Brown Marmorated Stink Bug
IPM Working Group Meeting

Carvel Research and Education Center
University of Delaware
16483 County Seat Highway
Georgetown, DE 19947

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Submitted by:

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Executive Summary

The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål) continues to spread throughout the United States. BMSB has been detected in 41 states and 2 Canadian provinces, posing severe agricultural problems in 6 states and nuisance problems in 15 other states. Large populations are now established in PA, NJ, DE, MD, WV, VA and D.C.; each state documented severe losses in crops and serious nuisance problems from BMSB since 2010. Agricultural and nuisance problems have been reported in KY, NC, NY, OH, OR, TN, WA. Though crop losses have not yet been reported, they are considered a nuisance problem only in CA, CT, IN, NH, MA, MI, RI and VT. In addition, BMSB has been detected in AL, AR, AZ, FL, GA, HI, IA, ID, IL, KS, ME, MN, MO, MS, NE, NM, SC, TX, UT, and WI. The BMSB IPM Working Group updated the BMSB map that is published on the www.StopBMSB.org web site; VT was added to states now experiencing nuisance pest problems.

The ninth formal BMSB Working Group meeting was held at Carvel Research and Education Center in Georgetown, Delaware, on June 16th, 2014. Research and extension personnel from Rutgers University, USDA-ARS, Penn State University, Cornell University, Ohio State University, University of Delaware, University of Maryland, Virginia Tech, University of California, University of Minnesota, University of Guelph, WV Wesleyan College as well as EPA, Northeastern IPM Center, Agriculture and Agri-Food Canada, Bedoukian Research, California Department of Food and Agriculture, CABI-Switzerland, Florida Department of Agriculture and Consumer Services, Hercon Environmental, National Peach Council, Oregon Department of Agriculture, Rodale Institute, U.S. Geological Survey and industry representatives attended the meeting. In addition, participating through webinar were representatives from the University of Connecticut and Ag Canada, industry members from DuPont Pioneer, AgBio, and South African Subtropical Growers Association.

There were approximately sixty-five participants in attendance. Specific discussions workshops were held on identification of BMSB, blacklight trapping, pheromone-based trapping and the injury diagnostics caused by BMSB in fruits, vegetables, and field crops. In addition, research and outreach updates included BMSB damage to lima beans, cold hardiness of BMSB, BMSB symbionts, BMSB ID and light trapping as well as pheromone-based trapping protocols for BMSB and the benefits of the BISON.

A 1.5 day workshop on identification of biological control agents also was held and led by Kim Hoelmer, Christine Dieckhoff, Matt Buffington and Elijah Talamas.

Research Priorities

Rank	Research Priority	Mean Score	# Responders
1	Development of IPM-friendly management tactics	87	33
2	Biocontrol agents--identification and study of parasitoids, fungal pathogens, and predators (native and foreign)	82	33
3	Evaluate efficacy and host range of candidate classical biological control agents	76	33
4	Evaluation of parasitoid host specificity	75	33
5	Response of indigenous natural enemies in relation to BMSB densities and their potential for management	73	33
6	Studies of basic BMSB behavior (host preferences, movement, responses to visual cues)	72	33
7	Determine factors affecting population densities	70	33
8	Impact of landscape and habitat on population (local)	69	33
8	Further study of pheromone-based monitoring (e.g. active space, trap design, attractants)	69	33
9	Define damage diagnostics, economics of injury and threshold	68	33
10	Standardized sampling methods	65	33
11	Host utilization, preference, and range	64	33
12	Examine overwintering biology (e.g. triggers for seeking and leaving sites; overwintering mortality factors)	63	33
12	Crop susceptibility and timing	63	33
12	Investigation of host-plant volatiles as attractants	63	33
13	Role of the gut symbionts and their potential for management	62	33
13	Evaluate effects of BMSB management plans on beneficial agents, including pollinators	62	33
14	Studies of basic BMSB biology (physiology, generations)	61	33
14	Develop economic models that include injury, monitoring and management costs	61	33
15	Identification of potential repellents	59	33
16	Examination of potential for trap-cropping	58	33
17	Mapping and assessment of distribution	57	33
18	Develop forecasting models to ID new risk areas, presence and where BMSB is and will not be	56	33
19	Develop baseline insecticide toxicity data for resistance monitoring	55	33
20	Assess secondary pest outbreaks related to chemical control of BMSB	53	33

Research Priorities *(continued)*

21	Evaluate potential impacts of cultural control measures	52	33
22	Determine how far will BMSB travel to overwintering sites	51	33
23	Standardize multiple methods for screening of new insecticide materials	49	33
23	Validate current physiology and phenology models in laboratory	49	33
24	Determine low and high temperature thresholds for all stages	48	33
24	Study potential for damage of harvested/value-added crops by contamination with BMSB	48	33
25	Evaluate impact of orchard groundcover management	47	33
25	Assessment of displacement of native stink bugs	47	33
26	Evaluate long term sub-lethal effects on BMSB (e.g. effects on reproduction)	45	33
26	Risk analysis of overwintering populations in natural landscapes	45	33
26	Determine why BMSB appears to not be present in coastal plains	45	33
26	Determine the impact of elevation on overwintering sites	45	33
27	Evaluate landscape-level/watershed-scale population distribution (regional - not local)	42	33
27	Determining monitoring strategies for urban areas	42	33
27	Determine conservation bio control efforts for indigenous natural enemies	42	33
28	Development of toxicants and inhibitors for plant transgenic delivery	40	33
29	Use of toxins in combination with attractants	36	33
30	Examination of cross-attractancy of BMSB and green stink bugs	35	33
30	Assessment of economic impact in urban environment	35	33
31	Evaluate potential impact of vertebrate predation	33	33
32	Methods development and improve rearing protocol for long term sustainable colonies	32	33
33	Examine interactions between native and exotic parasitoids (additive, synergistic or antagonistic)	3	33

Priority rank is based on scores provided by individual Working Group participants (importance of a particular priority on a scale of 0-100), calculating the mean value for each, and ranking them accordingly.

Extension Priorities

Rank	Extension Priority	Mean Score	# Responders
1	Develop revised and unified management plans	75	33
2	Education programs to growers and the general public	74	33
3	Deliver economic injury thresholds	71	33
4	Coordinate efforts of state and regional extension programs	69	33
4	Educating professionals to pest ID and diagnosis of injury	69	33
5	Education programs relevant to development of biological control projects	66	33
6	Demonstrate field application techniques for chemical control	54	33
6	Include education programs relevant to classical biological control	54	33
7	Educational programs relevant to invasive biology using BMSB	53	33
7	Educational programming for structural and landscape industries	53	33
8	Initiate public awareness campaigns - posters, public service announcements, educational materials, etc.	51	33
9	Develop treatment recommendations and guidelines for urban environments	50	33
9	Raise awareness of importance of BMSB as pest - APHIS, local political channels, etc.	50	33
10	Extension outreach and education programming for urban environment/homeowners	46	33
11	Use BMSB as an opportunity to educate children	37	33
12	Structure extension groups by commodity or region	31	33
13	Establish links between eXtension community of practice (COP) and stopBMSB.com.	25	33
14	Direct homeowners to local politicians for complaints	12	33

Priority rank is based on scores provided by individual Working Group participants (importance of a particular priority on a scale of 0-100), calculating the mean value for each, and ranking them accordingly.

Regulatory Priorities

Rank	Regulatory Priority	Mean Score	# Responders
1	Product testing and labeling of new active ingredients/products - only low toxicity/IPM compatible	71	33
2	Use of toxins in combination with attractants (regulatory status)	65	33
3	Define the economic and ecological threat	61	33
4	Expand use of existing registered products	60	33
5	Coordinate interagency and interdisciplinary funding	57	33

Priority rank is based on scores provided by individual Working Group participants (importance of a particular priority on a scale of 0-100), calculating the mean value for each, and ranking them accordingly.

Consumer/Urban Priorities

Rank	Consumer/Urban Priority	Mean Score	# Responders
1	Development of IPM friendly management strategies (trap style and efficacy, overwintering site selection, insecticide timing, repellent -push/pull, efficacy of treating exterior plants/landscapes)	63	33
2	Preventative measures for reducing entry into human-made structures - outreach needed	61	33
3	Define triggers for movement into homes	58	33
4	Important biological control agents around residential areas	56	33
5	Forecasting population size	53	33
6	Evaluate materials for home-garden and home-landscape protection	52	33
7	Determining repeated entry and exit by BMSB from overwintering sites	44	33
7	Evaluate efficacy of insecticides/killing agents for homeowners	44	33

Priority rank is based on scores provided by individual Working Group participants (importance of a particular priority on a scale of 0-100), calculating the mean value for each, and ranking them accordingly.

Overall Priorities

Rank	Category	Overall Priorities	Votes
1	Research	Development of IPM-friendly management tactics	23
2	Research	Biocontrol agents--identification and study of parasitoids, fungal pathogens, and predators (native and foreign)	16
3	Extension	Education programs to growers and the general public	12
4	Consumer/Urban	Development of IPM friendly management strategies (trap style and efficacy, overwintering site selection, insecticide timing, repellent -push/pull, efficacy of treating exterior plants/landscapes)	10
5	Research	Evaluate efficacy and host range of candidate classical biological control agents	9
6	Research	Response of indigenous natural enemies in relation to BMSB densities and their potential for management	8
6	Research	Further study of pheromone-based monitoring (e.g. active space, trap design, attractants)	8
7	Research	Evaluation of parasitoid host specificity	6
7	Research	Studies of basic BMSB behavior (host preferences, movement, responses to visual cues)	6
7	Research	Define damage diagnostics, economics of injury and threshold	6

Overall priority rank is based on Working Group participants designating their five top priorities across all categories; those priorities receiving designations by at least 10% of the membership were ranked.

BMSB Presentations

Presented by: Tracy Leskey[1] & George Hamilton[2]
USDA-ARS-AFRS[1] and Rutgers University[2]
Department of Entomology

Summary:

- Welcomed everyone to the 9th annual working group meeting
- Overview of day's schedule
- BMSB Distribution in North America - Updated BMSB map
- Priorities discussed – priority development
- BMSB News Reel

Progress on BMSB Outreach
Presented by: Steve Young
NE IPM Center

Summary:

- Offering a DVD for tracking BMSB
- Stink Bug Specimens for ID and Kit
- BMSB Stink Bug Identification Guide , Second Edition
- Survey of growers continuing
- Collection of articles were translated from Chinese, Japanese and Korean
- Chemical Controls for Sweet Corn was added to StopBMSB.org website
- StopBMSB Content picked up in Media, Social Media, Pinterest
- Two stories on BMSB appeared in latest *IMP Insights*
- There is a Spanish search box on StopBMSB.org website

Updates on BMSB Survey
Presented by: Keoki Hansen
Cornell University

Summary: Survey is not finished – will provide slides and results at a later time

Seasonal Field Parasitism of *Halyomorpha halys* and Co-occurring Non-target Species in China
Presented by: Tim Haye
Co-Authors: Tara Gariepy, Jinping Zhang
CABI Switzerland

Summary:

- *T. japonicus* most dominant species throughout the season, likely not much influenced by host plant
- Ecological host range of *T. japonicus* contains other species*, e.g. Plautia* and *Dolycoris*
- *T. japonicus* is an oligophagous species, non-target attacks likely, risk-benefit analysis needed
- *T. flavipes* less abundant, but maybe having a less broad host range
- *Anastatus* of minor importance in controlling *H. halys*
- 2014: exposure of egg masses at natural sites,
- Exposure of additional non-target species, including the predatory species *Arma chinensis*

Damage in Lima Beans
Presented by: Joanne Whalen
University of Delaware

Summary:

- No significant differences for number of pods or number of beans per plant – no pod and seed abortion ?
- No significant timing x density interaction
- Highest percentage damage during pod fill – both % damaged beans and puncture wounds per bean -- similar to native stink bugs
- 5 stink bugs per plant – higher percentage of damaged beans

Influence of Landscape Heterogeneity on Stink Bug Damage in Processing Tomato
Presented by: Kevin Rice
Penn State University

Summary: No slides – needs more analyses and conclusions

Molecular Studies on BMSB and Its Bacterial Symbiont
Presented by: Raman Bansal
Ohio State University

Summary: Will have slides posted after paper is published.

BMSB ID & Light Trapping
Presented by: George Hamilton
Rutgers University

Summary:

- Advantages
  - Catch both sexes
  - Season long attraction
  - Can detect 1st incidence on a farm
- Disadvantages
  - Cost of traps
  - Labor expense
  - No correlation with crop damage thus far
  - Lack of nymphal data

Bacterial Symbiont Genomics of BMSB
Presented by: Zakee Sabree
Ohio State University

Summary: No slides posted.

When *Halys* Freezes over: Cold Hardiness of BMSB
Presented by: Theresa Cira[1]
Co-Authors: John Aigner[2], Tom Kuhar[2], Rob Venette[3], Bill Hutchison[1]
University of Minnesota[1], Virginia Tech[2] and USDA Forest Service Northern Research Station[3]

Summary:

- Cold drives behavior
  - Study the triggers for overwintering behaviors
  - Study feeding at colder temperatures
- Cold can be directly lethal (but ecological relevance?)
  - Develop an estimate for what % of population is exposed to it (remains outdoors in winter)
  - What shelters are sufficient buffers
- Sub-lethal effects of cold may be more important for BMSB
  - Investigate fitness effects of sub-lethal temperatures
  - Investigate effects of multiple stressors (e.g. insecticides, time)
- Indications of phenotypic variability in cold hardiness potential
  - Understand the overall variability in cold tolerance
  - Investigate mechanisms for variability (e.g. diet, genes)
  - Predictions need to account for geographic acclimation

Spatiotemporal Dynamics and Movement of *Halyomorpha halys* (Stål, 1855) (Hemiptera: Pentatomidae) In and Between Adjacent Corn and Soybean Fields

Presented by: Dilip Venugopal
University of Maryland

Summary: No slides – waiting on publication

Integrated BMSB Management in Organic Peppers
Presented by: Peter Jentsch
Cornell University

Summary:

- 2013 BMSB Injury to Organic Pepper Hudson Valley, NY
    - The species was first documented in NY in the Hudson Valley Region in 2008. In 2012, the pest caused significant injury to pome fruit in three NY counties.
    - On August 12^{th}, 15 percent injury was observed in a 1-acre organic planting of Jalapeno Peppers in Marlboro, NY.
- Integrated pest management using 4 components employed to reduce BMSB field populations.
    - Netting
    - Halogen light
    - Pheromone blend
    - Biological control (*Beauveria bassiana*)
- Employing 3 applications of Mycotrol-O @ 16 oz./A were made on 14 August, 1 & 14 September. Applications on 1 & 14 September timed post rain events.
    - 2 nets attached to 8' posts were positioned along the northeastern edge of the field, 30m apart
    - 2 pheromone lure sets (USDA # 10 + MDT) placed along top edge of 7' x 14' netting, used to attract BMSB away from agricultural commodity as trap and kill stations.
- BMSB populations were observed on Black Walnut and Tree of Heaven, appearing to have acted as intermediate hosts, fostering migrations dispersal
- BMSB locations on netting traps with <u>only pheromone</u> were equally dispersed similar on the field and forested sides of net.
- Nights when lights were on, BMSB were heavily concentrated on the field side in front of the light, with higher numbers observed.

Pheromone-Based Trapping Protocols for BMSB
Presented by: Tracy Leskey
USDA-ARS-AFRS

Summary:

- Key Components of Trap-Based Monitoring
    - <u>Visual Stimulus</u>

        - Black pyramid (trunk-mimicking stimulus)
    - Olfactory Stimuli
        - 2-component BMSB pheromone
        - MDT (acts as a synergist)
    - Capture Mechanism
        - Tapered pyramid attached to inverted funnel jar
        - DDVP strip
    - Deployment Strategy
        - Traps placed in border of crop. Greatest captures (highest risk location along wood lines)
- Progress Toward Identification and Commercialization of BMSB Aggregation Pheromone *USDA-ARS, Beltsville, MD and Kearneysville, WV*
    - General Protocol
        - Black pyramid traps
        - Three odor treatments
            - 1) #10 (10 mg)
            - 2) MDT (119 mg) 10X greater
            - 3) unbaited control
        - Traps are deployed between wild host habitat and agricultural production areas.
        - Traps were deployed in mid-April and left in place season-long.
- 2013 Broad Multi-State Trial
    - Document season-long patterns of activity with pheromone and pheromone + synergist.
        - #10 (10 mg)
        - #10 (10 mg) + AgBio MDT (66 mg)
        - #10 (10 mg) + Rescue MDT (120 mg)
        - Control
    - ME, NH, CT, MA, PA, NJ, VA, WV, MD, DE, NC, FL, AL, MI, OH, IA, MO, UT, CA, OR, WA.
    - Bulk synthesis funded by USDA.
- BMSB aggregation pheromone and synergist have been identified.
- Can be synthesized at a commercial scale.
- Provide ability to reliably detect and monitor BMSB populations season-long.
- Sensitivity can be increased by increasing dose/release-rate of materials.
- Kill Strip Increased Captures 250%
- Development of a Trap-Based Treatment Threshold for BMSB in Apple
    - Visual Stimulus
        - Black pyramid trap
    - Olfactory Stimulus
        - BMSB Pheromone + MDT
    - Capture Mechanism
        - Tapered pyramid to inverted funnel jar with DDVP toxicant strip
    - Deployment Strategy
        - Traps placed in perimeter row of orchard
- Black pyramid trap is a good baseline trap.

- Must use combination lures and kill strip.
- Risk to crops and likelihood of detection greatest near wood lots.

BISON: 137M Mapped Species Records Now Includes IT IS-Enabled Search
Presented by: Annie Simpson
U.S. Geological Survey

Summary:

- Developed by the U.S. Geological Survey Core Science Analytics, Synthesis, & Libraries (CSASL) Program
- A species occurrence data aggregator providing 137+M species occurrence records for the U.S. and Territories including:
    - Almost every US species (animals, plants, fungi)
    - Various data types: observation-based, natural history collections (specimen-based), and literature-based
    - Federal and non-federal data
- Increase Data Access, Exposure,
- Discoverability, and Quality
- Data Mobilization through integration and application of standards, open data technologies, machine readable access
- Combine specimen and observation data with other data layers to detect relationships and patterns.
- Search is now more than "exact match" of a name, so taxon groups can be searched, including synonyms
- Uses powerful name resolution ability of the Integrated Taxonomic Information System
- 40+ data fields now supported, including several verbatim from provider
- Support for voucher images, video, audio files (later this summer)
- BISON Data Workflow Products
    - Final Package – original dataset + BISON (enhanced) dataset + metadata record (linked and archived) + ReadMe file (record of BISON data modifications)
    - Standardized data – Darwin Core format, Scientific Name mapping to ITIS, FIPS Code location references
    - Data updates – ongoing for *living* datasets
    - Data Quality – improvement reports/recommendations sent to Data Provider
    - Web and Web Services access – inc. mapping and visualization, and integration with other data layers
    - Multi-format data download – .csv, .kml, .zip
    - Machine access – via API
- BISON & BMSB-NEIPM -- *How can BISON help members of the BMSB-NEIPM working group?*
    - Submit-a-dataset"

- Smarter search including synonyms and children; search for host species and species groups
- Post BISON API search results on your Web pages as canned search results
- Use BISON data or visualizations in your publications

Stink Bug Impact Survey Longitudinal Data
Presented by: Eric Day[1]
Co-Authors: Theresa Dellinger[1], and Carrie Koplinka-Loehr[2]
Virginia Tech[1] and NEIPM[2]

Summary:

- State by state data:
  - 2011 one meeting, 21 respondents
  - 2012 Eighteen meetings, 833 respondents
  - 2013 Two meetings, 80 respondents
  - 2014 Twenty meeting, 757 respondents
  - 4 years, 41 commodity meetings, 1691 Respondents
  - Respondent = Grower, Farmer, Manager, Worker, Consultant, Educator
- Range:
  - 58% Reporting damage in Virginia in 2012 to 88% Reporting damage in Maryland in 2014
- Question 1. Reported primary occupations followed by number of respondents. Total of 984 and 779 respondents in 2012 and 2014, respectively.
- Question 2. Reported location of respondents. Total of 824 and 671 respondents in 2012 and 2014, respectively. New Jersey was not represented in the 2012 survey.
- Question 3. Respondents' ability to correctly identify a BMSB nymph. Total of 822 and 671 respondents in 2012 and 2014, respectively.
- Question 4. Characteristics respondents use to identify a BMSB. Total of 978 and 859 respondents in 2012 and 2014, respectively.
- Question 5, Photo 1. Respondents' experience with BMSB damage in field or sweet corn; number of respondents indicated after each answer. Total number of respondents was 759 and 624 in 2012 and 2014, respectively.
- Question 5, Photo 2. Respondents' experience with BMSB damage in apple or other tree fruit; number of respondents indicated after each answer. Total number of respondents was 774 and 629 in 2012 and 2014, respectively.
- Question 5, Photo 3. Respondents' experience with BMSB damage in pepper or tomato; number of respondents indicated after each answer. Total number of respondents was 755 and 625 in 2012 and 2014, respectively.
- Question 6. Reported observations of BMSB pressure in various crops by year.

Role of Abiotic Factors in Symbiont Acquisition by BMSB
Presented by: Christopher Taylor

Co-Authors: Peter L. Coffey and Galen P. Dively
University of Maryland

Summary:

- Although there weren't significant differences in survivorship and development between (C vs. W) treatments until the adult stage, graphed data suggests a trend similar to that of the chemical sterilization results.
- The high degree of variability in the data suggests that there are factors we aren't taking into account (such as location of egg mass on plant?)
  - Microclimate is likely playing an important role, but quantifying this is difficult.
- Despite the variability, there was a significant interaction effect between treatment and time to peak adult production across treatments.
- Dilip Venugopal's work has shown that on regional spatial scales, temperature is the driving force that influences BMSB population numbers.
  - Does this just affect the stink bugs themselves or the symbionts that they rely on as well?
- Unfinished work
  - qPCR analysis of adults from 3 treatments to determine whether symbiont load is lower in (W and H) treatment
  - Effects of humidity alone
    - Lower humidity negatively impacts the eggs and hatch rate (egg desiccation?)
  - Effects of temperature alone
    - Higher temperatures don't affect hatch rate (to a certain point) but final adult counts differ.

Update on the BMSB Population in Sacramento
Presented by: Chuck Ingels
University of California (Coop Ext)

Summary:

- Found in Alameda, Los Angeles, Riverside, Sacramento, San Diego, San Francisco, San Joaquin, Solano and Santa Clara
- Also Butte, Monterey, Yolo, San Luis Obispo, Siskiyou and Sutter
- 1^{st} Eggs on Spinach, Sacramento, May 5, 2014
- Species with Most Nymphs, Sacramento, Spring 2014:
  - Cherry, Peach, Nectarines, Sunflower, Tree of Heaven, Butterfly Bush and Young Elm
- Species of Note
  - *Pistachia chinensis*
- Early Fruit Damage:
  - Peach, Nectarine, Asian Pear
- BMSB Seasonal Development Model

- Generally 2 generations in Sacto./Lodi
    - First adults trapped Mar. 17 (traps set Mar. 12)
    - Development temperature thresholds:
        - Lower: 57°F   Upper: 97°F
    - Complete generation: 1107DD (A. Nielsen)
        - 968 DD (egg to adult) + 139 DD (to egg laying)
    - First eggs found in 2014: May 5
        - 2nd gen. eggs start July 23 (2 generations)
        - 3rd gen. eggs start Sept. 25 – insufficient time
    - 3 generations in Kern County
- Predators We Saw Feeding on BMSB
    - Jumping Spider, Assassin Bug, Little Brown Job (LBJ) – Bird , Feather-Legged Fly

Injury Diagnostics for Tree Fruit, Small Fruit & Grapes
Presented by: Tracy Leskey[1] and Anne Nielsen[2]
USDA-ARS-AFRS[1] and Rutgers University[2]

Summary:

- Early and Mid-Season Damage
    - Internal Damage Can Be Present Even When External Damage Is Not Detectable
    - Late-Season Injury on Peach - Corky flesh just beneath the skin
- Cold Injury on Loring Peaches –
    - External Injury - Obvious Injury Sites on Skin
    - No Internal Injury
- BMSB Threat To Apples
    - Early Season Superficial Injury -- Early season feeding results in nominal injury with discolored dot and feeding sheath beneath
    - Mid-Season Economic Injury -- Mid-season feeding results in possible discolored depressions and flesh surrounding feeding sheath appearing corky
    - Mid-Late Season Economic Injury -- Mid-late season feeding results in discolored depressions with larger, corky areas in flesh
- BMSB Threat To Grapes
    - Pre-harvest: Ripe Fruit Becomes Increasingly Attractive To BMSB and can remain in clusters
    - Mid-veraison reduced berry weight and/or sour rot
    - Feeding on Fruit at berry touch can result in aborted berries
    - Feeding on Fruit at pea or peppercorn size can result in aborted berries and Reproduction Can Occur if Invading Populations Not Managed.
        - Significantly more BMSB seen on Chambourcin, Merlot, and Traminette
        - Significant difference in stylet sheaths by variety
        - Presence doesn't indicate feeding

Injury Diagnostics for Small Fruit Crops

Presented by: Cesar Rodriguez-Saona[1]
Co-Authors: Nik Wiman[2], Vaughn Walton[2] & Joyce Parker[1]
Rutgers University[1] and Oregon State[2]

Summary:

- Postharvest analysis
    - Acid fuchsin-dyed stylet sheaths
        - Protein positive stain
    - Each berry weighed and examined
        - Necrosis
        - Discoloration
        - Number stylet sheaths
- Damage effects – Stylet sheaths
    - Increasing the number of BMSB per cluster increases feeding pressure. Less feeding on AURORA.
- Damage effects – Weight
    - Increasing the number of BMSB per cluster decreased berry weight at harvest (DUKE only)
- Damage effects – Discoloration
    - Discoloration was an inconsistent symptom for DUKE, but BMSB caused high levels of discoloration on AURORA
- Damage effects – Necrosis
    - No question that berry necrosis was a key feeding symptom. Necrosis was worse on DUKE.
- Conclusions – Blueberries
    - BMSB feeding pressure had <u>consistent</u> effects on:
        - Necrosis: major increases
        - Brix: lower sugar
    - Less consistent effects on:
        - Berry weight
        - Discoloration
    - Some evidence of timing effects
        - Some recovery from early damage
    - Other effects:
        - Dropped berries
        - Ripening effects
- Controlled Damage-Blackberry
    - Black Diamond was selected
    - Preliminary- not as much data as blueberry study
- Raspberries in 2014
    - Very similar protocol
- Conclusions – Blackberries

- Like blueberries, levels of necrosis were very high and were correlated with BMSB pressure
- Unlike blueberries, Brix may not be affected on blackberry
- Berry weight was affected only by intense feeding
- More research needed: replicate the study on blackberries and add raspberries

Injury Diagnostics for Vegetables, Soybean & Field Crops

Presented by: Galen Dively[1]
Co-Authors: C. Hooks[1], Terry Patton[1], P.D. Venugopal[1], P. Coffey[1], D.A. Herbert[2], T. Kuhar[2], J. Whalen[3] and B. Cissel[3]
University of Maryland[1], Virginia Tech[2] and University of Delaware[3]

Summary:

- Stink bugs move into soybean fields at the R4 (full pod) growth stage.
- Injury results in aborted pods, undeveloped pods, punctured and deformed seed.
- Reductions in seed quality and yield
- Delayed senescence (stay green)
- BMSB is spreading into OH but not so much on coastal plain of VA and MD.
- At the local scale, higher abundance is associated with more dwellings and landscapes fragmented with woodlots.
- At a broad spatial scale, abundance is negatively associated with higher temperatures (particularly during July).
- Injury and damage to soybean are similar to that caused by native stink bug species.
- Complete yield loss can occur along soybean field edges.
- Significant injury to corn kernels can occur on outer rows.
- Mycotoxin levels, particularly fumonisin, are higher in BMSB-damaged corn and positively correlated with the proportion of damaged kernels.
- Sweet corn, peppers, tomatoes, beans, eggplant, and okra are preferred
    - Sweet Corn
        - Damaged ears can exceed 100% for certain planting dates and small fields
        - Sweet corn can be attacked as early as late June in VA
        - Damage Evaluations in DE (Whalen & Cissell)
            - Discolored Kernels
            - Sunken Kernels
            - Blasted Kernels
            - Collapsed
            - Aborted
        - Infestations occurring prior to pollination may result in incomplete kernel fill
        - BMSB must be managed from ear shank emergence to harvest
- BMSB can also transmit bacteria and yeasts such as *Eremothecium coryli* to various fruits and vegetables via stylet feeding? Jerry Brust and Karen Rane (U. MD)
- When yeast is present in BMSB feeding site, it causes a collapse of the feeding area resulting in a 'crater' appearance.