



**Brown Marmorated Stink Bug  
Stakeholder Advisory Panel Meeting  
USDA/ARS  
Appalachian Fruit Research Station  
2217 Wiltshire Road  
Kearneysville, WV 25430  
November 28, 2012**

Submitted by:

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## Table of Contents

<b>Stakeholder Advisory Panel Participants</b>	<b>3-7</b>
<b>Introductions and Overview</b>	<b>9</b>
<b>Oral Presentation Summaries</b>	
Objective 1: Establish biology and phenology of BMSB in specialty crops	<b>10-17</b>
Objective 2: Develop monitoring and management tools for BMSB	<b>17-21</b>
Objective 3: Establish effective management programs for BMSB in specialty crops	<b>22-25</b>
Objective 4: Integrate stakeholder input and research findings to form and deliver practical outcomes	<b>25-26</b>
<b>Open Discussion</b>	<b>26-29</b>

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## **Introductions and Overview of 2012 Progress**

**Presented by: Tracy Leskey, USDA/ARS/AFRS**

### Summary:

- Planning Document was distributed in May to identify areas of duplication of effort and also helped identified sub-objectives that required modification
- Developed an Annual Report for each institution to submit annually
  - Technical Summary of Progress
  - Outlined Experimentation for Upcoming Period
  - Barriers to Success
  - Key Personnel Trained
  - Research and Extension Products
  - New/Leveraged Funding
  - Media Contacts
- 3 ways progress was measured
  - Institutional progress
  - Subobjective progress
  - Cross-institutional project progress
- Currently we are on schedule
  - Some objectives are nearing completion or will be completed by 2014
  - Others will require more time or need to be revised
  - Renewal will be written Fall 2013/Winter 2014
- Map update on distribution of BMSB in the United States
  - A fourth orange category was added to the map, “Agricultural and Nuisance Problems”.
    - Four states fall under this new category, New York, North Carolina, Ohio and Tennessee
  - Three states changed status from “BMSB Detected” to “Nuisance Problem Only”:
    - Massachusetts, Michigan, and Washington
  - One state was the only new “BMSB Detected” state:
    - Utah
- Regulatory Issues
  - 2012 Section 18 for Tree Fruit
    - Renewal of Section 18 for Dinotefuran
    - Approval of Section 18 for Bifenthrin
    - Renewal applications will be submitted for 2013
  - 2012 was the last year for Endosulfan use in peaches, but apples go through 2015
  - Continued progress in host specificity screening for classical biological control program. Now testing in Delaware, Florida, Oregon and Michigan. Estimate another 18 months before submission of application for release permit.

### **Oral Presentation Summaries**

#### **Objective 1: Establish biology and phenology of BMSB in specialty crops**

##### **1.1.1 Voltinism**



**Presented by: Peter Shearer, Oregon State University**

Summary:

- The frequency or number of annual broods
  - Univoltine: one generation per year
  - Polyvoltine: multiple generations per year
- Data generated using Anne Nielsen's model of critical temperature for degree day (DD) development
  - Preoviposition period: 148 DD
  - Egg hatch: 126 DD
  - Egg to adult development: 538 DD
  - Egg hatch occurs at 15 °C base temperature, 33 °C maximum temperature
- 2012 observations and concerns
  - Two complete generations documented in Mills River, NC and Kearneysville, WV
  - Two generations in Highland, NY.
  - High nymphal mortality and/or disappearance in Geneva, NY
  - One report of unsuccessful mating in field cages
  - Potential predation in cages: beetles, ants?
  - Need for standardization of monitoring and resources across states
- Degree days and also day length (14 hrs of daylight) trigger when eggs are laid
- Effect of latitude on day length
  - There are 17 days difference between when Geneva, NY (29 April) has 14 hours of daylight and Hendersonville, NC (16 May) has 14 hours of daylight making New York more suitable to lay eggs earlier because longer daylight hours are reached sooner.

**COMMENT:** Panel member indicated strong support for voltinism studies being conducted by the group, including Anne Nielsen's project.

**1.1.2 Movement to and from overwintering sites and overwintering survivorship**

**Presented by: Starker Wright, USDA/ARS**

Summary:

- BMSB seek out tight, dry and protected areas for overwintering
- BMSB overwinter in both human dwellings and in dead trees in natural landscapes
  - From sampling dead trees we learned that they could provide tight and protected crevices which seem to be a good place for insects to overwinter
  - November 2011 started sampling dead trees
    - Sampled 774 trees and found overwintering BMSB in 26 trees
      - Concluded BMSB preferred overwintering in standing trees versus downed trees

- Found underneath the bark and inside decomposed and porous tree tissue
    - Found in locust, oak, elm and ailanthus trees with larger than 60 cm circumference
  - These characteristics mirror exactly the micro habitat structures where we have found overwintering BMSB in human-made structures
  - BMSB were not found in ground leaf litter samples
- 3 trials tested to define dispersal capacity, detection and behavior
  - Flight mill measures the flight capacity
    - Based on the original design developed by Vince Jones lab at Washington State University.
    - Measured flight capacity of three different populations.
      - The first population was collected between late Aug and early Sept which represents an actively foraging population on host plants.
      - The second population was also collected from host plants. But, they were collected between late Sept and early Oct when a significant portion of the populations were dispersing to their overwintering sites in our area.
      - Retrieved ones that already had arrived in their overwintering sites between late Oct and early Nov.
    - Results: BMSB easily flew more than 1-2 km within 23 hours on the flight mill, showing the strong flight potential of this insect. The population which already arrived at their overwintering sites still had flight capacity comparable to the actively foraging population.
  - Harmonic radar
    - Harmonic radar systems continuously track BMSB movement for farm and landscape scales. Tracking individual BMSB in the field can fill the gaps between snap shot data such as trap captures to better understand how they move around during their dispersal from and to overwintering sites.
    - The radar-tag did not impact BMSB survivorship or mobility in the lab
  - Free-flight field observation
    - Radar bugs were reliably detectable from ca. 15 m
    - Flight was affected at least by temperature and sun's position

**COMMENT:** Panel member indicated interest in more work establishing dispersal capacity.

**COMMENT:** Panel member indicated study of overwintering BMSB in natural setting may not be useful based on low density detections.

### **1.1 and 1.3 Impact on Specialty Crops (Small Fruit)**

**Presented by: Cesar Rodriguez-Saona, Rutgers University**

Summary:

- BMSB population was lower in 2012 compared to 2011

- Very low numbers of adults found in transect, found nymphs present in June-August
- BMSB has become less of a concern in small fruit like blueberries, growers now are more concerned about the Spotted Wing Drosophila (SWD)
- Mapped 8 different blueberry farms in New Jersey, monitored them weekly, did a 3 minute count. Found more around the edges of woods versus in the interior. Numbers were not very high in south central NJ. Maximum number of adults was only 4. Nymphs had high numbers.
- Bag Experiment – Bagged branches in different development stages. Left for a week and moved to another bag, repeating this for 5 weeks. Experiment looked at discoloration; number of berries that fell inside the bag. This experiment was difficult to see the stylet marks on dark berries. Plan to use a staining method next year to help locate the stylet marks. We found nymphs caused more damage than adults.
- Choice Test – Do adult BMSB feed on damaged versus undamaged berries?
- Data looks promising with SPLAT

**COMMENT:** Panel member indicated interest in learning more about formation and detection of stylet sheaths.

## **1.2 and 1.3 Impact on Specialty Crops (Orchard Crops)**

**Presented by: Chris Bergh, Virginia Tech**

Summary:

- Exclusion Cage Study: 2011-2012
  - Peaches equally vulnerable to damage from fruit set to harvest
    - External injury on peach not necessarily indicative of extent of internal damage. Beat sampling method is best used in early season and visual sampling method is best used in late season.
  - Apples saw less injury in the early season due to an early harvest
    - Variability by apple cultivar for injury response occurring within 4 weeks before harvest by BMSB feeding. Generally, injury does not develop externally within 2 weeks before harvest.
    - More injury appears higher in the canopy and towards the border of the plot adjacent to a wooded habitat. Severity to a given fruit does not appear to be dependent upon tree location or location within the tree.

**QUESTION:** Panel member asked about size of trees evaluated in injury damage study? *All trees were > 4.5 m tall.*

## **1.2 & 1.3 Impact on Specialty Crops (Grapes)**

**Presented by: Doug Pfeiffer, Virginia Tech**

Summary:

- Grape is both a reproductive host and feeding host of *Halyomorpha halys*
- Distribution and abundance are greatly influenced by geography and surroundings
- Pronounced edge effect in vineyards when the population density is high
- No significant effect on the orientation of the vineyard plot on abundance of *Halyomorpha halys*

- Presence in vineyards can drop quickly near harvest period depending on adjacent crops like soybean and corn.
- Only one generation in Virginia vineyards
- *Halyomorpha Halys* can cause direct injury to the berries by inserting the stylets inside berries. The injury can be furthered by the fungal growth. BMSB will feed inside the cluster of grapes. When killed they remain in the cluster, when crushed with the berries it has the potential to create stink bug taint.
  - In 2011, there were fewer BMSB invading VA and MD vineyards at harvest; however, they were still present in numbers that lead to problems including increasing sorting/handling issues, juice contamination, and potential off-flavors in finished wine.
    - Replicated fermentations with known numbers of BMSB per lug of fruit are in progress. (UMD). Juice/wine evaluated at crush and at intervals after fermentation, using evaluation panels in triangle or other blind evaluation formats to identify contaminated samples. Once juice/wine went through the fermentation process the flavor was not affected.

**QUESTION:** Panel member asked, could associated rot from BMSB feeding lead to taint?  
*Still something that must be determined.*

## Open discussion

Summary:

- Anne Nielsen's study on ovarian development assessment seasonally to define voltinism
  - Data supports belief that photoperiod plays a major role in voltinism. About 10% population in Allentown, PA becoming reproductive after first generation so there is a potential for a second generation of adults, but the question is, are there enough degree days for completion?
- Evaluation of trapping at houses for controlling overwintering population. Some success with commercial structures. Looking at the plants they are on in July. Spray the building before they can go into the building. PMPs have been regulated so you cannot blanket spray buildings with pyrethroids anymore, must stream spray. It was suggested to retrofit houses to exclude bugs. New building materials need to be developed to exclude bugs.

**COMMENT:** Panel member indicated that collecting data on the relationship between photoperiod and reproduction is important.

## 1.2 and 1.3 Damage, Phenology and Impact of BMSB in Ornamental Systems Presented by: Paula Shrewsbury, University of Maryland

Summary:

- Ornamentals are the second largest economic import commodity in Maryland
- In 2008 green industry (nurseries, landscapes, greenhouses) gross receipts of ~\$2 billion
- BMSB in the nurseries must immigrate, emigrate, are very high in plant diversity with large blocks of trees

- In 2012, saw low numbers going into the season but increased as the season progressed only to crash in September
- Nursery used in Adamstown, MD where plants were in the ground for 1-7 years and have seen heavy BMSB pressure for the past 3 years
  - Natural enemies of eggs being studied. They were present from early June to early September
  - Trees looked at were ash, chestnut, poplar, redbud, sugar maple, sweet gum and weeping cherry. High population of BMSB in ash, poplar, redbud and weeping cherry.
  - Feeding cycle started on leaves, moved to fruit and at the end of the season started feeding on high sugar, smooth-barked, sycamores, and newly planted peach and cherry trees.
  - Not a huge amount of damage but concerned bark feeding may lead to secondary infections and bark boring insects.
- Pitfalls
  - Low densities of BMSB in autumn in 2011 and early season of 2012, and on herbaceous plants in general, may reduce sensitivity in resolving seasonal patterns in BMSB phenology and injury to plants
  - Difficult to separate direct BMSB damage from other causes and to document indirect damage to ornamentals (ex. vector, secondary pathogens)
  - Standardizing sampling methods across structurally diverse plants / crops
- Future plans
  - Complete second year of nursery surveys of BMSB phenology; integrate Degree Day information, plant phenology data
  - Implement manipulated studies to:
    - determine relationship between BMSB and damage to woody and herbaceous plants
    - elucidate effects of bark feeding on tree health and susceptibility to secondary pathogens
- Expected outcomes
  - Elucidate timing of initial immigration and oviposition, and predict seasonal changes in populations in nurseries
  - Help stakeholders to refine IPM programs (monitoring and management of BMSB)

**QUESTION:** Panel member asked what type of trees show obvious bark damage? *Smooth*

## **1.2 and 1.3 Impact on Specialty Crops (Vegetables)**

**Presented by: Tom Kuhar, Virginia Tech**

Summary:

- Sweet corn, peppers, tomatoes, beans, eggplant, and okra are impacted the most
- Difficult to assess region/statewide impact because of the patchiness of BMSB populations

- Sweet corn is sprayed regularly so it is hard to assess on big farms
- Organic farms are easier because they are not sprayed
- When bug densities are high on a farm, damage to the crops can be devastating
- Damaged ears can exceed 100% for certain planting dates and small fields
- Sweet corn can be attacked as early as late June in Virginia
  - Kernels on sweet corn can be aborted, discolored and sunken from BMSB feeding. Aborted kernels are most common during silking stage
- Infestations occurring prior to pollination may result in incomplete kernel fill
- BMSB must be managed from ear shank emergence to harvest
- Lima Beans do not suffer as much
- Tomatoes saw 65% damage in Maryland but could not find BMSB on them
  - Yeast was found on tomatoes causing a collapse of the feeding area resulting in a “crater” appearance. The yeast is taken up and becomes lodged in the stylet pouch when the BMSB feeds on the infected host plant. *E. coryli* is transmitted as fragments of mycelia and as small buds, after the insect has fed on infected host plants.

**QUESTION:** Panel member asked what the potential effect of BMSB damage on canned whole tomato processing is? *Answer not known, but could be significant*

### **1.3.2 Determine the time lag and impact of BMSB as it colonizes new habitats**

**Presented by: Jim Walgenbach, North Carolina State University**

Summary:

- In 2010, BMSB becomes established in New York, SE Virginia, and North Carolina
- Potential for multiple generations in Virginia and North Carolina will reduce lag time between establishment and crop injury
  - Movement follows a predictable lag time pattern of ~5 years between detection and economic injury reports in cultivated hosts
    - WV detected in 2005, 2010 economic disaster year
    - NY detected in 2007, 2012 economic problem in apples
    - SW VA detected 2004, 2010 economic problem
    - W NC detected 2009, have not seen an economic problem yet
- Most infestations are in larger cities, Hudson Valley in NY, Lake Ontario region
- BMSB was detected in soybeans in 44 of the 56 major soybean counties in Virginia

### **1.4 Identify landscape and temporal risk factors associated with BMSB on crops and in adjacent ecosystems**

**Presented by: George Hamilton, Rutgers University**

Summary:

- Identify cause to move around in the fields and measure movement outside fields
- Spatial patterns 2011
  - Edge effects were identified in relation to corn and soybeans
    - High population found next to soy bean versus sod

- Significant location and field effects were found
- Landscape and temporal effects in peaches
  - Unable to identify surrounding cover effects
  - Movement within the fields was dependent on fruit ripeness and availability
  - Some of the pitfalls encountered were low population levels and growers' spray schedule
  - Will repeat the study in 2013 but will select orchards farther away from each other

## 1.5 Genetic Studies

Presented by: Leslie Pick, University of Maryland

Summary:

- Understanding genes to gain insight into biology; target genes to control them
- Analyze transcriptome of BMSB: identifying genes is important for development and fertility
  - Reducing redundancy in the assembly by keeping only the best splice/sequence variant per gene
  - Necessary for comparisons to other insects
  - The best sequence variant of a gene has:
    - Similarity to full-length transcripts in the databases
    - Even sequencing coverage, without abrupt changes
- Identifying important gene families (insecticide-resistance, Hox genes, insulin pathway)
- Assessing lateral gene transfer and symbionts status
- Develop methods to target specific genes for pest control
  - Test RNA interference methods
    - To study gene function
    - As pest control strategy
- RNA interference (RNAi): concept
  - Basic idea: Identify a vital gene; trick insect into destroying it
  - Animals have normal mechanisms to fight viruses which use dsRNA
  - Trick animal into thinking their own genes are viral by designing dsRNA
- BMSB *v-ATPase* RNAi Preliminary
  - *v-ATPase* dsRNA or injection buffer were injected into the abdomen of adult BMSB
    - Results:
      - *v-ATPase* group, three out of six dead within 24 hours
      - Buffer only group, zero out of 5 dead
      - All the surviving bugs were still alive after ten days
  - One day fasting experiment
    - *v-ATPase* group, three out of three dead
    - Buffer only group, one out of five dead

- Next phase: test effectiveness of feeding dsRNA
  - Advantages: ability to target BMSB-specific gene regions to decrease off-target effects
  - Challenges: delivery of dsRNA

**QUESTION:** Panel member asked who covers RNAi technology?

## **Objective 2: Develop monitoring and management tools for BMSB**

### **2.1 Developing Effective Monitoring Tools for Brown Marmorated Stink Bug Presented by: Tracy Leskey, USDA/ARS**

Summary:

- Identification of pheromone and other olfactory attractants
  - September 2011 successful in identifying BMSB pheromone #10 (Beltsville, MD) by using fewer bugs in cylinders (16 different stereoisomers)
  - Early spring March-April tried #10
    - Led to a broad validation in multistate trial. It's attractive early, more so than MDT in spring and not surpassed until mid-late summer.
    - Crude formulation gave identical responses
      - Doesn't need to be purified which means it's an economical product
  - Methyl (2*E*,4*E*,6*Z*)-decatricionate (MDT) attractive to adults only during the late-season
  - Traps baited with #10 captured ~15x more than control and ~3-4x more than other treatments.
  - Leveraged and In-Kind Support; USDA-ARS, USDA-APHIS, AgBio, Sterling/Rescue
  - Deployed a total of 350 traps across 12 states
  - Aggregation pheromone of BMSB and a synergist have been identified
  - These stimuli provide reliable, season-long detection of BMSB
  - Likely will need a higher loading of #10 if used alone. Synergist significantly increases attractiveness and sensitivity.
  - Optimization of pheromone and kairomone dispensers for monitoring BMSB
    - Commercial companies developing new formulations of MDT.
    - Commercial companies provided a small amount of #10 to formulate into different release devices.
    - Pending release-rate studies (Brunner and others)
- Season long field trials 2012
  - A total of 21 traps baited with light-based stimuli captured 13,457 adult BMSB in ~6 weeks during late summer
    - Traps provisioned with a white light source captured significantly more BMSBs and significantly more non-targets.



- Traps provisioned with blue light sources captured fewer BMSBs, but also fewer nontargets.
- Although captures of BMSB were lower in traps provisioned with black light sources, patterns of capture are significantly correlated among all light-based stimuli.
- Capture patterns essentially identical among white, blue and black light sources.

**COMMENT:** Panel member requested more trapping locations be initiated. Growers could assist with monitoring.

### **New OREI Grant**

**Presented by: Anne Nielsen, Rutgers University**

#### Summary:

- \$2.67 million grant over a 3 year period to identify management tactics for organic growers
- All work must be conducted on certified organic land or land “in transition”
- Five current farmer collaborators: Red Bud Farm, Rodale Institute, JEM Farm, Strawberry Creek Farm and Abington Organics
- 5 objectives
  - Develop habitat manipulation tactics based upon how host plant phenology impacts BMSB preference and dispersal
    - Identify top two trap crop candidates
    - Compare as perimeter border
  - Determine biotic and abiotic factors affecting adult and juvenile BMSB whole-farm movement
    - Factors affecting adult flight behavior
    - Factors affecting nymphal dispersal behavior
    - Characteristic of human-made structures of overwintering habit.
    - Develop and evaluate an overwintering trap using farm materials
  - Determine the identity and importance of extant natural enemies of stink bugs and their impact on BMSB populations
    - Impact of natural enemies
    - Impact of trap crops on natural enemies
    - Potential of Insectary plants to enhance mortality
    - Impact of organic insecticides on natural enemies
  - Evaluate integrated management plans for BMSB and endemic stink bugs specific to organic production systems
    - Barrier fabrics for cultural control
    - Integrated organic management in final year
  - Extension and outreach

**QUESTION:** Panel member asked if larger organic growers were going to be included in the grant? *Still identifying participants*

### **2.2.1 Evaluate efficacy of registered and developmental insecticides against BMSBs**

**Presented by: Greg Krawczyk**

**Co-Authors:** Chris Bergh, Galen Dively, Tom Kuhar, Tracy Leskey and Joanne Whalen

Summary:

- Direct residual and feeding effects based laboratory assessments of a large array of insecticides against BMSB have been performed. General efficacy across classes and research methodologies line up.
- Tested over 30 insecticides
  - Insecticide concentrations based on highest labeled rate and 100 gal/acre water output
- Field efficacy does not always line up with laboratory-tested efficacy of different insecticides (such as with Lannate and Thionex), but many products tested in the lab do have relative efficacy in the field.

### **2.2.5 Asian Natural Enemies**

**Presented by: Christine Dieckhoff**

Summary:

- Classical biological control is the best hope for sustainable management of BMSB
- Predators are out there but not that efficacious
- Reported low rates of parasitism from native natural enemies in fruit crops, but some higher rates reported in ornamentals and vegetable crops.
- From 2007-2012 Kim Hoelmer sampled 14 Asian locations in China, Japan and South Korea
  - Recovered 14 parasitoids which are now in colony and being tested at the Newark facility
- Focus is on *Trissolcus halyomorphae* for potential efficacy and release against BMSB in the US
  - Attacks solitary egg parasitoids of Pentatomidae
  - Projection of ~10 generations/year for *Trissolcus halyomorphae* compared with about 2 generations from the native parasitoids.
- USDS-APHIS-PPQ regulates the release of non-native biocontrol agents. Applicants must provide information of life history, biology, potential environment risks, and host specificity.
- Host specificity screening
  - Parasitoid females used in the tests
    - 24 hours old
    - Mated but naïve
    - Exposed to an egg mass for 24 hours
  - 20 replicates per parasitoid-host species combination
- In no-choice tests, *Trissolcus halyomorphae* attacked Podisus eggs
- Longevity study
  - Honey-fed lasted up to 100 days
  - Water only increased life by 8 days
- Pitfalls encountered

- Seasonality of egg mass production (fall/winter depression)
- Availability of non-target species
- Host plant requirements of non-target hosts unknown or incorrect
- Limitation of space and man-hours
- Disease outbreak in stink bug lab colonies
- At least 7 species of native egg parasitoids have been identified attacking BMSB in eastern United States

**QUESTION:** Panel member asked what thresholds are considered by APHIS in decision making for release of exotic parasitoids.

**Biology, Ecology & Management of Brown Marmorated Stink Bug in Orchard Crops, Small Fruit, Grapes, Vegetables and Ornamentals: Emphasis on Native Natural Enemies Presented by: Cerruti Hooks, University of Maryland**

**Co-Authors:** Ashley Jones, Kathy Kamminga, Joanne Whalen, John Tooker, Paula Shrewsbury and Tom Kuhar

Summary:

- Objective
  - Determine the species composition of parasitoids and predators of BMSB
  - Determine rates of BMSB egg mortality due to parasitism, predation and other causes
- Fate of BMSB eggs on woody ornamental plants in Maryland from June-September 2012
  - Total Sampled 24124
    - 46.3% hatched
    - 30.1% parasitized
    - 23.6% unhatched (unascribed mortality (predation or other unknown factor)
- Fate of BMSB eggs on sweet corn in Delaware in 2012
  - Sentinel eggs
    - Sweet Corn total sampled 323
      - 25.1% hatched
      - 6.2% parasitoid
      - 53.6% unhatched
      - 15.2% predator
  - Wild eggs
    - Sweet Corn total sampled 56
      - 53.6% hatched
      - 28.6% parasitoid
      - 0% unhatched
      - 17.9% predator
- Results of tether study (48 hr exposure time period)
  - 8 Aug 15 nymphs – 0 killed
  - 5 Sep 12 adults – 0 killed
  - 12 Sep 14 adults – 1 of 14 killed
- Pitfalls
  - Expand surveys to fruit trees, more sites and known perennial BMSB hot spots

- Compare species composition of natural enemies among different crops and habitats
- Parasitoid attraction to stink bug pheromone traps
- Compare egg mortality with local stink bug populations
- Determine if the activity of parasitoids can be enhanced through the provision of flowering plants

### **2.2.7 Cultural Control**

**Presented by: Doug Pfeiffer**

Summary:

- High densities of BMSB have been observed on both sunflower and sweet corn
- Trap cropping experiment – 2012
  - Two internal rows of peppers bounded by sunflowers of different planting dates
  - No significant difference between crops for all life stages

### **2.2.9 Host Plant Resistance**

**Presented by: John Tooker, Penn State University**

Summary:

- Host plant resistance on ornamentals (Holly Martinson, Erik Bergmann, Paula Shrewsbury, Michael Raupp, Department of Entomology, University of Maryland)
  - Survey of large commercial nurseries and found BMSB did not do well and are not a threat to greenhouses
  - No visible damage was found
- BMSB Saliva: Its characterization and role in inducing plant defenses (Gary Felton, Michelle Pfeiffer)
  - Bugs feeding: inject saliva, suck up partially digested plant material
  - Two types of saliva
    - Salivary sheath – anterior and posterior lobes
      - Sheaths will be deposited when they try to feed, even on plastic cups
    - Watery saliva – Salivary duct and accessory gland
      - Proteins in BMSB watery saliva and salivary sheaths
      - Protein content is clearly different
  - Saliva-based conclusion
    - BMSB nymphs do not survive on tomato plants sans fruit.
    - Counting sheaths on tomato fruit is not an accurate estimate of feeding
      - Bugs groom and many sheaths do not remain on the fruit.
      - Salivary sheaths have been used to estimate stink bug feeding in other crops.
    - Sheath and watery saliva can be collected independently.
      - Proteomic analyses indicate very little overlap between the two.
      - Watery saliva comprises a greater number of hydrolytic digestive enzymes.

- Functional analyses of sheath salivary proteins may reveal mechanisms of sheath formation
- Stink bug sheath saliva triggers jasmonic acid (JA) response, but not a salicylic acid (SA) response.
  - Only for sheath saliva that is collected from BMSB feeding on tomato.
  - Sheaths deposited from empty cups do not elicit plant response.
- Sheath saliva from tomato-fed bugs contains substantial amounts of tomato proteins
  - Including peroxidases which are absent from watery or sheath saliva deposited in cups.
- No evidence of yeast or bacteria in saliva based upon:
  - Culture dependent methods
  - Screening salivary proteins against bacterial or yeast databases.

**QUESTION:** Panel member asked how long does it take BMSB to produce a stylet sheath?

### **Objective 3: Establish effective management programs for BMSB in specialty crops**

#### **3.1 and 3.2 Crop Specific IPM Programs (Small Fruit)**

**Presented by: Cesar Rodriguez-Saona, Rutgers University**

Summary:

- Performing attract and kill studies with SPLAT in laboratory bioassays. Using bifenthrin as killing mechanism. Field experiments forthcoming.
- Spotted Wing Drosophila is a new threat to small fruit crops
  - 2008 – First US detection in California
  - 2010 – No reports in the Northeast
  - 2011 – First found in the Northeast
  - 2012 – Widely spread in Mid-Atlantic and Northeastern states

#### **3.1 IPM in Orchard Crops**

**Presented by: Chris Bergh, Virginia Tech**

Summary:

- Integrated Pest Management in many eastern orchards has been severely impacted
- Currently, IPM is mainly about “Integrated Pesticide Management” to:
  - mitigate BMSB effects
  - manage other pests
  - manage insecticide resistance
  - minimize 2 pest outbreaks
- Some pre-BMSB recommendations still relevant
- New/revised recommendations regarding product selection and timing predicated on new information from BMSB research and observations in the field
- Differences between pome and stone fruit

- Target mite eggs, San Jose scale and woolly apple aphid in pre-bloom
- In pome fruit, target first wave of overwintered adults and their progeny starting late May (in a “normal” year)
  - Overwintered adults may be more susceptible to insecticides than later generation(s)
  - Nymphs generally more susceptible than adults
- Scout to assess injury
- Apples from the upper canopy of trees in rows adjacent to woodland may show injury earliest
- Alternate-row-middle sprays through much of season
- Rotate among classes
  - BMSB may not be as prone to insecticide resistance due to extensive refugia, although other pests likely are
  - Maintain effective programs against CM and/or OFM (according to thresholds, DD models, and spectrum of activity)
  - Tank-mixed or premixed products
- In apples, reserve products most prone to incite 2 pests (and most effective against BMSB) until late season
  - Anecdotal reports of predatory mites tolerating pyrethroids
  - Instances of San Jose scale and woolly apple aphid (late season) outbreaks
  - Use Section 18 products (hopefully) wisely
- Suggestions for future research
  - Resistance monitoring in adult BMSB populations
    - Baseline susceptibility
    - Effects of selection pressure
    - Resistance stability
  - Generational changes in susceptibility within seasons
  - Susceptibility of predatory mites to pyrethroids
  - Management decisions based on BMSB monitoring & developmental models
  - Tactics based on behavioral manipulation

### **3.1 and 3.2 Crop Specific IPM Programs (Vineyards)**

**Presented by: Doug Pfeiffer, Virginia Tech**

Summary:

- Managing BMSB and spotted wing drosophila (SWD) together
  - Most of the same materials used for both species
- Elimination of pyrethroids from pest management guides in 2010
- Kaolin treatment in vineyard indicated it may have some control on BMSB

### **3.1 and 3.2 Specific IPM Programs (Ornamentals)**

**Presented by: Paula Shrewsbury, University of Maryland**

#### Summary:

- Short term mitigation of BMSB risk within ornamentals
  - Chemical management
    - Trials in nurseries on woody plants; Ready To Use (RTU) products for home gardens (lab); products for outside of building (lab and field)
      - Sprayed cups and let dry for 2 days for dry residue. Some effective uses of RTU
  - Nursery field trials (natural and caged BMSB)
    - Thiamethoxam provided control, but overall nursery results not very effective
    - Low population of BMSB may have been a contributing factor of the low effectiveness
- Establish Ornamental IPM Program for BMSB
  - Need more chemical efficacy
  - Host use
  - Biocontrol; species and hosts that favor natural enemies
  - BMSB biology/phenology
    - Associate significant life cycle activities with degree days
  - Spatial dynamics and movement
    - Immigration/emigration; edge effects, patch dynamics
    - Landscape plants/overwintering populations in structures
  - Develop educational materials and training events

### **3.1 and 3.2 Specific IPM Programs (Vegetables)**

**Presented by: Tom Kuhar, Virginia Tech**

#### Summary:

- IPM recommendations for BMSB on vegetables
  - No real action thresholds
  - Check field margins next to woodlots for the first sign of invasion
  - Direct examinations for adults and nymphs as well as for injured fruit/pods
  - Treating areas 30-50 feet from field edges next to woodlots may stop invasion (corn and beans)
  - Multiple applications spaced 5-7 days apart may be necessary, if re-invasion occurs
- Chemical control of BMSB in vegetables
  - Several pyrethroids and neonicotinoids as well as products containing both active ingredients provide effective (>60%) control of BMSB on vegetables
  - The only other efficacious insecticides on vegetables are the OP/carbamates: acephate, methomyl, and oxamyl
  - Though also effective, endosulfan will no longer be registered on vegetables in the future and should not be considered
  - All of the aforementioned insecticides are disruptive to natural enemies and can undermine IPM programs
- Sweet Corn

- BMSB potential risk from late June – Sept. Corn in northern VA was attacked in late June 2012
- Most commercial growers typically spray pyrethroids on a regular basis anyway for corn earworm control
- Growers relying on Bt transgenic corn solely will need to inspect fields
- Infestations occurring prior to pollination may result in incomplete kernel fill
- BMSB must be managed from ear shank emergence to harvest
- Neonicotinoid insecticides applied via drip irrigation or drench treatment
  - Pretty good control after 2 treatments

**Objective 4: Integrate stakeholder input and research findings to form and deliver practical outcomes**

**Economic Evaluation Team Report - 2012**

**Presented by: Jayson Harper, Penn State University**

Summary:

- What's gone wrong with the cost of spraying
  - 2009 – \$400 per acre, 8 sprays
  - 2012 - \$1000 per acre, 22 sprays
- Summary of Potential Research and Extension Output
  - Gauge the impact of BMSB on the profitability of producing a given commodity
  - Determine the costs and potential benefits of proposed management tactics
  - Evaluate potential physical and financial constraints faced by producers in implementing the proposed tactics
  - Fine tune management recommendations and provide feedback to producers on the status and commercial viability of proposed control tactics
  - Make information on cost and benefits of proposed management strategies available through extension channels
- Request from Jay Harper, as researchers develop new methods, provide him with data so he can help with economic values on techniques

**4.2 Outreach**

**Presented by: Carrie Koplinka-Loehr and Chris Gonzales, NEIPM Center**

Summary:

- Purpose
  - Build platform to provide educational materials to the specialty crop community
  - Launch website to deliver research findings and management recommendations to stakeholders
- Communication Channels
  - Poster
    - Distributed in print and electronically
  - Main Communication List



- Targets the majority of our contacts database
  - BMSB Core
    - Principal investigators on SCRI grant
  - BMSB Research
    - Those assisting with research
  - BMSB SAP
    - The Stakeholder Advisory Panel
  - BMSB Science Communication
    - For members of the public and grower communities who have an interest in findings from the project
  - BMSB SCRI Staff
- Website Development
  - September 25, 2012 launched the StopBMSB.org website
  - Findings are evolving and must update the website periodically. It must be dynamic
- BMSB Curriculum Pre-survey
  - Purpose
    - Gather feedback from our Outreach Advisory Group (OAG) on how to approach BMSB curriculum
    - Provide the backbone for a survey of the Stakeholder Advisory Panel
  - What we did
    - Brainstormed ideas at NEIPMC
    - Posted each specific idea in an online survey
    - Likert scale: Strongly dislike, dislike, like, strongly like
    - Sent e-mails inviting 8 members of OAG to respond and comment
    - Made follow-up telephone calls
  - Results
    - 6 of 8 members responded
    - OAG very supportive of ideas
    - No one strongly disliked anything
  - Curriculum Development Timeline
    - December 2012 Analysis Stakeholder Advisory Panel survey results
    - January – June 2013 assemble short talks into a series on the StopBMSB.org website
    - July 2013 soft launch
    - August 2013 full launch curriculum
- Continue to tailor the website to growers' needs and expand the grower survey to other states

## Open Discussion

### Summary:

- Continued discussion on curriculum and if video clip was necessary
  - Would just call the experts
  - What was to be gained from growers doing video clips?
    - There are many talks out there that we could link into them
    - Use what already exists
      - Who would gather this data and link it?
  - Webinars, have more of them, record them and post them on the site
    - Do not see growers using webinars
    - Facebook – pictures work versus video clips
    - If using videos keep it 1-5 minutes long
  - Could create videos in chapter style
  - Could have an executive summary in short version and long version so you would have a choice
  - Post PowerPoint slides to tell the story
  - Was infographic a good idea?
- Scholar site – by enrollment only
  - Upload projects there and project manager could move to link on StopBMSB.org
- How can we take Grower Survey or bring it to other states?
  - Could do it at extension meetings or BMSB meetings
    - Could do presentations as they are doing the survey to help explain it.
  - Eric Day will post survey on Scholar site. Anyone wants to do it let him know. He's trying to include other states and all commodities this coming year.
  - Can we use the survey to change process over time?
    - Yes, good idea
- How can we better present to Stakeholder Advisory Panel
  - Follow-up with conference call after meeting for ideas/issues that may come up later
  - What is the best way Stakeholders can give feedback? What can we say that matters?
    - Outreach Program
    - Stakeholders can point out areas needing more research and ones that aren't so effective
    - Seems we still have a lot to learn. Will BMSB be the next Japanese beetle and fade out? Mother Nature may just need more time to control BMSB. Stakeholders could push for the renewal of the project.
  - Row crops could contribute to soybean next to specialty crop. Where are the grains in this project (excluding soy and field corn)?
    - We made the case that those crops affect specialty crops. Row crop BMSB work being funded by Cotton Inc. USB. We're committed to sharing that info.
  - Traps – we need these traps out now. Give all this information to these producers and we will buy some and sort out which ones work best. Don't take 1.5 years to figure out what's best. We have a model.

- How will traps be used? Monitoring tool or control?
  - Monitoring and efficacy of spray program
  - Is it developed enough to put in hands of growers?
  - There are a lot of questions about functionality of the trap itself.
  - Wouldn't want to put a good trap in the middle of the orchard; could damage the tree (attract BMSB).
  - Cases show other sampling works better than just putting traps out there.
  - Put it out there and next year we'll correct the things we do wrong. We're all experiencing frustration and impatience. Haven't put the first trap up on farm yet because there's no protocol. Perhaps there are folks who could partner with growers to get more traps and locations out in the field and help gather more data.
- Outreach
  - StopBMSB.org is fantastic but need to use what is already out there. Email update sent when there is new information and it can direct us to where to go for info. Use resources that are already in place. Not everyone has a Facebook page.
  - National Fruit Council is willing to get the word out about our website.
- Economic Data
  - Create protocol so growers can give specific data to Jay Harper. What format do you need it in?
- Overwintering
  - Stop overwintering studying because results were so small.
  - Willing to stop if everyone agrees.
  - Important to find out the proportion of where stinkbugs overwinter; we don't know
  - Do BMSB leave homes and then to woods?
  - Harmonic Radar should help with movement study.
- Duplication of Effort
  - Concern over duplication of effort was taken seriously last year and gives us feedback so we can develop the 2013 plan.
- New lures
  - Will new lure be available early in 2013? Last year there was a shortage of #10 and time is of the essence because the seasons go by quickly.