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

December 1, 2015

Submitted by:

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Table of Contents

Brown Marmorated Stink Bug Stakeholder Advisory Panel Participants

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Introductions and Overview of 2015 Progress

Presented by: Tracy Leskey, USDA/ARS/AFRS

Summary:

- Introduction of each person in attendance.
- Information for attendees regarding the contents of program packet provided.
- Presentation on Stakeholder Advisory Panel purposes, objectives, funding, and accomplishments to date.
- Reviewed published manuscripts which supported each objective and reviewed each objectives' progress along with further pending questions
- Presented number of key personnel trained
- Feedback from 2014 SAP meeting reviewed

Oral Presentation Summaries

Objective 1. Voltinism, Dispersal, Landscape and Temporal Risk Factors

Presented by: Anne Nielsen, Rutgers University

Summary:

- Overwintering BMSB emerged over a period of ~2.5 months
- Early, smaller peak of emergence appeared to be primarily associated with a period of warmer temperatures (smaller and/or weak bugs depleted of resources?)
- Later, larger peak associated with temperature and/or change (stabilized?) in photoperiod
- Pheromone traps appeared to reflect onset emergence reasonably well
- Marked bugs assumed to have dispersed from emergence site
- Need to conduct studies in north-south transect with naturally settling adults
- Individual-based model developed to predict voltinism.

Objective 1. Nutritional Ecology including diet optimization, salivary gland characterization, gut symbionts and colony procedures

Presented by: Chris Taylor, University of Maryland and Nik Wiman, Oregon State University

Summary:

- Adults emerging from overwintering exhibit a steady decline in lipids, glycogen, and sugars as they emerged later in the season. This suggests that overwintering for longer periods of time uses up more nutrient reserves.
- Adults that emerged from overwintering in May-June had numerically lower weights and nutrient reserves than their counterparts collected from holly in OR at the same time. This suggests that feeding on host plants may have replenished their reserves.
- Mixed host plant diets proved to be optimal for nymphal survivorship and development
- Nymphs reared on mixed diets and ToH developed faster and they resulted into bigger and heavier adults

- Peach appeared to be the most suitable single host for BMSB development among the host plants tested
- Nutrient levels of adults that developed from nymphs reared on different diets were different across treatments
- Results suggest that *H. halys* optimizes diet by utilizing multiple hosts during its development
- Colony Rearing and Diapause - Summary of findings
    - Optimal temperature and humidity
    - Mixed diet of proteins and carbohydrates
    - Diapause considerations
    - Issues with microsporidian infection

Objective 1. Commodity Report – commonalities and distinct aspects (injury diagnostics, period of risk, how they invade, level of risk, etc.)
Presented by: Chris Bergh, Virginia Polytechnic Institute and State University

Summary:

- Feeding by 2nd & 3rd instar BMSB nymphs on apples and pears did not cause as much injury as feeding by 4th & 5th instars or adults
- BMSB abundance on fruiting ornamentals tracked seasonal availability of fruit. De-fruiting trees caused pronounced reduction in BMSB abundance
- Initial indications that feeding by BMSB on Chardonnay and Pinot Noir grapes tended to make them more vulnerable to SWD infestation
- Damage on Bosc more severe than on d'Anjou pears from same exposure to BMSB just before harvest
- BMSB feeding injury increased ethylene production and respiration rate in Bosc but not d'Anjou pears during cold storage

Discussion Break:

- Photoperiod inclusion in individual-based model – Homestead FL data –populations will not be severe.
- Are minerals important for the development of BMSB – unknown
- If you find microsporidia in your colonies – contact Anne Hajek at Cornell, as these could be used as a biocontrol measure. Field collections showed high 20 to 25 percent parasitism – this may help biocontrol
- More BMSB overwintering – outside overwintering, more bugs, more forests. Has to be overwintering – 35,000 bugs shed at top of mountain
- Pollinator concerns may result in loss of neonics in management program. Neonics – EPA to restrict for applied – application on labels very restrictive. Management plans need to adapt and give growers alternative tools.
- Standardization of traps and lures for each specialty crop, but likely not same across crops.
- Insecticides work – possible resistance. Pyrethroids/neonicotinoids. Baseline susceptibility needs to be tracked – consider baseline – impact of insecticides

Objective 2. Short-Term Mitigation (Insecticide-Based Management Benefits and Challenges)
Presented by: Greg Krawczyk, Penn State University

Summary:

- Most effective insecticides against BMSB
  - Pyrethroids (IRAC Group 3A)
    - Bifenthrin (Brigade)
    - Fenpropathrin (Danitol)
    - Cyfluthrin (Baythroid)
    - λ-cyhalothrin (Warrior)
  - Neonicotinoids (IRAC Group 4A)
    - Dinotefuran (Venom, Scorpion)
    - Thiametoxam (Actara)
    - Clothianidin (Belay)
    - Imidacloprid (Provado, Admire Pro)
    - Acetamiprid (Assail)
  - Other (IRAC Groups 1A, 1B, 2A)
    - Methomyl (carbamate) (Lannate LV and SP)

Objective 2. Monitoring Tactics for BMSB
Presented by: Tracy Leskey, USDA

Summary:

- Identification and commercialization of BMSB aggregation pheromone and pheromone synergist
- Early season attraction documented for BMSB from March 20-April 17, 2012
- Two-component BMSB aggregation pheromone identified - Khrimian et al. 2014
- No significant difference in BMSB responses to varying levels of purity
- Collaborations with commercial companies throughout the project.
- Provided commercial collaborators with samples of BMSB pheromone for formulation and testing.
- Coordinated lure trials in 2014 and 2015 with current commercial formulations.
- Most lures perform equally as well as the experimental standard.
- Traps provisioned with white light sources were most attractive in the field, but blue light sources were most specific for BMSB

Objective 2. Biological Control of BMSB (Native and Classical)
Presented by: Christine Dieckhoff, USDA

Summary:

- *Trissolcus japonicus* is oligophagous - it attacks several Asian pentatomid species
- These populations are adventive – they were not released nor did they escape quarantine!

- DC area populations are genetically similar to populations sampled in Japan and S. Korea
- WA population is genetically similar to populations sampled in S. Korea
- On average, about 40-50% of the eggs we found of other stink bugs were parasitized; i.e. 10-fold the number of eggs parasitized compared to naturally laid BMSB eggs. Most of these (~70%) are Scelionidae – Trissolcus and Telenomus spp.
- Parasitism of sentinel and naturally laid eggs low by native natural enemies throughout season, across years and locations (2006/2007 through 2015)
- Survey of parasitism of non-BMSB naturally laid eggs suggests that native egg parasitoid species are present and active in the same habitats as BMSB
- Species composition of sentinel and naturally laid eggs:
    - dominated by *Anastatus spp.* (Eupelmidae)
    - highly variable between years
    - proportion of undeveloped eggs highly variable between year, partly due to state of egg mass at deployment (frozen vs. fresh)

Objective 2. Other control tactics (progress on cultural, behavioral and RNAi)
Presented by: Rob Morrison, USDA

Summary:

- The major BMSB secretion compound (C13) has no effect on feeding activity.
- E2-decanal (E2) demonstrate dual functions in petri dish assay. At low concentration (>100 µg), it acts as feeding stimulant; while at high concentration (<100 µg), it acts as feeding deterrent.
- A blend of tridecane (C13) and E2-decanal (E2) (1:1 ratio) showed significant feeding deterrent activity.
- Isolongifolenone (En), a mosquito and tick repellent, exhibits strong feeding deterrent activity.
- A blend of C13, E2, and En (1:1:1 ratio) also exhibits strong feeding deterrent activity.
- Although identified feeding deterrents are natural products, they cannot be directly applied on the plants (surface burning). New formulation is ready to be tested in the field this fall.
- The identified feeding deterrents/repellents can be easily commercialized and used for protecting agricultural crops from *H. halys* damage in support of ongoing *H. halys* management programs.

Objective 3. IPM Principles for BMSB management
Presented by: Tom Kuhar, Virginia Polytechnic Institute and State University

Summary:

- BMSB is a border-driven pest and we should focus on border-driven management tactics – border sprays, attract and kill, etc.
- Monitoring tools being developed for specialty crops
- Trap captures reflected relative, local densities of BMSB in various studies.

Threshold = 10 adults per trap resulted in a 40% reduction in insecticide applications with injury at harvest statistically equivalent to blocks treated weekly in apple. Baited traps can be used to guide management decisions in apple orchards.

- Net structures fall into three basic types depending on their use: A completely enclosed orchard, that a tractor can be driven through, has both top and sides. A sturdy structure (posts and wires) is required to support the nets and entryways.

Objective 4. Extension/Outreach efforts at state, regional and national levels.
Presented by: Chris Gonzales, Northeastern IPM Center

Summary:

- 3,500 stakeholders on Center e-mail list
- 375 recipients on BMSB e-mail lists
- 4,600 regional addresses receive print
- Facebook: 267 likes
- Twitter: 1,911 followers / 225 retweets (past year)
- YouTube (over 27,000 views in past year, 52 subscribers)
- Flipboard (81 viewers)

Objective 4. Economics of BMSB
Presented by: Jay Harper, Penn State University

Summary:

- Penn State Logo Change
- More data on the impact of BMSB on the cost of producing apples, peaches, and tomatoes will be evaluated in 2016.
- Will be helping determine the costs and potential benefits of proposed management tactics in 2016 (and beyond).
    - Estimate cost and benefits of proposed management strategies and make available through extension channels.
    - 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 strategies.

Other Related Projects:

OREI
Presented by: Anne Nielsen, Rutgers University

Summary:

- Sorghum was generally the most attractive trap crop tested for BMSB

    - Sunflower was more attractive earlier in the season with sorghum becoming more attractive in August
- Sunflower is attractive to natural enemies
- Colonization of cash crop was delayed
- Higher damage in peppers occurred under 'high' pressure
- Also attractive to native stink bugs
- Nymphs have a strong walking capacity.
- Can disperse 10m in 3 hours
- Nymphs show strong response to the olfactory attractant and traverse large distances to reach source
- Nymphs select host plants
- Based off of phenology
    - Preference for fruiting bodies
    - Identified common odors correlated with attraction
- Egg mass predation is higher in organic systems than conventional
- Most predators are generalists or opportunists
    - Sucking predators, orthopterans
- Can be increased through habitat manipulation
    - Until *T. japonicus* is widespread, focus should be on plants that increase predator community
        - Horsemint (*Monarda* sp) and Coreopsis
    - Insecticides like Entrust decrease NE populations
- Parasitism is increasing
- Is Organic Management Feasible?
    - Yes, *under moderate pressur*e!
- Understand hot spots on the farm
    - Key early season host plants
    - Crops that are preferred hosts by all life stages
- Manipulate the habitat surrounding these areas
    - Support natural enemies
    - Trap crop using sunflower and sorghum
    - Re-design trap crop layout
- Under intense BMSB pressure the finest mesh netting provides protection from stink bug injury
- Remove overwintering populations on-farm

SARE Attract and Kill System for Apple
Presented by: Brent Short, USDA

Summary:

- Lower cost lures
    - Competition/Volume/Refinement of production
    - Smaller doses

    - Inclusion of Host Plant Volatiles
- Fewer lures
    - Fewer per tree and/or fewer baited trees
- Less frequent spray applications
    - Threshold + Perimeter-Based Management
- Impact on farm-level management
- Long-term reduction of BMSB populations

United Soybean Project
Presented by: Galen Dively, University of Maryland

Summary:

- Soybean yield sampling – drop off/2 min visual count threshold
- Difference in temperance – aspect slope
- Pocket guide – card with lanyard
- Reduced yield – doesn't fill pod – wait until it turns color
- Presented project results and information on the biology and management of BMSB at 13 invited out-of-state crop conferences and professional events and 58 in-state producer meetings
- Six scientific papers on the results of the project are either in the review process or published.
- Produced an extension field guide that summarizes much of what was accomplished in this project. http://unitedsoybean.org/brown-marmorated-stink-bugs/

Integrating BMSB management into tree fruit IPM
Presented by: Brett Blaauw, Rutgers University

Summary:

- IPM-CPR reduces insecticide use by up to 75%
- Pest control and fruit damage at levels equal to current management recommendations
- Promising data in apples as well
- May reduce negative impact on natural enemies
    - Important for secondary pests?

Final Discussion

- 25 percent injury – late start in applying – near forests – using pheromone trap – increased 4 traps 16 sampling sites – 8-10 percent really late season
- go for additional grant
- Bring everyone together after field season
- End Aug 2016 – go on by webinar
- Helpful counts – move ahead – develop threshold – trap and lure standard

- Project – reduce species – invasive species – stronger controls – will talk to you about it – agenda again with less insecticide
- Working Group meeting will continue – growers invited and can still come
- Very impressed with collaborator communication – real gift – appreciate appointment and to see what is going on with BMSB and as a Stakeholder Advisory Panel member

Next Steps/Assessments

- Wrapping up – Final grant ends August 31, 2016
- Hope to use the input from each of you for grading objectives/priorities
- Three pieces –
    - SCRI Stakeholder Review - Standard Feedback Form
    - BMSB NEIPM Priorities
    - BMSB Western Priorities
- Smithsonian – Genome *Japonicus* Grant submitted
- OECD funding in Europe?
- OREI/OREF/SARE
- Stop Pest/HUD/NPM
- Private Donors
- Gates Foundation
- Specialty Crop Block grants
- Research and extension personnel were given thanks for being such hard workers
- Nice Job! Team effort