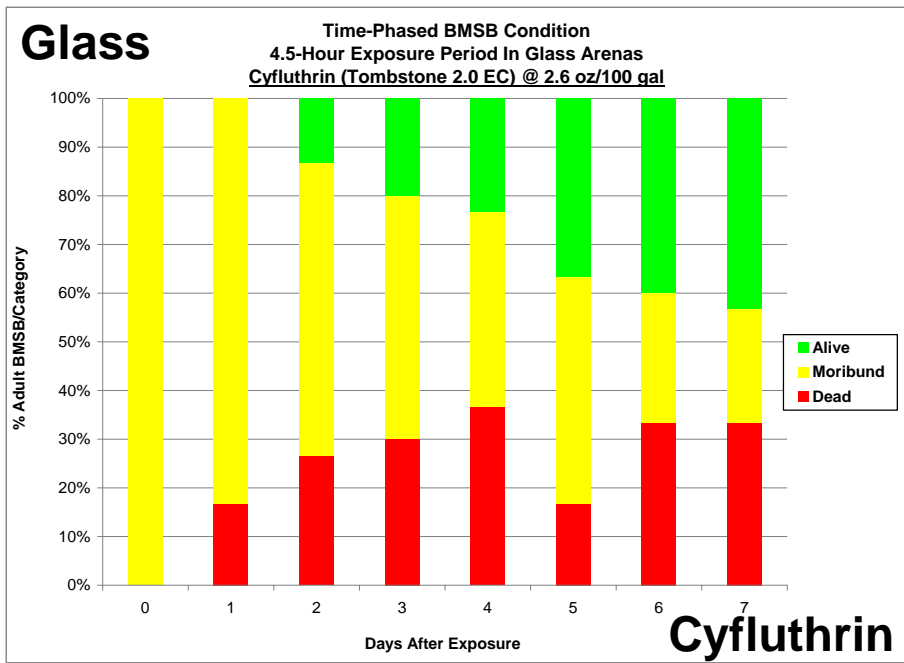
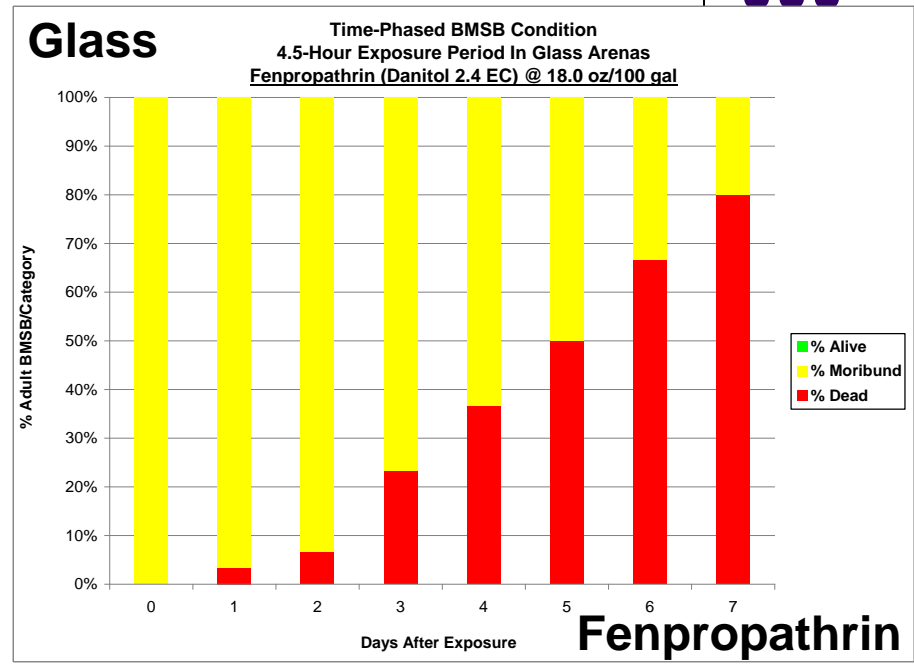
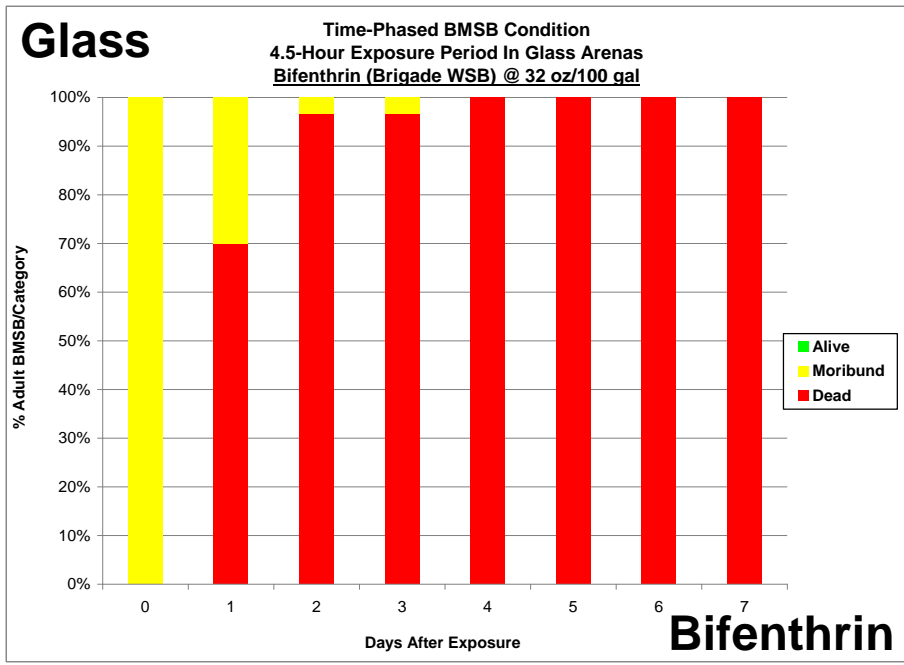
Mortality tracked for 7-d followed by final vertical movement trial.

Overall Lethality



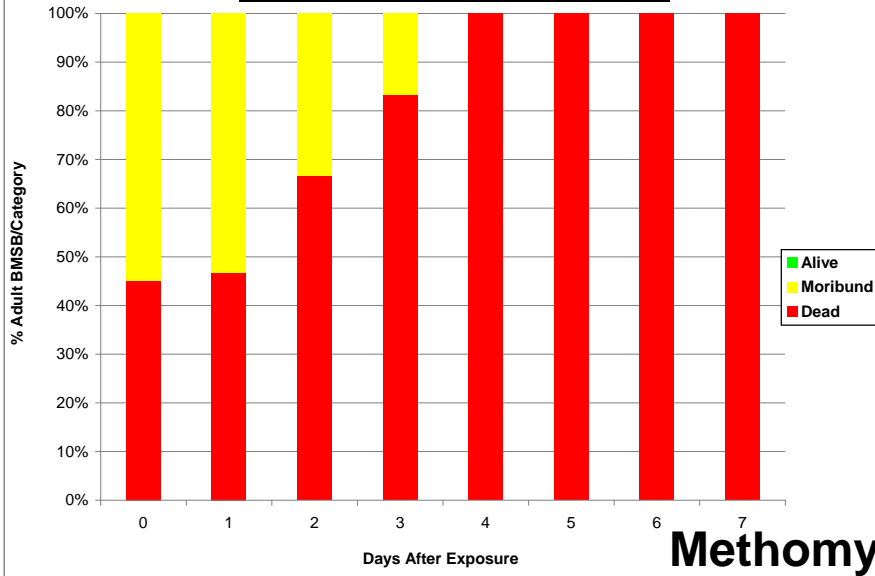
- Individual adults placed in cup with food and water.
- Condition recorded for 7 consecutive days (alive, moribund, dead)
- Two Prolonged Examinations
 - How quickly does toxicant take hold?
 - How profound are exposure effects?





Glass

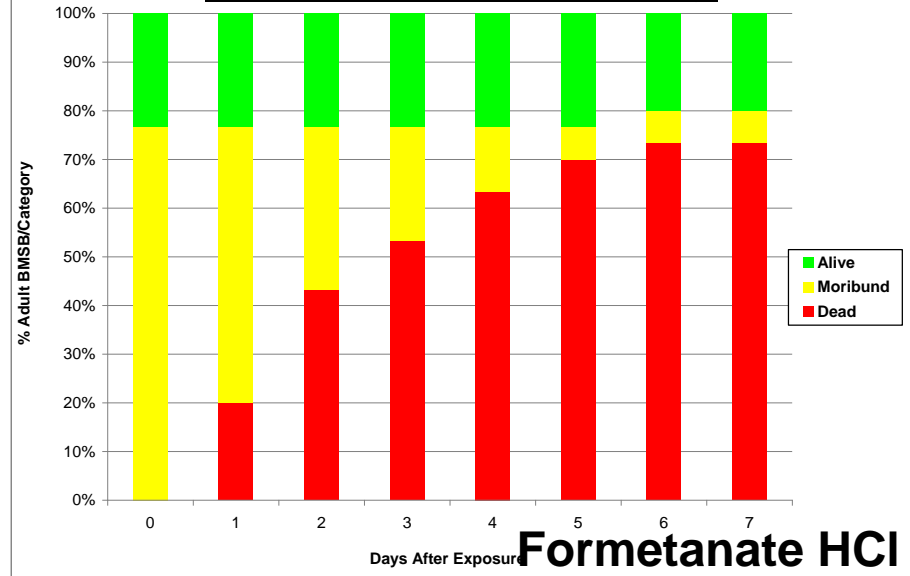
Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Methomyl Combined (Lannate SP) @ 1 lb/100 gal



Methomyl

Glass

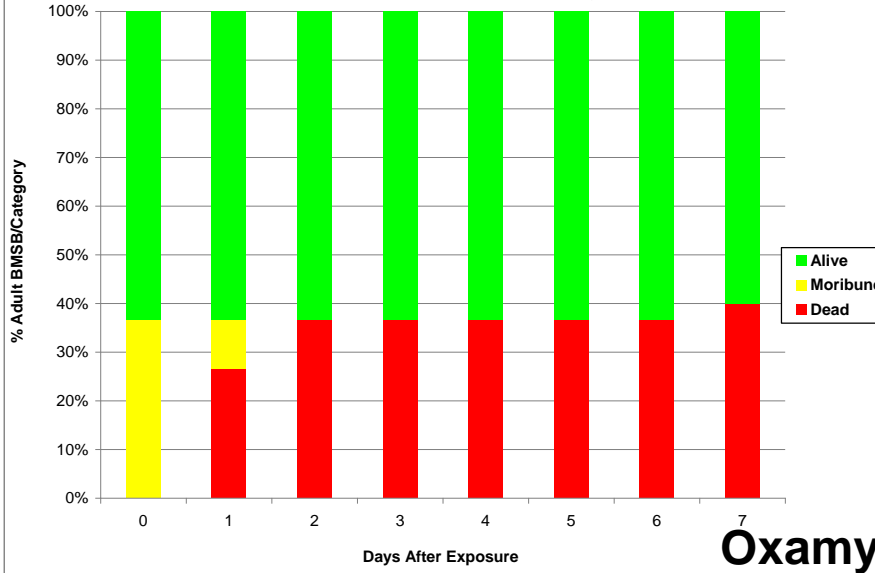
Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Formetanate Hydrochloride (Carzol SP) @ 1.25 lbs/100 gal



Formetanate HCl

Glass

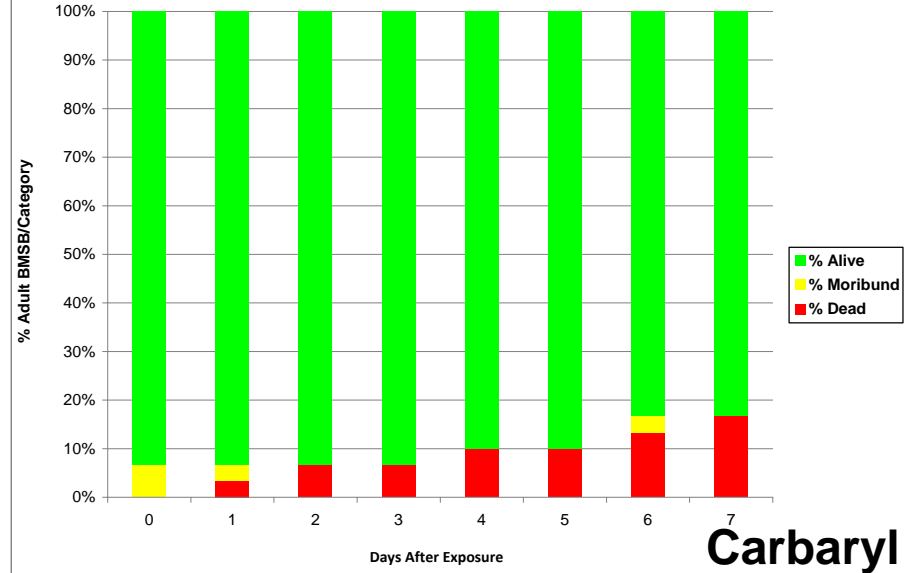
Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Oxamyl (Vydate L) @ 3.0 pts/100 gal



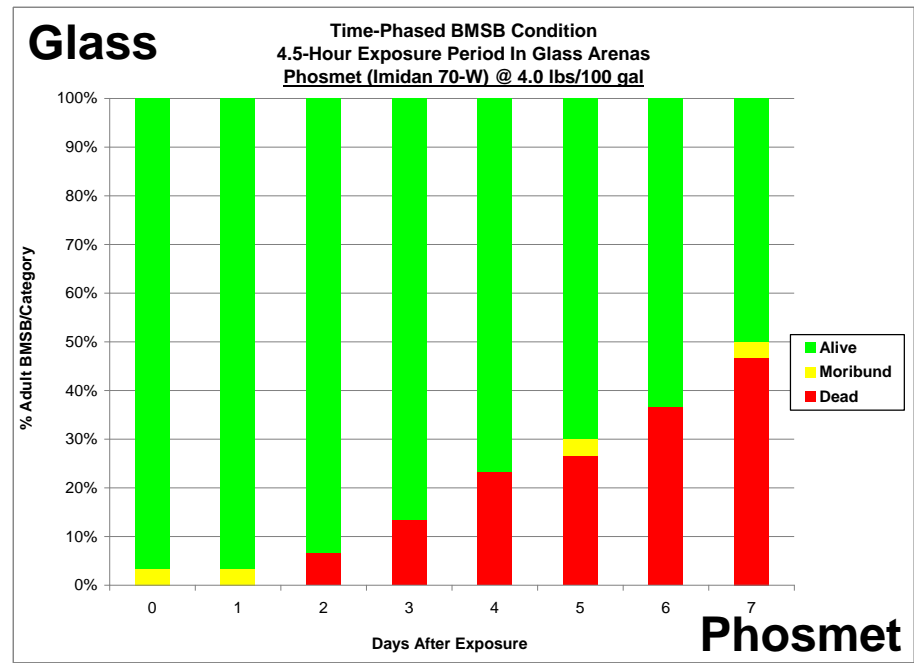
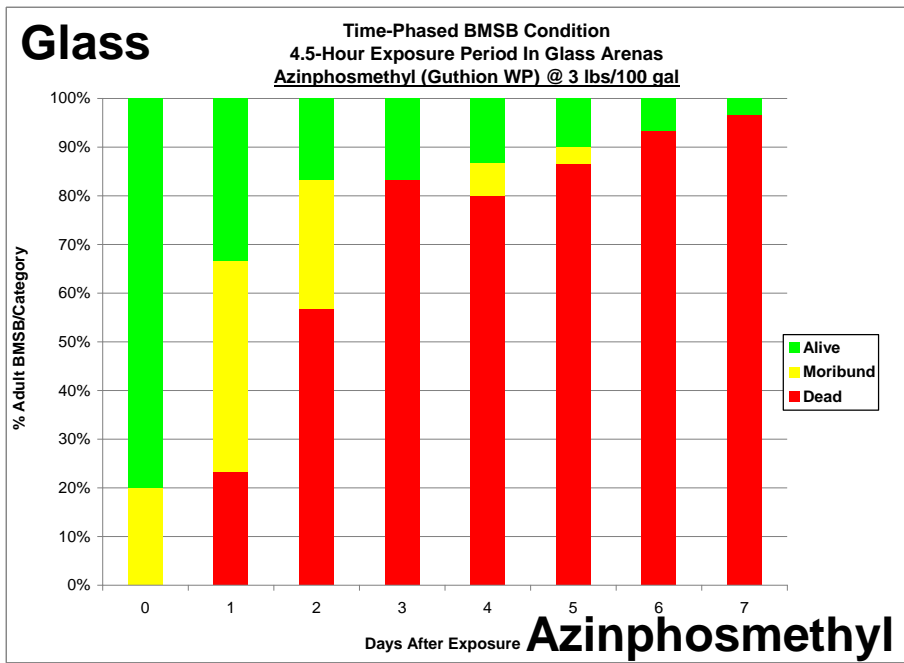
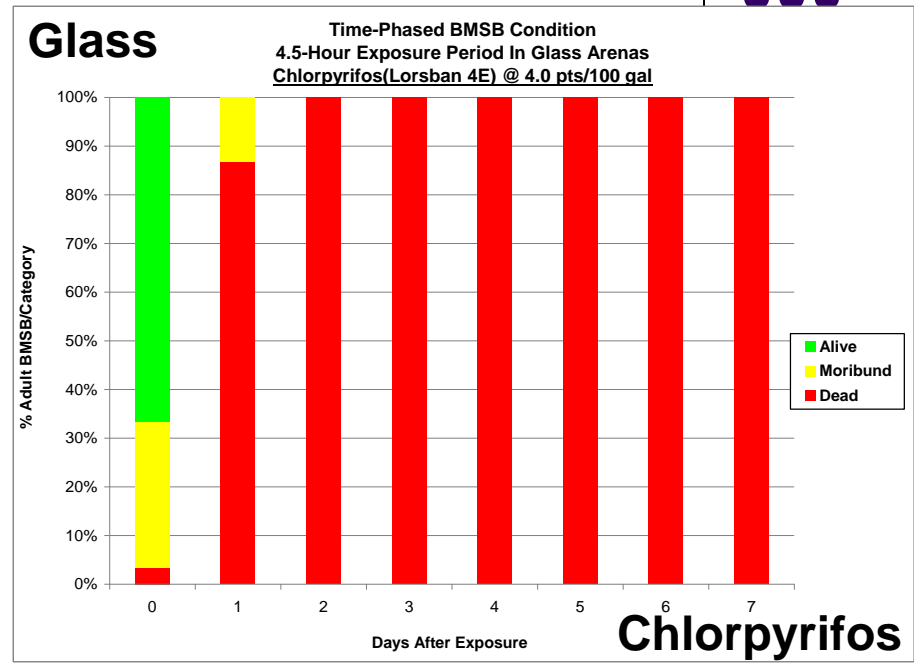
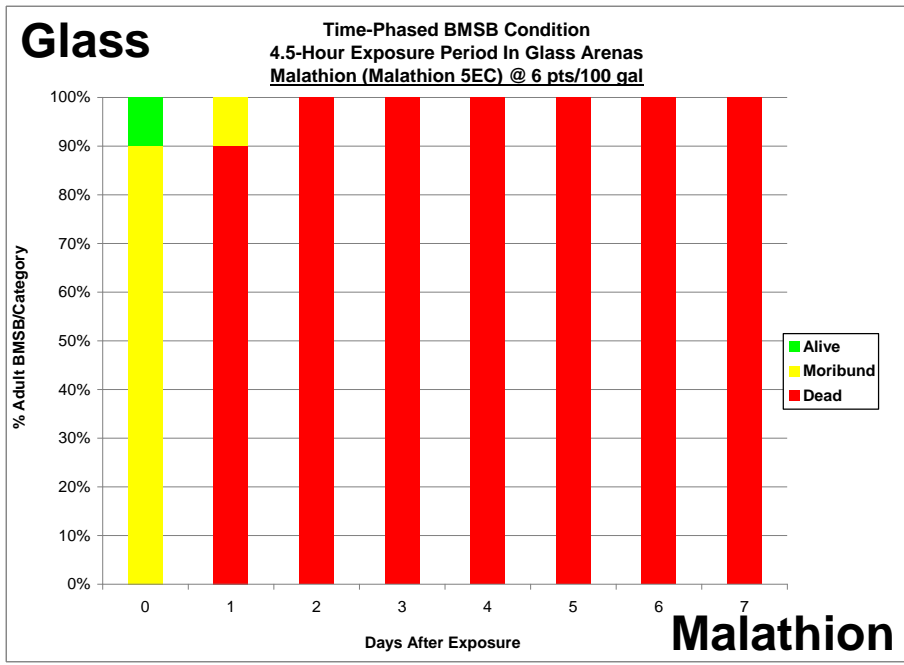
Oxamyl

Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Carbaryl (Sevin XLR) @ 2.0 qts/100 gal

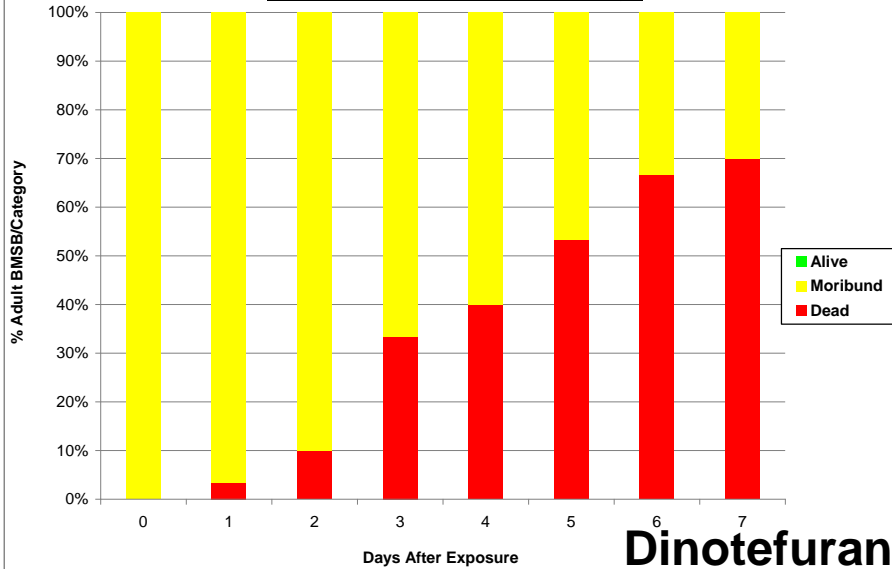


Carbaryl



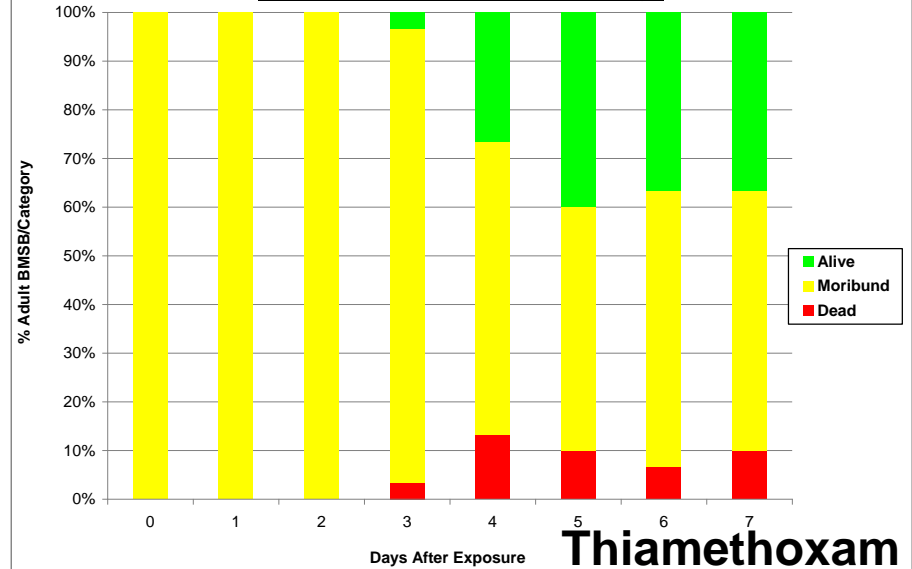
Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Dinotefuran (Safari 20 SG) @ 16 oz/100 gal



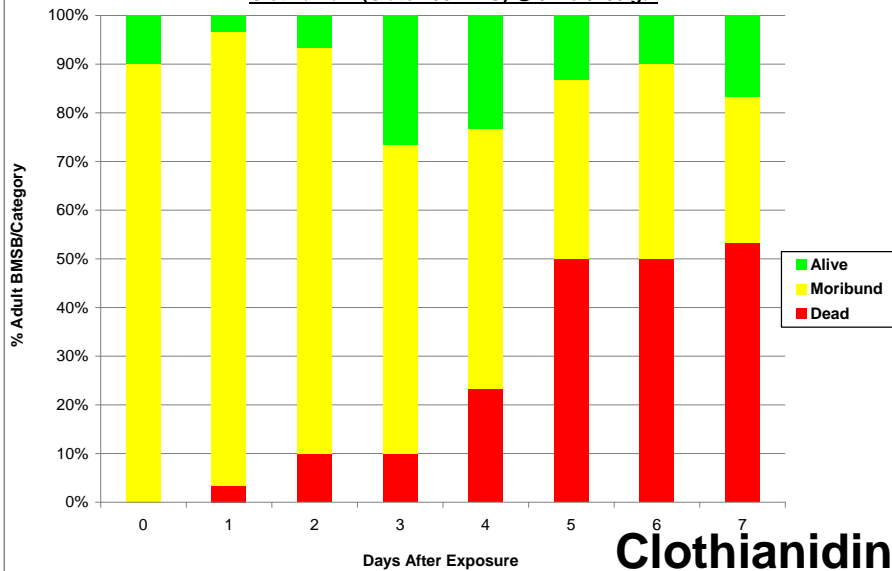
Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Thiamethoxam (Actara WDG) @ 4.5 oz/100 gal



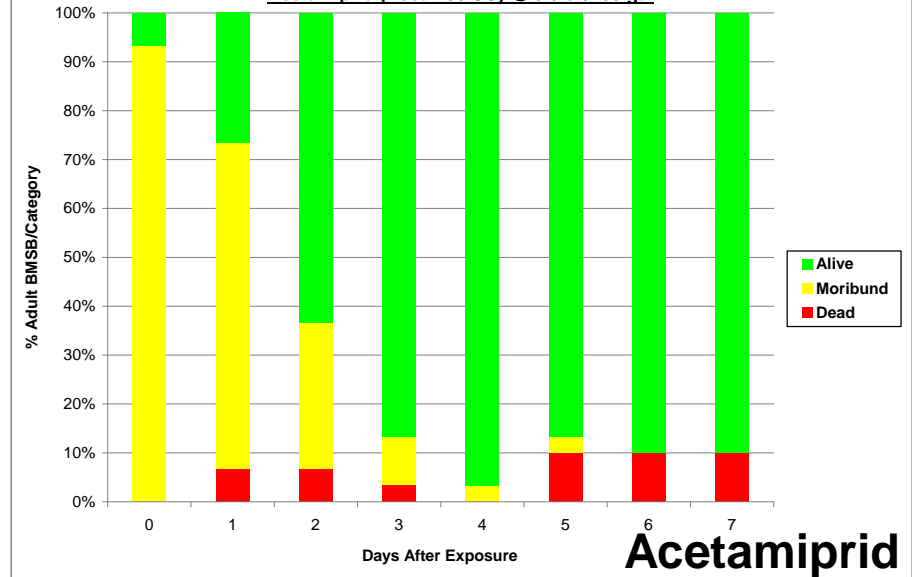
Glass

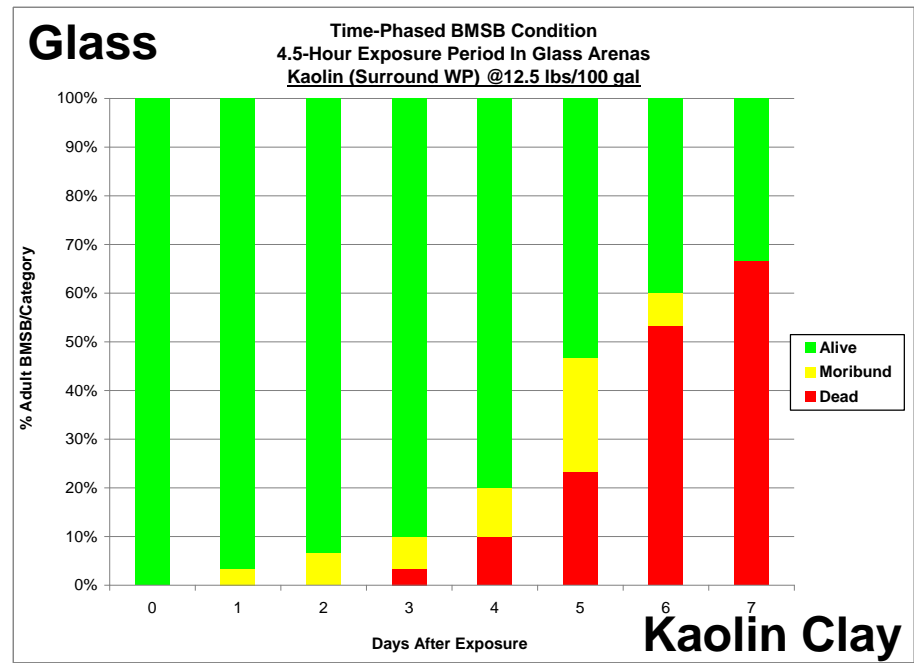
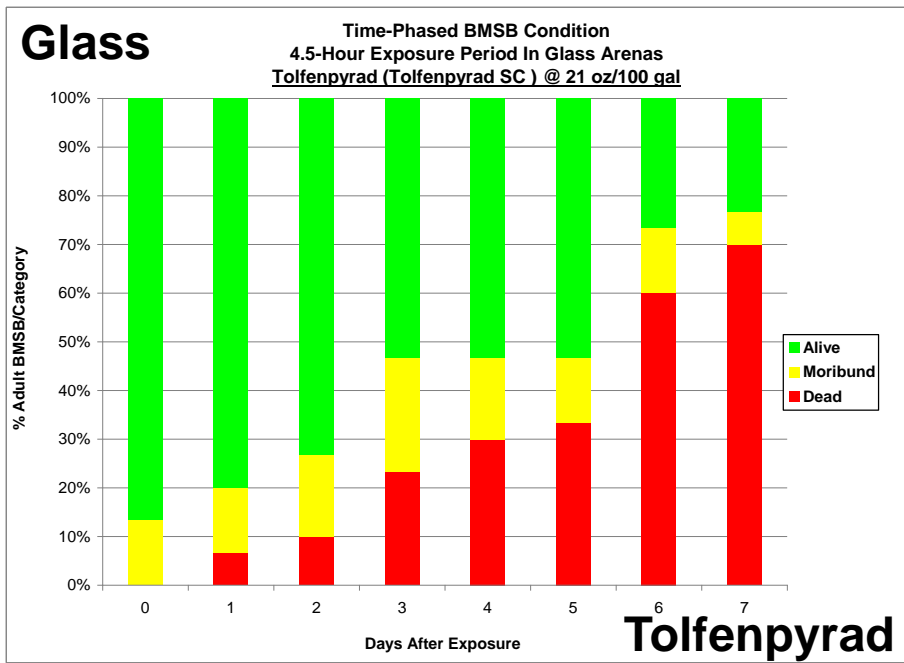
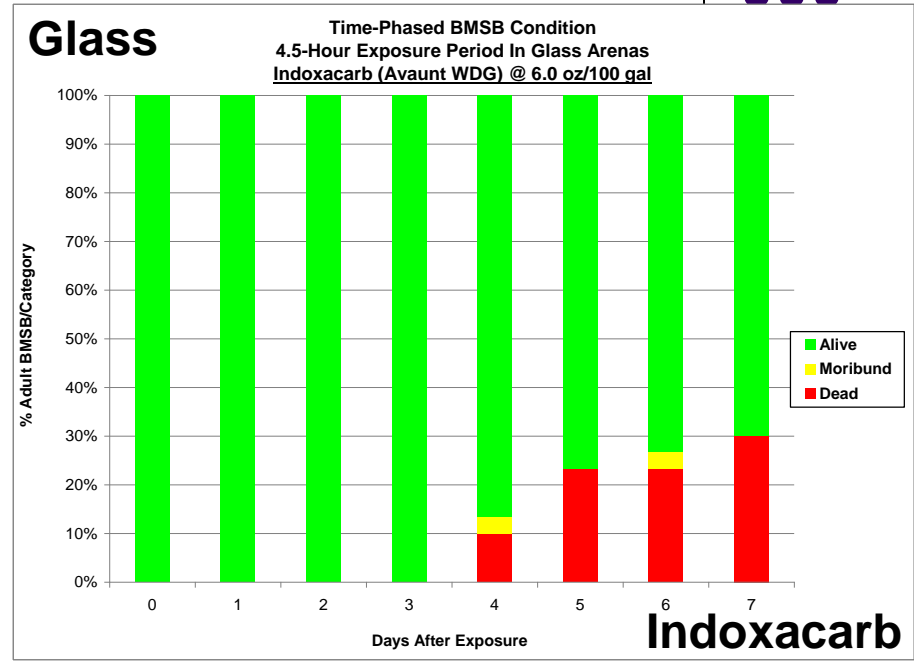
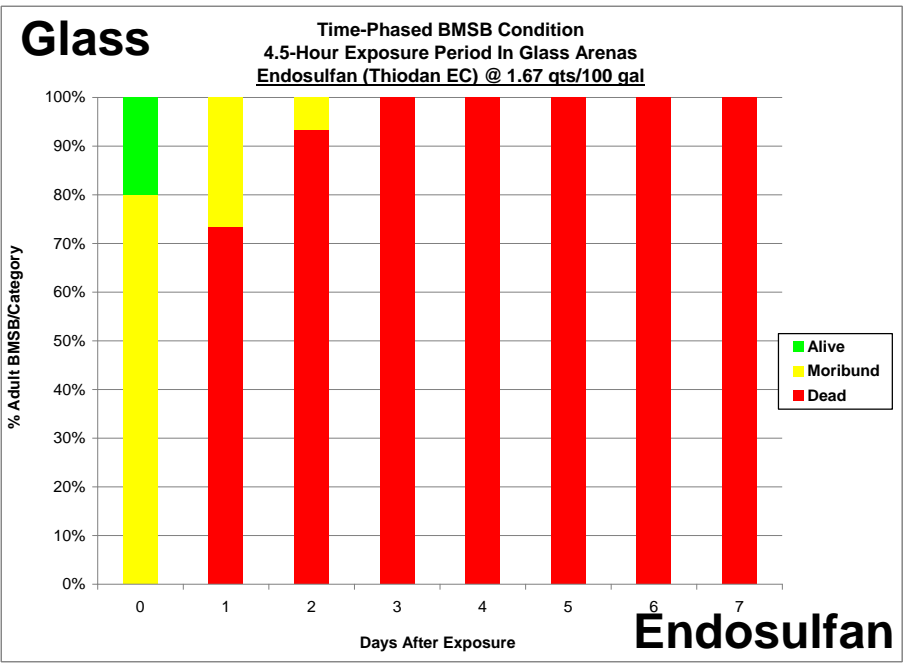
Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Clothianidin (Clutch 50 WDG) @ 3.2 oz/100 gal



Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Acetamiprid (Assail 30 SG) @ 8.0 oz/100 gal





BMSB Toxicity Testing

Lethality Index



$$\text{Lethality Index} = \left[\frac{\text{Day 0-7} \text{ (BMSB Alive x 0.0)} + \text{Day 0-7} \text{ (BMSB Moribund x 0.5)} + \text{Day 0-7} \text{ (BMSB Dead x 1.0)}}{240} \right] \times 100$$

The maximum value of the Lethality Index for each material is 100.0; the minimum value is 0.0, and compounds are ranked in descending order of value.

- * After testing ~45 materials, the Lethality Index was modified to accommodate four conditional categories: Alive (0.0); Affected (0.25); Moribund (0.75); and Dead (1.0). This change in conditional interpretation does not change the comparability of Lethality Index across tested materials.

BMSB Toxicity Testing

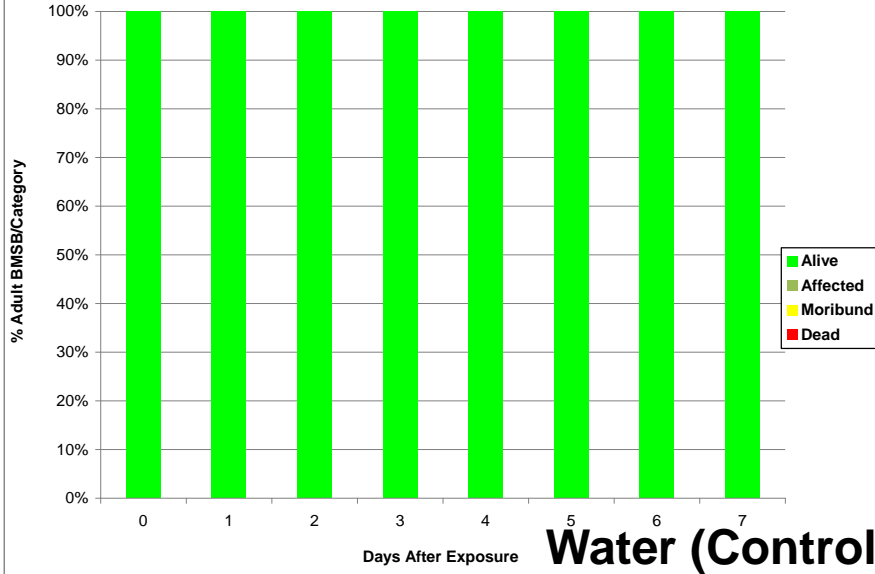
Lethality Index



| Active Ingredient | Trade Name | Lethality Index | Active Ingredient | Trade Name | Lethality Index |
|--------------------------------|-------------------|------------------------|--------------------------|-------------------|------------------------|
| Chlorpyrifos/Gamma-Cyhalothrin | Cobalt | 95.4 | Oxamyl | Vydate | 46.8 |
| Dimethoate | Cygon | 93.3 | MBI-203 | MBI-203 | 43.4 |
| Malathion | Malathion | 92.5 | Esfenvalerate | Asana | 43.3 |
| Bifenthrin | Brigade | 91.5 | Imidacloprid | Provado | 40.0 |
| Endosulfan | Thionex | 90.4 | Tolfenpyrad SC | Tolfenpyrad SC | 36.5 |
| Methidathion | Supracide | 90.4 | MBI-205 | MBI-205 | 35.7 |
| Methomyl | Lannate | 90.1 | Tolfenpyrad EC | Tolfenpyrad EC | 33.3 |
| Chlorpyrifos | Lorsban | 89.0 | Pyrifluquinazon | Pyrifluquinazon | 28.3 |
| Acephate | Orthene | 87.5 | Kaolin Clay | Surround | 23.1 |
| Fenpropathrin | Danitol | 78.3 | Diazinon | Diazinon | 20.4 |
| Permethrin | Permethrin | 77.1 | Phosmet | Imidan | 20.0 |
| Azinphosmethyl | Guthion | 71.3 | Acetamiprid | Assail | 18.8 |
| Dinotefuran | Safari | 67.3 | Thiacloprid | Calypso | 18.3 |
| Kaolin Clay/Thiamethoxam | Particle Delivery | 66.7 | Abamectin | Agri-Mek | 16.3 |
| Formetanate HCl | Carzol | 63.5 | Indoxacarb | Avaunt | 11.3 |
| Gamma-Cyhalothrin | Proaxis | 59.0 | Spirotetramat | Movento | 9.8 |
| Zinc Dimethyldithiocarbamate | Ziram | 57.5 | Carbaryl | Sevin | 9.2 |
| Thiamethoxam | Actara | 56.3 | Water | Control 6 | 9.2 |
| Clothianidin | Clutch | 55.6 | Flonicamid | Beleaf | 7.7 |
| Beta-Cyfluthrin | Baythroid | 54.8 | Water | Control 2 | 6.9 |
| Lambda-Cyhalothrin | Warrior | 52.9 | Water | Control 3 | 6.3 |
| Zeta-Cypermethrin | Mustang Max | 52.1 | Water | Control 5 | 6.0 |
| Cyfluthrin | Tombstone | 49.0 | Water | Control 4 | 4.2 |
| MBI-206 | MBI-206 | 48.4 | Cyantranilprole | Cyazypyr | 1.7 |

Glass

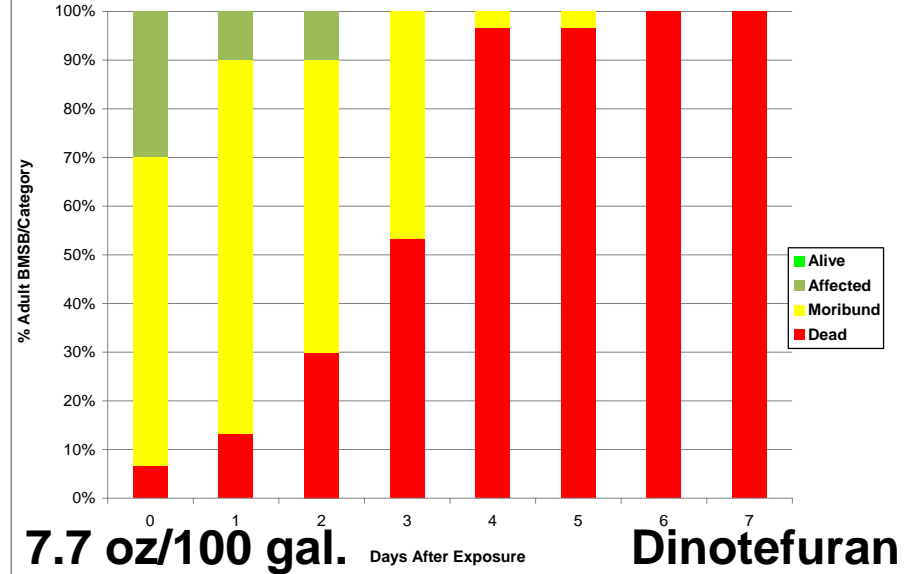
Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Dinotefuran Retest (Scorpion 35 SL) @ 0 oz/100 gal



Water (Control)

Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Dinotefuran Retest (Scorpion 35 SL) @ 7.7 oz/100 gal

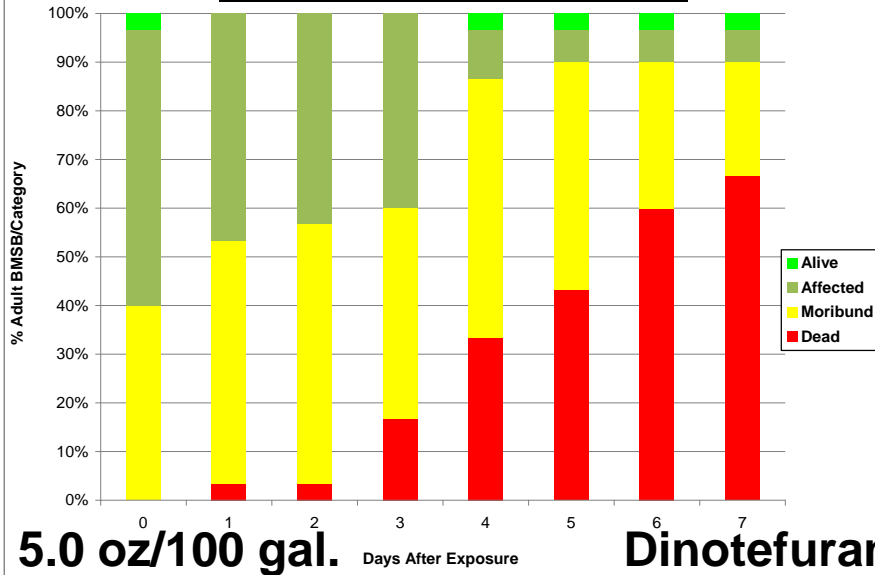


7.7 oz/100 gal.

Dinotefuran

Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Dinotefuran Retest (Scorpion 35 SL) @ 5.0 oz/100 gal

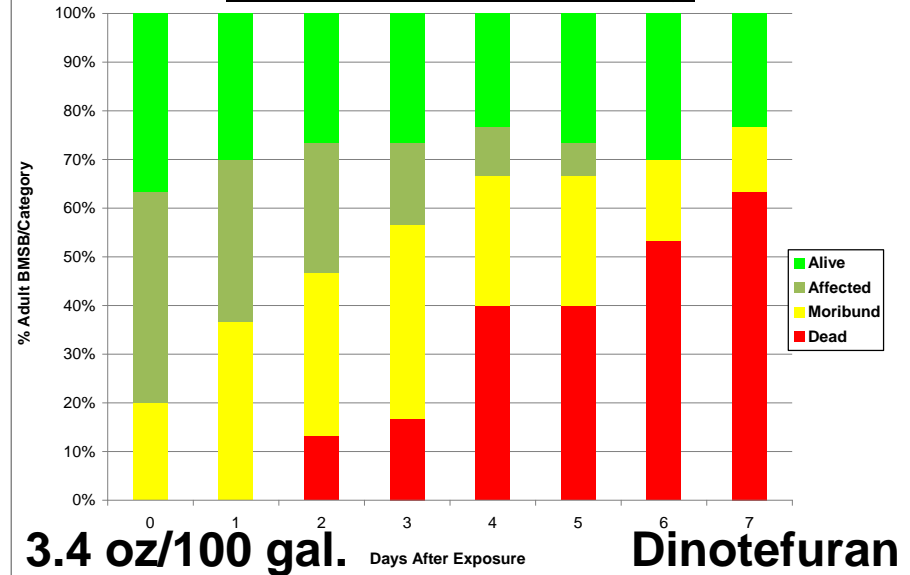


5.0 oz/100 gal.

Dinotefuran

Glass

Time-Phased BMSB Condition
4.5-Hour Exposure Period In Glass Arenas
Dinotefuran Retest (Scorpion 35 SL) @ 3.4 oz/100 gal

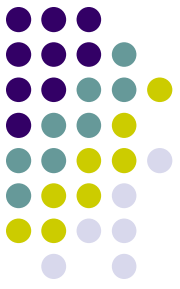


3.4 oz/100 gal.

Dinotefuran

BMSB Toxicity Testing

Conclusions



- There are materials within each chemical class that show promise for ability to kill BMSB by contact with dried residues (malathion, bifenthrin, endosulfan, methomyl).
- In general, neonicotinoids did not provide the level of “fast kill” that other classes did, but bugs were routinely paralyzed very soon after exposure.
- In neonicotinoid and pyrethroid treatments, bugs remained moribund for a very long period of time and still may recover 7 or more days after paralysis.
- For many compounds, exposure via treated plant tissue will likely reduce lethality of dry insecticide residues; however, toxicant uptake via feeding will contribute to the lethality of many materials.

Good Information Is Out There



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Brown Marmorated Stink Bug

Halyomorpha halys

The brown marmorated stink bug (BMSB), an insect not previously seen on our continent, was apparently accidentally introduced into eastern Pennsylvania. It was first collected in September of 1998 in Allentown, but probably arrived several years earlier. As of September 2010, *Halyomorpha halys* has been recorded from the following 37 counties, although it is probable that they are in all counties:

Adams, Allegheny, Armstrong, Beaver, Berks, Blair, Bucks, Butler, Cambria, Carbon, Centre, Chester, Clinton, Columbia, Cumberland, Dauphin, Delaware, Franklin, Indiana, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Mercer, Mifflin, Monroe, Montgomery, Northampton, Northumberland, Perry, Philadelphia, Pike, Snyder, Washington, Westmoreland and York

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Jersey Roots, Global Reach

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How to Identify the Brown Marmorated Stink Bug

■ [Report a Sighting of the Brown Marmorated Stink Bug](#)


The Brown Marmorated Stink Bug has a "shield" shaped body that is characteristic of all stink bugs. The adults are approximately 17 mm (5/8 inch) long with a mottled brownish grey color. The next to last (4th) antennal segment has a white band and several of the abdominal segments protrude from beneath the wings and are alternatively banded with black and white. The underside is white, sometimes with grey or black markings, and the legs are brown with faint white banding.

Adult Male. Adult Female. Aggregation on Crab

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Brown Marmorated Stink Bug

The brown marmorated stink bug (*Halyomorpha halys*) is native to eastern North America. Adult bugs are 14-17 mm and dark mottled brown. The antennal segments have alternating light and dark bands. The edges of the abdomen also have light and dark bands. The nymphs are yellowish and mottled with black and red. The host list is long and includes trees and woody ornamentals such as Paulownia, Butterfly Bush, Catalpa, Rosa rugosa (honey-suckle), and Acer platanoides (Norway maple). It appears as small necrotic spots on leaves and fruit. It also can be a nuisance in homes and buildings as they seek shelter like Asian ladybird beetles and boxelder bugs.

Management: Prevent them from coming in the home with caulk, use weather stripping around doors and window air conditioners, close all possible entry points up the bugs and place in an outdoor trash receptacle. If many of them are squashed or pulled into a vacuum can be quite strong.

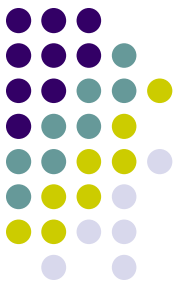
There are no chemical recommendations currently available. For heavy infestations outdoors, contact a pest control professional.

Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål)



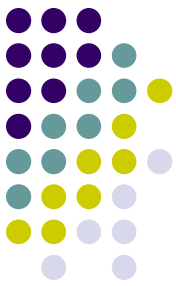
I. Introduction: A new addition to the [stink bug complex](#) is brown marmorated stink bug, *Halyomorpha halys* (Stål). Brown marmorated stink bug (BMSB) has recently been introduced from Asia into the northeastern U.S. It was first detected in 1998 in Allentown, Pennsylvania (see [NAPIS map](#); this map underrepresents the situation in Virginia). It was later found in New Jersey, Maryland and Delaware, and in October 2004 it was found in Montgomery County, Virginia, and in Tennessee in 2008. A [collection of images](#) has been posted on the web. In its native region (China and other parts of Asia) it is a pest of fruits, vegetables and soybeans. It may also invade houses in large numbers in the fall as it seeks overwintering sites. There is a possibility of it having become established in [Oregon](#). A localized infestation was found in California in 2005, in a storage facility in materials stored by a resident recently moved from Pennsylvania. In 2007, it was found for the first time in Europe

Education And Awareness Needed



The good, and bad, stink bug varieties in Oregon. The bad variety, known as the Brown Marmorated Stink Bug or BMSB, was seen for the first time on Washington soil two weeks ago .

Tracking the Spread: Report a BMSB Detection



Monitoring for the Brown Marmorated Stink Bug: Report a Sighting - Microsoft Internet Explorer provided by ARS Cybersecurity -

https://njaes.rutgers.edu/stinkbug/report.asp

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« Back to: Monitoring for the Brown Marmorated Stink Bug

Report a Sighting

If you believe that you have seen a Brown Marmorated Stink Bug in your area, please fill out this secure form, and we will contact you for verification.

If you are able to capture a specimen, please send it to:

Attn: BMSB Reports
Department of Entomology
Rutgers, The State University of New Jersey
93 Lipman Drive
New Brunswick, NJ 08901-8524

Please place live specimens in any type of container such as a plastic medicine bottle or a film canister.

Secured by 2011-04-01



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Need more information about Reporting a Sighting of the Brown Marmorated Stink Bug? Contact your Cooperative Extension county office for answers to your questions.

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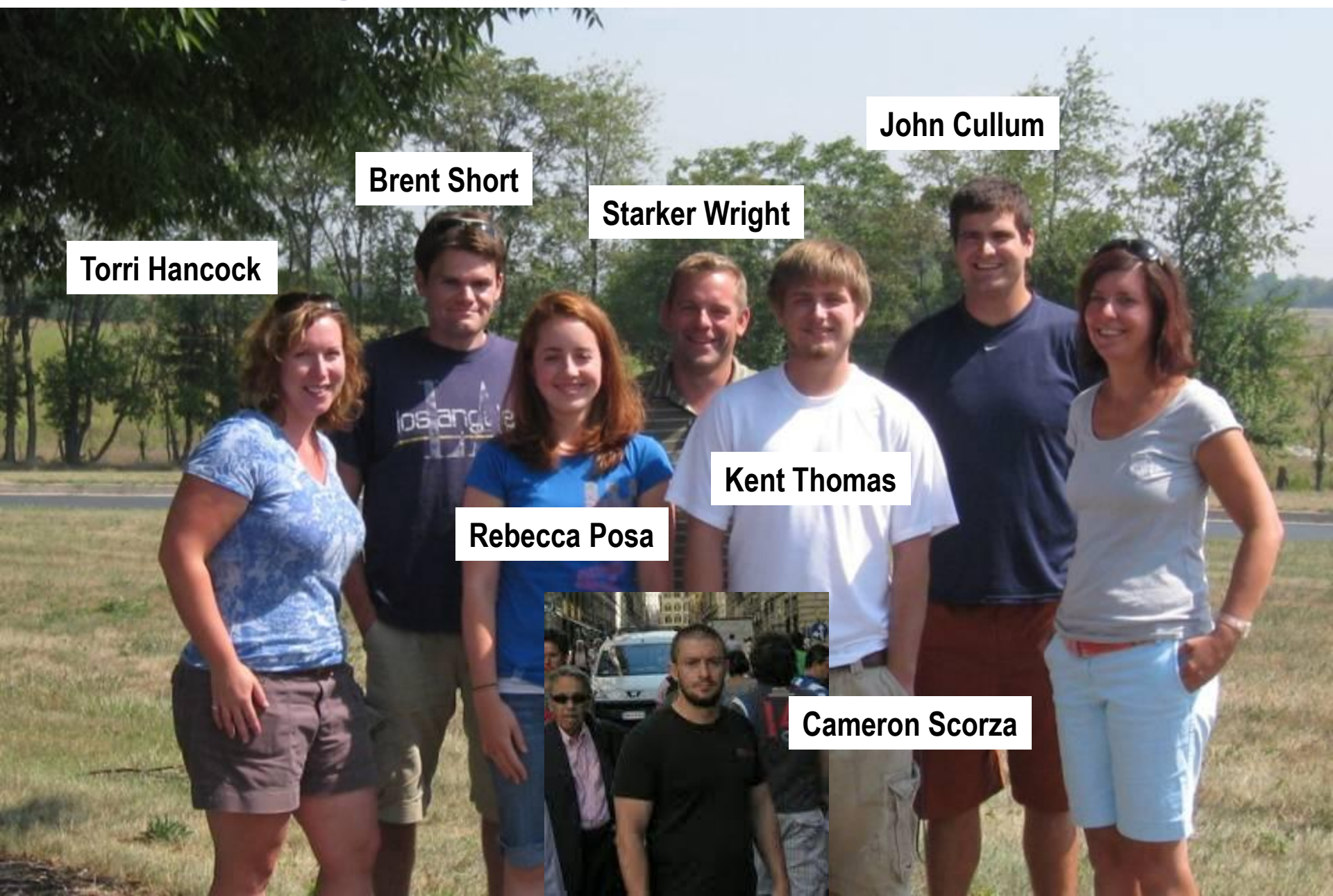
http://discovery.rutgers.edu/

Internet 100%

start BMSB Raupp Les... 2 Microsoft Offi... 2 Microsoft Offi... Stink bug number... Monitoring for th... 10:38 AM

<https://njaes.rutgers.edu/stinkbug/report.asp>

Acknowledgments



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