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

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USDA

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.

3rd

2nd





Egg Mass

1st



Bivoltinism Based on Field Cage Study of BMSB Development



~50 d (range of 48-57 d) from Egg to Adult



Threat To Commercial Tree Fruit















Development of a Behaviorally Based Monitoring Tools for BMSB



- No effective monitoring tools for BMSB.
- Growers need a tool that allows them to detect presence, abundance, and seasonal activity.
- Development of treatment thresholds.

Development of a Behaviorally Based Monitoring Tool for BMSB

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



20009-2010 BMSB Response to Visual Stimuli



TrunkFoliarFoliarUnapparentUnapparentMimicStimulusStimulusStimulusStimulus

- 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.



Adult and Nymphal Captures



Monitoring Adult and Nymphal Populations (2011)

- Black pyramid traps will be 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.
- Six orchards in MD, three orchards in WV. Checked weekly.



Response To 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)	Darkness	
•	100 Lux 400 Lux 1600 Lux	Fixed Full Spectrum	

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



Light Bioassay



% BMSB Detected At Treatment Zone Male vs. Female, Overwintered BMSB Tabb Collection (02/16/2011)





% BMSB Arrival in Treatment Zone Male vs. Female, Overwintered BMSB Tabb Collection (02/16/2011)



Indirect Light Source Intensity (Lux)







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 BMSB Aggregation Pheromone



Tentative Conclusions



- Dark ground-deployed pyramid trap. Visually stimulating and capture mechanism works well because both nymphs and adults have a tendency to walk up surfaces.
- Nymphs were attracted to traps baited with methyl (2E, 4E, 6Z)– decatrienoate season-long.
- A season-long attractant for adults is critical. Identification of true pheromone is critical.
- Augment trap designs with specific wavelengths and intensities of light to improve overall sensitivity and specificity.

2011 Research Plans Associated with Development of Monitoring Tools

<u>Monitoring Traps</u>

- Season-long monitoring of nine commercial orchards in MD and WV with prototype black monitoring trap and kairomone. Complimentary fruit sampling.
- Comparison of baited and unbaited black light and pyramid traps.

<u>Known Kairomone</u>

- Determine if BMSB are attracted to methyl (2E, 4E, 6Z) decatrieonoate early in the season.
- Establish active space of known doses/release rates of methyl (2E, 4E, 6Z)-decatrienoate.

Visual Cues (Light)

- Continue with laboratory bioassays identifying attractive intensities and wavelengths of light.
- Field evaluation of traps: 1) traps with light; 2) traps with light+attractant; 3) traps with attractant; and 4) unbaited traps.

Chemical Ecology

• Initial field evaluation of BMSB aggregation pheromone.



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 reinfestation 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 completely ineffective.

Laboratory-Based BMSB Insecticide Evaluations USDA-ARS-AFRS



- Because of the constant (season-long) pressure from BMSB populations located outside orchards and other cropped areas, BMSB continuously re-infests plots.
- Thus, immigrating BMSB are unlikely to encounter direct contact with finished (wet) spray material.
- This population poses *the primary threat* to crops. Control depends on residual effectiveness and likelihood of uptake.
- Laboratory insecticide trials designed to be biologically relevant and based on control of this primary threat.
- Evaluation of each material requires a total of 24 person hours.

BMSB Insecticide Testing, USDA-ARS-AFRS October 28, 2010 - February 1, 2011

Carbamates

- Carbaryl (Sevin)
- Methomyl (Lannate)
- Oxamyl (Vydate)
- Formetanate HCI (Carzol)

Organophosphates

- Phosmet (Imidan)
- Chlorpyrifos (Lorsban)
- Acephate (Orthene)
- Azinphosmethyl (Guthion)
- Malathion (Malathion)
- Methidathion (Supracide)
- Dimethoate (Cygon)
- Diazinon (Diazinon)

Pyrethroids

- Fenpropathrin (Danitol)
- Cyfluthrin (Tombstone)
- Bifenthrin (Brigade)
- Permethrin (Permethrin)
- zeta-Cypermethrin (Mustang)
- beta-Cyfluthrin (Baythroid)
- Esfenvalerate (Asana)
- lamba-cyhalothrin (Warrior)
- gamma-cyhalothrin (Declare)

Neonicotinoids

- Thiamethoxam (Actara)
- Clothianidin (Clutch)
- Dinotefuran (Safari)
- Imidacloprid (Provado)
- Thiacloprid (Calypso)
- Acetamiprid (Assail)

Organochlorine

• Endosulfan (Thiodan)

Other Classes

- Flonicamid (Beleaf)
- Indoxacarb (Avaunt)
- Spirotetramat (Movento)
- Cyantraniliprole (Cyazypyr)
- Abamectin (Agri-Mek)
- Tolfenpyrad (Tolfenpyrad)
- Pyrifluquinazon
- Kaolin Clay (Surround)
- Particle Delivery (Surround+)



Experimental Trials



EthoVision trials for measuring horizontal mobility on insecticidetreated surfaces.







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



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Phosmet20.0Acetamiprid18.8Thiacloprid18.3Abamectin16.3Indoxacarb11.3Spirotetramat9.8Carbaryl9.2Flonicamid7.7Water (Control)5.8Cvantraniliprole1.7			Diazinon	20.4			
Acetamiprid18.8Thiacloprid18.3Abamectin16.3Indoxacarb11.3Spirotetramat9.8Carbaryl9.2Flonicamid7.7Water (Control)5.8Cvantraniliprole1.7			Phosmet	20.0			
Inaciopid18.5Abamectin16.3Indoxacarb11.3Spirotetramat9.8Carbaryl9.2Flonicamid7.7Water (Control)5.8Cvantraniliprole1.7			Acetamiprid	18.8			
Avallectin10.5Indoxacarb11.3Spirotetramat9.8Carbaryl9.2Flonicamid7.7Water (Control)5.8Cvantraniliprole1.7			Abamostin	18.3			
Spirotetramat 9.8 Carbaryl 9.2 Flonicamid 7.7 Water (Control) 5.8 Cvantraniliprole 1.7			Indoxacarb	10.5			
Spholenania9.8Carbaryl9.2Flonicamid7.7Water (Control)5.8Cvantraniliprole1.7			Spirotetramet	0.0			
Flonicamid 7.7 Water (Control) 5.8 Cvantraniliprole 1.7			Carbaryl	9.0 Q 7			
Water (Control) 5.8 Cvantraniliprole 1.7			Flonicamid	7.2 7.7			
Cvantraniliprole 1.7			Water (Control)	5.8			
			Cvantraniliprole	1.7			

BMSB Insecticide Testing Summary Results



- Based on contact lethality, older broad spectrum materials including dimethoate, malathion, bifenthrin, methidathion, endosulfan, and methomyl provided highest levels of contact lethality.
- Within each chemical class, patterns of lethality are similar, but there is a substantial amount of variation between active ingredients in the intensity of effects on mobility and mortality.
- One piece of the story. Finished wet spray material, feeding trials, sublethal effects, field studies.

2011 Research Plans Associated with Development of Management Strategies

Behaviorally Based Control

- Establish active space of known doses/release rates of methyl (2E, 4E, 6Z)-decatrienoate.
- Establish parameters associated with increasing response to known attractant.
- Baited trap trees or trap crops for more spatially precise management of BMSB.
- Deterrents and repellents. Push-pull strategies.
- Augment with light?

Insecticidal Work

Behaviorally based insecticide trials

<u>Fruit Injury</u>

- Caged fruit at different points in the season.
- Identification of late-season injury.
- Post-harvest studies.

<u>Voltinism</u>

• Repeat voltinism experiments.



Acknowledgments

