

Biology, Ecology, and Management of Brown Marmorated Stink Bug in Orchard Crops, Small Fruit, Grapes, Vegetables and Ornamentals



Our long-term goals for this project are to develop economically and environmentally sustainable pest management practices for the brown marmorated stink bug (*BMSB*), *Halyomorpha halys* (Stål), in specialty crops and to implement a coordinated, rapid delivery system to disseminate critical information generated from this project to specialty crop end-users. USDA-NIFA SCRI # 2011-51181-30937



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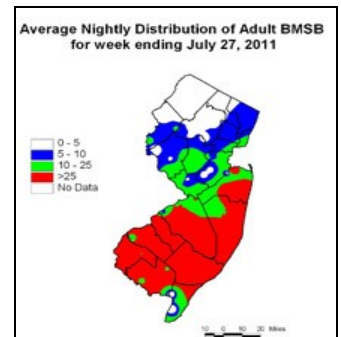
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OBJECTIVES

- Objective 1.** Establish biology and phenology of BMSB in specialty crops.
- Objective 2.** Develop monitoring and management tools for BMSB.
- Objective 3.** Establish effective management programs for BMSB in specialty crops.
- Objective 4.** Integrate stakeholder input and research findings to form and deliver practical outcomes.

PROJECT DIRECTORS

- Tracy Leskey, USDA-ARS
- George Hamilton, Rutgers University
- Cerruti Hooks, University of Maryland
- Grzegorz Krawczyk, Penn State University
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- Carrie Koplinka-Loehr, Northeastern IPM Center
- Peter Shearer, Oregon State University
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Researchers discover the brown marmorated stink bug's winter hideout

Researchers believe they have identified where brown marmorated stink bug (BMSB) gathers in natural landscapes during winter, and their findings could help farmers manage this invasive insect.

Doo-Hyung Lee, a postdoctoral research associate with USDA's Agricultural Research Service, wants to understand precisely what the risks are to growers from BMSB overwintering in natural landscapes. Lee works with a team of scientists led by Tracy Leskey at the Appalachian Fruit Research Station in West Virginia.

"We know BMSB aggregate inside human-made structures in very high numbers," Lee explains. "However, in the natural landscape, BMSB are spread out. They can be anywhere. They can remain unchecked by any management strategies, spreading randomly and building their population."

If researchers could better understand stink bug behavior in the natural landscape, Lee reasoned, they would be able to develop a defense strategy for growers whose farms are located near woodlands. He and his colleagues ventured out into the woods to gather this information first-hand.

Treasure hunting

Lee began his search on a chilly, overcast, winter afternoon in a desolate Maryland forest. "I felt as though I was hunting for treasure with no map," he recalls. He and his team randomly mapped out plots of Maryland and West Virginia forest, then explored these areas for BMSB hideouts. After searching among dead trees, both standing and fallen, as well as in leaf litter on the ground, they found 26 aggregations of BMSB, a 3% find rate.

Using what they had learned, the researchers developed a more specific profile of BMSB's preferred winter setting: large, dry, dead standing trees, more than 60 cm in circumference, particularly oak and locust, with porous dead tissue and peeling bark that gives BMSB a place into which to crawl. Lee and his team then returned to the woods, targeting only trees that matched their profile. This time, they found BMSB in 33% of trees, a finding that seems to confirm a BMSB preference for this winter refuge.



While inspecting for BMSB in the woods, researchers observed tree characteristics such as moisture level, type, size, and surface permeability. Source: D. Lee, USDA Agricultural Research Service

From forest to farm

BMSB poses a huge risk to agriculture, Lee says, because 11 percent of trees in the natural landscape have the potential to harbor BMSB. Therefore, improving our ability to track BMSB movement from woodlands into agricultural areas is critical.

As Lee tracks the brown marmorated stink bug, he is deploying several high-tech tools, including a flight mill that measures the distance and speed a stink bug is able to fly. He hopes to publish detailed information about the insect's flight capacity within the next year. For now, he cites Asian studies suggesting that BMSB is able to fly long distances and find new cultivated crops readily.

Lee is also pioneering use of harmonic radar to track stink bugs by mounting a tiny antenna to the back of the 17 mm-long insect. This device will relay signals to researchers wearing equipment that can reliably detect tagged bugs up to 50 meters away.

Humankind's best friend soon will join the defense against its new pest, Lee predicts. Dogs trained to detect the scent of BMSB will make it easier to monitor and manage BMSB in agricultural areas.

Outbreak pest

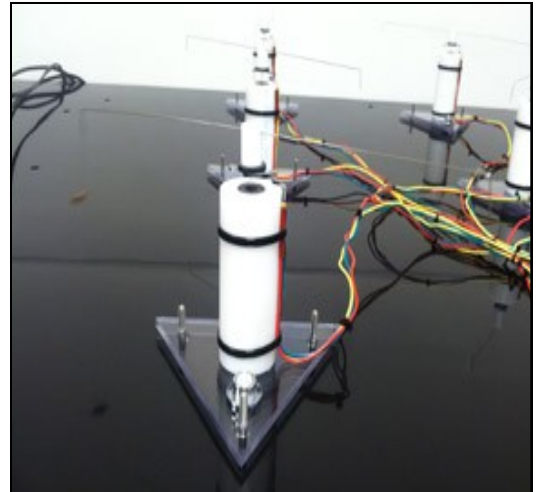
BMSB is characterized in Asian studies as an outbreak pest, which means that the insect might go undetected for months or years before suddenly bursting on the scene in an agricultural area and causing much devastation. Now that we better understand the sites that provide winter refuge for BMSB, Lee believes, we will be better prepared to prevent future invasions of nearby farms.

Assisting Lee in his research were John Cullum, Sean Wiles, Starker Wright, Torri Hancock, Brent Short, and Cameron Scorza. The research is part of a broader Coordinated Agricultural Project entitled "[Biology, Ecology and Management of the Brown Marmorated Stink Bug in Specialty Crops](#)" that has been funded through the USDA-NIFA [Specialty Crop Research Initiative](#).

"People are interested in our project because we are asking very basic questions about the biology of the insect that scientists have not looked at yet," Lee said. "They are curious because our findings characterize the overwintering behavior of BMSB in the natural landscape. People are very excited."

These words, while attempting scientific understatement, show the exhilaration of the entomologist who just found the keys to the BMSB hideout in the forest.

by [CHRIS GONZALES](#)



A treadmill for stink bugs: As the insect flies in circles, the top of this device spins, measuring distance and speed. This baseline information is paired with study of BMSB flight in natural settings. Source: D. Lee, USDA Agricultural Research Service

This research project supports objective 1: Establish biology and phenology of BMSB in specialty crops.

Native parasitoids hold promise in stink bug defense

Researchers suspect that our best defense against the brown marmorated stink bug (BMSB) could be a large group of parasitic wasps that would serve as natural control agents against the invasive pest. At a recent workshop in Newark, Delaware, entomologists shared critical information about native parasitoids that attack stink bugs in North America.

Kim Hoelmer, a USDA scientist who helped organize the event, is particularly interested in a group of tiny parasitic wasps that are very specialized in their choice of a host insect. Some types of parasitic wasps attack and develop inside spiders, beetles, or aphids; other groups are known to attack stink bugs.

The 24 researchers and graduate students who attended the workshop are expanding what is known about natural enemies of BMSB. They learned to distinguish the different kinds of natural enemies of BMSB so they would know whether parasitoids they encountered in the field were new or already reported elsewhere.



Researchers participate in a hands-on exercise to identify natural enemies of brown marmorated stink bug during an April 2012 workshop in Delaware. Source: K. Hoelmer, USDA Agricultural Research Service

Each participant received a master key to identify native parasitoids of BMSB, which presented current observations previously scattered across different scientific journals. They practiced identification with unlabeled specimens—all known parasitoids of BMSB—and some brought unknown specimens they had collected in the field.

The parasitic wasp is very tiny, growing inside a host BMSB egg, emerging at maturity at 1.5 mm. Its small size presents challenges for researchers trying to study it, so workshop leaders shared special techniques for handling and mounting such small specimens. For example, Hoelmer explained, quality of microscope optics is an issue if you need to see whether or not a ridge on a part of the body is interrupted or runs from one side of the body to the other

Armed with this information, researchers can use their knowledge to recognize locally important natural enemies of BMSB and to monitor the levels of parasitism in the field. Both are important parts of a strategy to control the invasive insect using natural means.

In a day and a half we presented tools and materials to help a keenly interested group of researchers identify natural enemies of BMSB,” Hoelmer said. “I was amazed and astonished by the level of interest.”

The workshop, which Hoelmer led with colleagues Christine Dieckhoff, Kathy Tatman and Matt Buffington of USDA’s Agricultural Research Service, was part of a broader project entitled [“Biology, Ecology, and Management of Brown Marmorated Stink Bug”](#) that has been funded through the [Specialty Crop Research Initiative](#). The University of Delaware let organizers use a teaching laboratory that was perfect for this event.

“We were expecting maybe 8 to 10 people would attend,” Hoelmer said, “but we found there was much greater interest. We had to turn away some due to lack of seats.” The group may plan another workshop to meet demand. To learn more, or to receive information about future workshops, contact [Christine Dieckhoff](#).

by [CHRIS GONZALES](#)



An adult Trissolcus basalis female attacks an egg mass of the stink bug species Nezara viridula, similar in appearance to the eggs of brown marmorated stink bug. Several related Trissolcus species attack BMSB in its native Asian range and in North America. Source: M. Roche, USDA Agricultural Research Service European Biological Control Laboratory

This research project supports objective 2: Develop monitoring and management tools for BMSB.

Establishing parasitism and Predation Rates by Native Natural Enemies Attacking BMSB in Specialty Crops

Researchers from the University of Maryland and USDA-ARS have developed a brown marmorated stink bug (BMSB) natural enemy survey protocol for monitoring BMSB parasitism and predation using sentinel (colony-produced) and wild egg masses (laid in the field). The protocol was developed by Cerruti Hooks, an Assistant Professor in the Department of Entomology at the University of Maryland, and Kim Hoelmer, Research Entomologist currently serving as Director of the European Biological Control Laboratory, Montpellier, France, as a means to standardize procedures across the Biological Control team for the SCRI project

Because biological control activity varies according to host plant and is influenced by location and surrounding landscapes, it is critical to obtain information from specialty cropping systems, neighboring field crops and natural landscapes. Surveys are being conducted across the country to determine levels of parasitism and predation and identify key species of natural enemies that are having an impact on BMSB survival.

Fifteen scientists from eight universities participated in the survey this year. Participants in this survey included: Christine Dieckhoff and Kathleen Tatman, USDA-ARS, working in natural landscapes; George Hamilton and Joyce Parker, Rutgers University, in peaches and blueberries; Doug Pfeiffer and Tom Kuhar, Virginia Tech, in grapes and vegetable crops, respectively; Paula Shrewsbury, Ashley Jones, and Cerruti Hooks, University of Maryland, in vegetables, field crops near vegetable systems, fruit and ornamentals; Mark Abney and Jim Walgenbach, North Carolina State University, in orchards, vegetable crops and natural landscapes; Shimat Joseph, Virginia Tech, in orchards and natural landscapes; Brian Kunkel and Joanne Whalen, University of Delaware, in ornamentals, sweet corn and Lima beans; Peter Shearer, Chris Hedstrom and Nik Wiman, Oregon State, in hazelnuts and wine grapes; and John Tooker and David Biddinger, Pennsylvania State University, in tomatoes and row crops.

The protocol required that participants use egg masses produced by laboratory-based colonies, and naturally laid wild egg masses in the field. Lab colony egg masses are deployed in the field as “sentinels”. Egg masses are attached to foliage for two to three days and then retrieved along with any wild egg masses, and returned to

the laboratory. Presence and identity of predators and parasitoids seen on the egg masses are recorded during egg mass placement and retrieval. Any emerging parasitoids in the laboratory have been retained and sent to Kim Hoelmer’s laboratory for identification or identified by individuals trained at a two day parasitoid identification workshop sponsored by Kim Hoelmer, Christine Dieckhoff and other members of his Newark, DE Laboratory.



Sentinel BMSB egg mass attached to a leaf.

Source: Cerruti Hooks, UMD

BMSB adults were also collected throughout the season to establish if they were attacked by tachinid flies. If tachinid eggs are found on adult BMSB, adults are taken to the laboratory to determine if eggs hatch, larvae successfully colonize BMSBs, and ultimately if adult flies emerge. Any BMSB life stages showing evidence of pathogen-infection also are being collected in field surveys for identification. In addition, David Biddinger has identified that predatory sand wasps, *Bicyrtes quadrifasciatus*, are provisioning nests with BMSB nymphs in greater numbers compared with other stink bug species indicating these wasp are good predators of immature stages of BMSB. Some additional predators observed using BMSB eggs or nymphs as prey by Cerruti Hooks include the big-eyed (*Geocoris* sp.), minute pirate bug (*Orius* sp.), soft winged flower beetle and various spiders.

The following are results received to date from surveys conducted in 2011 and 2012. Using sentinel egg masses (Table 1), rates of parasitism ranged from 0.0% in tree of heaven in VA to as high as 6.2% in sweet corn in DE. Predation was higher, up to 34% in tree of heaven in VA. For wild egg masses (Table 2), parasitism rates were higher, as high as 32% in ornamentals. Notably, predation rates (combined with unknown mortality factors) in ornamentals also were very high (25.4%).

The preliminary results collected to date indicate that there are several species of stink bug natural enemies native to North America that are having an impact on BMSB populations. These results vary according to cropping systems and regions, but they offer another mechanism that can contribute to overall management of BMSB.



T. podisi adult emerging from a brown stink bug egg. Source: Brian Cutting (UDeI Research Specialist stationed at BIIR)

This research project supports objective 2: Develop monitoring and management tools for BMSB.

Table 1: Results of sentinel egg mass surveys in 2012

System	Host	Institution	Deployment Location	Egg Masses	Eggs	Parasitism Total (%)	Predation Total (%)	BMSB Nymphs Total (%)
Vegetable	sweet corn	UDEL	Interior	11	323	20 (6.2)	49 (15.2)	81 (25.1)
Vegetable	Lima beans	UDEL	Interior	3	63	0	29 (46)	0
Orchard Crops	hazelnut cane- berry blueberry	OSU ¹ OSU OSU	Adjacent	72	1530	93 (6.1)	206 (13.5)	48 (3.1)
Wild Host	Tree of Heaven	VT	Interior	22	538	0	185 (34)	168 (31)
Orchard Crops	Apple	PSU	Adjacent	243	6059	6 (0.1)	--	3867 (63.8)

¹ OSU results combined across crops

Table 2: Results of wild egg mass surveys in 2011 and 2012

System	Host	Institution	Deployment Location	Egg Masses	Eggs	Parasitism Total (%)	Predation Total (%) ¹	BMSB Nymphs Total (%)
Vegetable	sweet corn	UDEL	Interior	2	56	16 (28.6)	10 (17.9)	30 (53.6)
Vegetable	Eggplant ²	UMD	Interior	--	522	121 (23.2)	180 (34.5)	221 (42.3)
Field Crop	field corn ²	UMD	Interior	--	923	529 (57.3)	310 (33.6)	84 (9.1)
Ornamentals	<i>Acer rubrum</i>	UMD	Interior	--	5729	1089 (19)	1075 (18.8)	3565 (62.2)
Ornamentals	<i>Prunus kwanzan</i>	UMD	Interior	--	7435	2380 (32)	1850 (24.9)	3205 (43.1)
Ornamentals	<i>Ulmus Americana/parvifolia</i>	UMD	Interior	--	10960	3791 (34.6)	2780 (25.4)	4389 (40)
Orchard Crops	hazelnut	OSU ³	Adjacent	240	6333	257 (4)	226 (3.5)	4994 (78.9)
Small Fruit	caneberry	OSU	Adjacent	--	--	--	--	--
Small Fruit	blueberry	OSU	Adjacent	--	--	--	--	--
Vegetables	Mixed ²	VT	Interior	9	226	48 (21.2)	--	--
Wild Host	tree of heaven ²	VT	Adjacent	96	2449	155 (6.3)	--	--
Vegetables	mixed	VT	Interior	13	208	82 (39.4)	--	--
Wild Host	tree of heaven	VT	Adjacent	111	2964	122 (4.1)	--	--

¹Includes other unascrbed mortality factors in some locations;² Results collected in 2011; ³OSU results combined across crops

Scientists draw maps to stop stink bug pirates

A monitoring system set up in the early 1980s to track common vegetable pests in New Jersey has led to a treasure trove of maps about a new invader, the brown marmorated stink bug (BMSB). Scientists are analyzing the maps to stop BMSB from pirating a wide range of fruit and vegetables in North America.

George Hamilton, an entomologist and extension specialist at Rutgers University, leads a team that is using this valuable store of historic information about BMSB movement to help them predict future BMSB activity across other regions.

The 2004 invasion

“In 1999, we first detected BMSB in New Jersey,” Hamilton said. “In 2004, Anne Nielsen and I monitored an invasion of BMSB as it came into Philipsburg, NJ, right across the river from Allentown, PA.” Nielsen is an extension specialist in fruit entomology at Rutgers who at the time was a PhD student studying BMSB. Since then, Hamilton and his team have followed the expansion of BMSB throughout New Jersey using a statewide network of black light traps. Growers, working with scientists, had installed a series of 70 or more black light traps on their farms in the early 1980s, sentinels against the European corn borer and corn earworm. This integrated pest management program has been running continuously, albeit with modifications such as new computer technology, for more than 30 years.

Hamilton’s group prepares weekly statewide maps of their BMSB catches in New Jersey. These maps signal to growers where hotspots—rising numbers of BMSB and other pests—are found.

In 2004, they did what they could to warn growers to check their crops, but at the time BMSB was not classified as an agricultural pest. “What we can do now,” Hamilton said, “is more accurate hotspot identification.”



This black light trap stands guard against fruit and vegetable pests, including the brown marmorated stink bug, in a network of about 70 similar traps in New Jersey. Source: G. Hamilton, Rutgers University

How growers use this information

Scientists use the maps to track insect counts, distance, and time. This information helps them estimate how quickly BMSB reproduces and how far it travels. The predictions about what areas may be at risk are immensely valuable for growers. As Hamilton knows, it's hard work to go into the field, collect samples, and update the database. Yet for growers who live in areas where BMSB is getting established, these reports could mean the difference between a healthy harvest and crop losses.

One of Hamilton's PhD students, Noel Hahn, has been studying BMSB movement in and out of orchards. In 2012 he visited orchards weekly, sampling specific trees on the borders and in the middle, and noting land-use types. He analyzes landscape features and tries to determine statistically from where BMSB is invading. Adam Wallner, a post-doctoral researcher with Rutgers trained in geospatial relationships and statistics, is working on making forecasts and predicting trends.

Accurate maps, useful forecasting

Today scientists seek out the maps made from historical data, wanting to understand what it looks like when BMSB invades new territory.

Hamilton has created maps of his team's data since 2010, but he can map any year by going back to the 1980s-era vegetable and pest monitoring system. "We can look at the [2004] invasion as if it were happening in real time. We can assess how fast BMSB mates, how far it can move every year. I'm aware of only a few invading pests—the emerald ash borer would be one—where we had such an extensive monitoring system already in place."

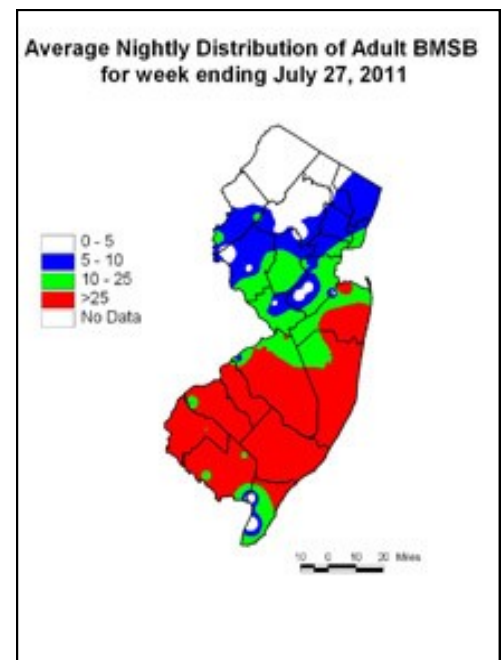
Bringing maps to growers on the Internet

"Three years ago," Hamilton said, "we started publishing these maps. We put them in our newsletters. Growers can receive our newsletters, go to the website, and find BMSB hotspots. If there is a BMSB hotspot in their area, they should go out in their fields, looking themselves. If they find BMSB, they will need to make their own management decisions."

The map research is part of a broader Coordinated Agricultural Project entitled "[Biology, Ecology and Management of the Brown Marmorated Stink Bug in Specialty Crops](#)" that has been funded through the USDA-NIFA [Specialty Crop Research Initiative](#).

"Other states are calling us about this program," Hamilton said, with a touch of reserved pride. "Michigan, California, and Oregon have contacted us to learn more about it."

by [CHRIS GONZALES](#)



A map shows the intense BMSB activity of July, 2011, illustrating the potential of mapping to warn growers about pest risk. Source: G. Hamilton, Rutgers University

This research project supports objective 2: Develop monitoring and management tools for BMSB.

The Race to Identify the BMSB Aggregation Pheromone

Monitoring tools are used to assess the presence, abundance, and seasonal activity of pest species to allow growers to make informed management decisions. Certainly, the need for a reliable monitoring tool for BMSB is critical based on their season-long activity and devastating damage to so many crops. Scientists at the ARS Invasive Insect Biocontrol and Behavior Laboratory (IIBBL) in Beltsville, Maryland have been leading research efforts to identify attractants for BMSB. Previously, researchers had demonstrated that methyl (2E, 4E, 6Z)-decatrienoate (MDT) was a sensitive late-season attractant for BMSB with adults actively responding to this stimulus beginning in mid-August. MDT, is in fact, the pheromone of another Asian stink bug species, *Plautia stali*, but is cross-attractive to BMSB adults late in the season. Unfortunately, this compound is not attractive to adults in the early- or mid-season—resulting in the critical need for a season-long attractant to increase the sensitivity of monitoring tools.

Led by efforts of Ashot Khimian, the aggregation pheromone of BMSB was tentatively identified. In September 2011, field trials conducted in Kearneysville, WV and Beltsville, MD, revealed that male-produced compounds were very attractive to BMSB adults. However, the timing of this trial also led to a critical question of early-season attraction. Based on the positive responses from adults in a small pre-trial, a larger multi-state trial was initiated. In this case, standard black pyramid traps baited with 10mg lures of the BMSB aggregation pheromone—also known as #10 were compared with traps baited with Rescue MDT (Sterling) lures and unbaited traps.

Traps were deployed at the interface between agricultural production and wild, unmanaged habitat in mid-to-late April and left in place until late October. Trapping sites included tree fruit orchards, small fruit plantings such as blueberries, vineyards, ornamental nurseries, and vegetable plantings in DE, MD, MI, NC, NY, PA, NJ, OR,VA, WA, and WV.



Pyramid trap (AgBio) used in multi-state trials to evaluate BMSB pheromone lures.

Source: Tracy Leskey

Results are summarized in Table 1. Throughout the early season, traps baited with #10 reliably captured BMSB adults. By mid-summer, these same traps also were capturing nymphs, although numbers were low in many locations. Traps baited with #10 continued to attract BMSB in the late-season.

Traps baited with MDT were not attractive to BMSB adults in the early-season. However, as nymphal populations began to increase, traps baited with MDT captured these immature stages. Beginning in mid-August, adults also responded strongly to MDT. MDT is an extremely attractive stimulus to adults in the late-season. The MDT lures used in this study had ~10x more material per lure compared with #10 lures; this obvious difference in release rates was apparent in late-season captures. Unbaited traps captured very few BMSB season-long.

Overall, these results are encouraging and point to the promise of a sensitive monitoring tool for BMSB detection and monitoring in the near future. In addition, the potential for combining stimuli including light-based cues could further enhance our capacity to reliably detect BMSB. As the SCRI project continues, these approaches as well as questions of trap type, capture mechanism and deployment strategy will be addressed.



Table 1. Mean number and total (in parentheses) of BMSB adults and nymphs captured per trap per sampling period across all states and sampling sites.

Life Stage	Sampling Period	#10	MDT	Control
Adult	Early (mid-April to mid-June)	3.2 (280)	0.4 (34)	0.3 (22)
	Middle (mid-June to mid-August)	7.2 (644)	5.4 (482)	0.7 (61)
	Late (late-August to late-October)	50.4 (4489)	172.3 (15332)	7.7 (687)
Nymph	Early (mid-April to mid-June)	0.02 (2)	0.1 (11)	0.0 (0)
	Middle (mid-June to mid-August)	60.2 (5356)	144.5 (12856)	7.7 (687)
	Late (late-August to late-October)	48.8 (4342)	166.8 (14849)	7.4 (663)

This research project supports objective 2: Develop monitoring and management tools for BMSB.



In September 2012, the Northeastern IPM Center launched the StopBMSB.org website to report the latest research findings and outreach efforts. Content also includes a photo identification guide and state-by-state map depicting the presence and pest status of BMSB across the country.

StopBMSB.org provides information about our team's efforts to control brown marmorated stink bug (BMSB), through funds provided by the USDA's Specialty Crop Research Initiative.

Stop BMSB
Biology, ecology, and management of brown marmorated stink bug in specialty crops

Search

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Overview

The brown marmorated stink bug, *Halyomorpha halys* (Stål), is a voracious eater that damages fruit, vegetable, and ornamental crops in North America. With funding from USDA's Specialty Crop Research Initiative, our team of more than 50 researchers is uncovering the pest's secrets to find management solutions for growers, seeking strategies that will protect our food, our environment, and our farms.

Calendar of Events						
S	M	T	W	T	F	S
		1	2	3	4	5
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Updates

Native Parasitoids Hold Promise in Stink Bug Defense. Researchers teach workshop participants to recognize natural enemies of brown marmorated stink bug, part of the strategy to control the invasive insect.

Project Researchers Test for a Winning Pheromone. Researchers are conducting early season trials of "odor #10" in nine states to confirm whether this is the true pheromone and an effective attractant for BMSB.

Stink Bug Management with Trap Crops on Organic Farms. If you missed the live version of this recent webinar by Dr. Russell Mizell, you can view it online at extension.org.

Stink Bugs Migrating to the Deep South. On the front line of the brown marmorated stink bug invasion, Doug Inkle counted 56,205 in his house and garden last year.

Economic Cost of Stink Bugs. C-SPAN interviews BMSB IPM Working Group members.

BMSB Working Group Will Meet in June. A collaboration of more than 130 growers, researchers, educators, and others who are spearheading the search for solutions will gather in Westminster, MD, to share the latest developments.

Funding

USDA United States Department of Agriculture National Institute of Food and Agriculture
Specialty Crop Research Initiative

Collaborators

OSU, Rutgers, Penn State, Virginia Tech, University of Delaware, University of Maryland, Washington State University, North Carolina IPM Center, Cornell University, OSU, NC State University

USDA-NIFA SCRI Coordinated Agricultural Project, grant #2011-01413-30037. Web site maintained by the Northeastern IPM Center. Last update: April 26, 2012.

This research project supports objective 4: Integrate stakeholder input and research findings to form and deliver practical outcomes.

Project Outputs

Research Publications

- Jentsch, P. 2012. The Unpredictable Brown Marmorated Stink Bug in New York State. NY Fruit Quarterly. 20(1): 11-15.
- Joseph, S.V., J.C. Bergh, S.E. Wright and T.C. Leskey. Factors affecting captures of brown marmorated stink bug, *Halyomorpha halys* (Hemiptera: Pentatomidae) in Baited Traps. Journal of Entomological Science (in press).
- Kamminga, K.L., T.P. Kuhar, A. Wimer, and D.A. Herbert. 2012. Effects of the insect growth regulators novaluron and diflubenzuron on the brown marmorated stink bug. Plant Health Progress (In press).
- Kuhar, T.P., K.L. Kamminga, J. Whalen, G.P. Dively, G. Brust, C.R.R. Hooks, G. Hamilton, and D.A. Herbert. 2012. The pest potential of brown marmorated stink bug on vegetable crops. Online. Plant Health Progress doi:10.1094/PHP-2012-0523-01-BR.
- Lee, D-H., S.E. Wright, and T.C. Leskey. Impact of insecticide residue exposure on the invasive pest, *Halyomorpha halys* (Stål)(Hemiptera: Pentatomidae): analysis of adult mobility. Journal of Economic Entomology. (in press).
- Leskey, T.C., G.C. Hamilton, A.L. Nielsen, D.F. Polk, C. Rodriguez-Saona, J.C. Bergh, D.A. Herbert, T.P. Kuhar, D. Pfeiffer, G. Dively, C.R.R. Hooks, M.J. Raupp, P.M. Shrewsbury, G. Krawczyk, P.W. Shearer, J. Whalen, C. Koplinka-Loehr, E. Myers, D. Inkley, K.A. Hoelmer, D-H. Lee, and S.E. Wright. 2012. Pest Status of the Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål), in the USA. Outlooks on Pest Management. 23: 218-226.
- Leskey, T.C., D-H. Lee, B.D. Short and S.E. Wright. 2012. Impact of insecticides on the invasive *Halyomorpha halys* (Stål)(Hemiptera:Pentatomidae): analysis on the insecticide lethality. Journal of Economic Entomology 105: 1726-1735.
- Leskey T.C., B.D. Short., B.B. Butler and S.E. Wright. 2012. Impact of the invasive brown marmorated stink bug, *Halyomorpha halys* (Stål) in mid-Atlantic tree fruit orchards in the United States: case studies of commercial management. Psyche. Article ID 535062, 14 pages doi:10.1155/2012/535062.
- Leskey T.C., S.E. Wright., B.D. Short. and A. Khimian. 2012. Development of behaviorally based monitoring tools for the brown marmorated stink bug, *Halyomorpha halys* (Stål) (Heteroptera: Pentatomidae) in commercial tree fruit orchards. Journal of Entomological Science. 47: 76-85.
- Martinson, H.M., P.M. Shrewsbury, and M.J. Raupp. Invasive stink bug wounds trees, liberates sugars, and facilitates native Hymenoptera. Annals of the Entomological Society of America. (in press).
- Pfeiffer, D.G., T.C. Leskey and H.J. Burrack. 2012. Threatening the harvest: The threat from three invasive insects in late season vineyards. p. 449-474. In: N.J. Bostanian, C. Vincent and R. Isaacs (eds.), Arthropod Management in Vineyards: Pests, Approaches, and Future Directions. Springer, Dordrecht, The Netherlands. 505 p.
- Sargent, C., H.M. Martinson, and M.J. Raupp. 2011. The Orient Express in Maryland: The Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål) (Hemiptera: Pentatomidae). The Maryland Entomologist 5(3): 2-21.

Research Talks

- Aigner, J.D., T.P. Kuhar, D. Mullins, and S. Gabbert. (2012). Entomological Society of America- Eastern Branch. Supercooling points of the brown marmorated stink bug (*Halyomorpha halys*). March 16-19, 2012, Hartford, CT.
- Basnet, S. and D.G. Pfeiffer. (2012). Entomological Society of America- Eastern Branch. Feeding injury and management of brown marmorated stink bug in Virginia vineyards and raspberry plantings. March 16-19, 2012, Hartford CT.
- Basnet, S., D.G. Pfeiffer, T.P. Kuhar and C.A. Laub. (2011). Entomological Society of America. Field evaluation of pesticides having different modes of actions against brown marmorated stink bug in raspberry plantings. November 13-16, 2011, Reno NV.
- Bergh, J.C. and S.V. Joseph. (2012). Entomological Society of America-Eastern Branch. Prescribed versus grower standard programs targeting brown marmorated stink bug in commercial apple and peach orchards in Virginia. March 16-19, 2012, Hartford, CT.
- Bergh, J.C. and T.C. Leskey. (2012). Virginia Horticultural Society. The latest update on BMSB. January 2012, Richmond, VA.
- Bergh, J.C., J.P. Engelman, and S.V. Joseph. (2011). 87th Annual Cumberland-Shenandoah Fruit Workers Conference. Insecticide trials targeting brown marmorated stink bug. December 1-2, 2011, Winchester, VA.
- Bergh, J.C., S.V. Joseph, and J.P. Engelman. (2011). BMSB IPM Working Group Meeting. Small-plot trials for managing brown marmorated stink bug in tree fruits: November 29, 2011, Winchester, VA.
- Bergh, J.C. and S.V. Joseph. (2011). Entomological Society of America. News from the Front: Brown marmorated stink bug management in Virginia fruit orchards. November 13-16, 2011, Reno, NV.
- Bergmann, E. and M.J. Raupp. (2011). Brown Marmorated Stink Bug Working Group Meeting. Ready to Use Insecticides for Brown Marmorated Stink Bug. Presented with Erik Bergmann. June 2011, Westminster, MD.
- Bergman, E., K. Kamminga, H.M. Martinson, T. Kuhar, P.M. Shrewsbury, and M.J. Raupp. (2012). Entomological Society of America-Eastern Branch. Patterns of host use on woody plants: What does brown marmorated stink bug really like? March 16-19, 2012, Hartford, CT.
- Cissel W. (2011). Mid- Atlantic Vegetable Workers Conference. Brown Marmorated Stink Bug Management in Sweet Corn. November 2011, Newark, DE.
- Jentsch, P. (2012). BMSB IPM Working Group Meeting. Is There Scientific Value in Citizen Science BMSB Research? June 2012, Westminster, MD.
- Gill, S., K. Rane and B. Kunkel. (2012) BMSB IPM Working Group Meeting, Carroll County University of Maryland Extension Office, June 2012, Westminster, MD.
- Hamilton, G.C. (2012). International Congress of Entomology. The current status of *Halyomorpha halys* (BMSB) in the United States. August 2012, Daegu, South Korea.
- Hamilton, G.C. (2011). Entomological Society of America. Introduction, distribution and spread of BMSB in the United States. 20 minute talk, November 11, 2011, Reno, NV.
- Hedstrom, C., V. Walton, J. Miller, P. Shearer, J. Olsen. (2012). Orchard Pest Management Conference. Feeding Damage on hazelnuts by *Halyomorpha halys*, Brown Marmorated Stink Bug (Hemiptera: Pentatomidae). January 11-13, 2012, Portland, OR.

- Hedstrom, C., V. Walton, J. Miller, P. Shearer, J. Olsen. (2012). Entomological Society of America. Feeding Damage of Brown Marmorated Stink Bug (*Halyomorpha halys*), on specialty crops in Oregon. November 11-14, 2012, Knoxville, TN.
- Jones, A.L., C.R.R. Hooks, and P.M. Shrewsbury. (2012). Entomological Society of America-Eastern Branch. Survey and evaluation of indigenous natural enemies of brown marmorated stink bug in field, vegetable and ornamental crops. Presented in the Brown marmorated stink bug – One year later Symposium. March 2012, Hartford, CT.
- Joseph, S.V., J.C. Bergh, and T.C. Leskey. (2011). Entomological Society of America. Incidence of brown marmorated stink bug feeding injury in eastern tree fruits: Temporal effects. November 13-16, 2011 Reno, NV.
- Joseph, S.V., J.C. Bergh, and T.C. Leskey. (2011). Vulnerability of peach and apple fruit to brown marmorated stink bug: Temporal effects. BMSB IPM Working Group Meeting, November 29, 2011, Winchester, VA.
- Joseph, S.V., B.D. Short, J.C. Bergh, and T.C. Leskey. (2011). 87th Annual Cumberland-Shenandoah Fruit Workers Conference. Effects of late-season feeding by brown marmorated stink bug in post-harvest injury expression on apples. December 1-2, 2011, Winchester, VA.
- Joseph, S.V., J.C. Bergh, and T.C. Leskey. (2011). Entomological Society of America. Incidence of BMSB feeding injury in eastern tree fruit: temporal effects. November 2011, Reno, NV.
- Kamminga, K., T.P. Kuhar, and D.A. Herbert. (2012). Entomological Society of America-Eastern Branch. Seasonal biology of the brown marmorated stink bug in Virginia. March 16-19, 2012, Hartford, CT.
- Kamminga, K.L. and T. Kuhar. (2011). BMSB IPM Working Group Meeting. Seasonal Biology and Landscape Ecology Observations on BMSB in Virginia in 2011. November. 29, 2011, Winchester, VA.
- Kamminga, K.L., T. Kuhar, H. Doughty, A. Wallingford, A. Wimer, J. Jenrette and C. Philips. (2011). Entomological Society of America. Results of Bioassays on *Halyomorpha halys*. November 13-16, 2011, Reno, NV.
- Krawczyk, G., L.A. Hull and D.J. Biddinger. (2012). International Congress of Entomology. Impact of invasive brown marmorated stink bug, *Halyomorpha halys*, on IPM programs in eastern US fruit orchards. August 2012, Daegu, South Korea.
- Krawczyk, G. and L. A. Hull. (2012). Entomology Society of America-Eastern Branch meeting. The impact of BMSB management on IPM practices in fruit system. March 2012, Hartford, CT.
- Krawczyk, G. (2012). Brown Marmorated Stink Bug 7th International IPM Symposium. Impact on IPM programs in Eastern US Apples. Memphis, TN.
- Kuhar, T.P., K. Kamminga, and C. Philips. (2012). Abstracts of the 2012 Ecological Society of America-Mid-Atlantic Chapter. Host plants and agro-ecology of the invasive brown marmorated stink bug in Virginia. Disturbed Environments: Ecological Impact & Management. April 14-15, 2012.
- Kuhar, T. (2012). Ecological Society of America-Mid-Atlantic Branch. Host plants and agro-ecology of the invasive brown marmorated stink bug in Virginia. April 14-15, 2012, Blacksburg, VA.
- Leskey, T.C. (2012). Entomological Society of America- Eastern Branch. Important Considerations for Development of Monitoring Tools for Brown Marmorated Stink Bug. Hartford, CT.

- Leskey, T.C, A. Khrimian, A. Zhang, D. Weber, and J. Aldrich. (2012). International Congress of Entomology. Chemically-based monitoring of the brown marmorated stink bug. August 2012, Daegu, South Korea.
- Leskey, T.C. and A.L. Nielsen. (2012). International Congress of Entomology. Brown marmorated stink bug: Impact of an Asian species introduced into North America. August 2012, Daegu, South Korea.
- Leskey, T.C. (2012). Specialty Crop Research Forum. Emerging insect pests: detection and management. August 2012, Lorain, OH.
- Leskey, T.C. National Plant Board Meetings. (2012). Developing management solutions for the brown marmorated stink bug. July 2012, Mystic, CT.
- Leskey T.C. (2012). Eco-Apple/Red Tomato Annual Meeting. What we have learned about the brown marmorated stink bug. Bard College, Annandale-on-Hudson, NY.
- Leskey T.C. (2012). Rutgers University. Departmental Seminar. Developing monitoring and management tools for the invasive brown marmorated stink bug. New Brunswick, NJ.
- Leskey T. C. (2012). Entomological Society of Washington. Brown marmorated stink bug: what we have learned so far. Smithsonian Museum of Natural History, Washington, DC.
- Leskey T.C. (2012). Piedmont/Blueridge Horticultural Society. The impact of the invasive brown marmorated stink bug. Blandy Experimental Farm and State Arboretum. Boyce, VA.
- Leskey, T.C. and S.E. Wright. (2011). Entomological Society of America. Integrating olfactory and visual stimuli as attractants for BMSB. Reno, NV.
- Leskey, T.C. (2011). Purdue University. Departmental Seminar. Developing monitoring and management tools for the brown marmorated stink bug. West Lafayette, IN.
- Leskey, T.C. J. Fiola and D. Pfeiffer. (2011). Entomological Society of America. Impact of the BMSB in vineyards. November 2011, Reno, NV.
- Martinson, H., P. Shrewsbury, and M. Raupp. (2011). Entomological Society of America. BMSB smackdown: The use of woody plants in designing a new alien out of the residential landscape, in the Communicating Challenges in Turfgrass & Ornamental Pest Management Symposium. November 2011, Reno, NV.
- Miller, J.C. (2012). Entomological Society of America-Pacific Branch. Initiating Classic Biological Control Projects: A response to two recent exotic insect pests. March 25-28, 2012, Portland, OR.
- Miller, J.C. (2012). Oregon State University, Department of Horticulture and Crop and Soil Science. Exotic pest threats and Conservation.
- Miller, J.C. (2012). Entomological Society of America-Pacific Branch. Initiation of Classical Biological Control for Two Exotic Pests in Oregon. March 25-28, 2012, Portland, OR.
- Owens, D., D.A. Herbert, T.P. Kuhar, D.R. Reissig, and G.P. Dively. (2012). Entomological Society of America-Eastern Branch. Brown marmorated stink bug (*Halyomorpha halys*) feeding injury and damage potential to mid-Atlantic soybeans. March 16-19, 2012, Hartford, CT.
- Pfeiffer, D.G. (2011). Vineyard Commodity Team Report. Stakeholders Advisory Panel, SCRI Grant. Brown Marmorated Stink Bug Working Group, November 30, 2011, Winchester, VA.
- Pfeiffer, D.G. (2011). BMSB IPM Working Group. Using Scholar to Manage BMSB Information and Communication. November 29, 2011, Winchester, VA.

- Pfeiffer, D.G., C. Rodriguez-Saona and J. Fiola. (2011). Entomological Society of America. Potential impacts on grapes and small fruits in the mid-Atlantic US. Symposium entitled "Impact of Brown Marmorated Stink Bug in US Agroecosystems". November 13-16, 2011, Reno, NV.
- Pfeiffer, D.G. (2012). Entomological Society America-Eastern Branch. Brown marmorated stink bug management issues in vineyards. Symposium entitled "Brown marmorated stink bug – one year later." March 16-19, 2012, Hartford, CT.
- Pfeiffer, D.G. (2011). 85th Annual Western Orchard Pest and Disease Management Conference. Brown marmorated stink bug: What's in it for Virginia vineyards? January 12-14, 2011, Portland, OR.
- Raupp, M.J., H. Martinson, and P. Shrewsbury. (2011). Entomological Society of America. Brown marmorated stink bug in ornamentals: Unique modes of injury and patterns of host utilization. Impact of Brown Marmorated Stink Bug in US Agroecosystems Symposium. November 2011, Reno, NV.
- Riley, C. (2012). Socio-Environmental Synthesis Center. The Battle Against BMSB. August 2012, Annapolis, MD.
- Rodriguez-Saona, C. and D. Polk. (2012). Entomological Society of America– Eastern Branch. Impact of BMSB in Fruit Crops in New Jersey. March 19, 2012, Hartford, CT.
- Shearer, P., J. Aldrich and A. Khimian. (2011). Entomological Society of America. The Brown Marmorated Stink Bug: An early Perspective. November 13-16, 2011, Reno, NV.
- Shearer, P., C. Hedstrom, V. Walton, J. Brunner, T. Murray. (2012). Entomological Society of America-Pacific Branch. The Brown Marmorated Stink Bug, An Alien Invader in the PNW. March 25-28, 2012, Portland, OR.
- Shearer, P. and A. Nielsen. (2012). Entomological Society of America Meeting-Eastern Branch. BMSB: The early years. March 16-19, 2012, Hartford, CT.
- Wallner, A.N., G. Hahn, A. Nielsen, G.C. Hamilton and C. Rodriguez-Saona. (2012). International Congress of Entomology. Examining the spatial and temporal factors that facilitate the distribution of *Halyomorpha halys* (Hemiptera: Pentatomidae) in New Jersey, USA, August 2012, Daegu, South Korea
- Wright, S.E. and T.C. Leskey. (2011). Entomological Society of America. Behaviorally based evaluation of insecticides for BMSB: mobility, mortality and recovery. Reno, NV.
- Wright, S.E. and T.C. Leskey. (2011). New England, New York, and Canadian Tree Fruit Pest Management Workshop. Monitoring and control efforts for brown marmorated stink bug in commercial apple and peach orchards. Burlington, VT.
- Wright, S.E. and T.C. Leskey. (2011). Cumberland-Shenandoah Fruit Workers' Conference. Laboratory and field evaluations of insecticides for control of brown marmorated stink bug. Winchester, VA.

Research Posters

- Brodo, C. (2012). Socio-Environmental Synthesis Center. Brown Marmorated Stink Bug: Native natural enemies of an exotic insect. August 2012, Annapolis, MD.
- Jones, A.L., C.R.R. Hooks, and P.M. Shrewsbury. (2012). Survey and evaluation of indigenous natural enemies of brown marmorated stink bug in field, vegetable and ornamental crops. The Brown marmorated stink bug – One year later Symposium. Entomological Society of America-Eastern Branch. March 2012, Hartford, CT.
- Kuhar T., G. P. Dively, J. Whalen, G.C. Hamilton, G. Brust, and K. Kamminga. (2012). Proceedings of the 7th International Integrated Pest Management Symposium: IPM on the World Stage P015 Pest threat of the invasive brown marmorated stink bug to vegetable crops in the U.S. p. 85 in 2012 Memphis, TN, March 27–29, 2012.

Riley, C. (2012). Socio-Environmental Synthesis Center . Designing a Sustainable Landscape: The distribution of BMSB and the implications for a pest resistant environment. August 2012, Annapolis, MD.

UMD (2011). APS National Meeting. First Report of BMSB transmission of the yeast *Eremothecium coryli*. Honolulu HI.

Research Workshops/Meetings/Symposia

Hamilton, G.C. and T.C. Leskey. (2012). Entomological Society of America- Eastern Branch. Brown Marmorated Stink Bug: One Year Later. Symposium. 10 speakers from 5 states. Hartford, CT.

Hoelmer, K., C. Dieckhoff and M. Buffington. (2012). Identification of Native Parasitoids. Newark, DE. Stakeholder Advisory Panel Meeting, AHS AREC, Virginia Tech. (2011) Winchester, VA, November SCRI PD/PI Planning Meeting, USDA-ARS, Appalachian Fruit Research Station. (2012). Kearneysville, WV.

Nielsen, A. and G. Hamilton. (2011). Impact of Brown Marmorated Stink Bug in US Agroecosystems. Four hour Symposium. Entomological Society of America, Reno, NV. November 11, 2011. BMSB IPM Working Group Meetings. (2012). Westminster, MD and Winchester, VA.

Research Oriented Websites and Digital Products

Use of Citizen Science-based data to track BMSB throughout NYS.

<http://imapinvasives.org/nyimi/map/> IPMNET website with BMSB fact sheets and section devoted to current BMSB research at University of Maryland BMSB Updates

<http://ipmnet.umd.edu/bmsb/index.htm>

Scholar site for BMSB Working Group maintained at Virginia Tech (<http://scholar.vt.edu>) (by enrollment only)

ENY Brown Marmorated Stink Bug Project: <http://hudsonvf.cce.cornell.edu/bmsb1.html> (incorporates Flash and Vimeo movies of presentations on BMSB for tree fruit and small fruit growers, plus additional websites and online resources)

StopBMSB.org website. The Northeastern IPM Center, with input from collaborators, created the website. This fully searchable website offers original articles about BMSB research, state specific BMSB sites, updates on the impact of BMSB, RSS (syndication), feed alerts for updated material, and links to Facebook and Twitter.

Brown Marmorated Stink Bug in NC. Includes extension articles and a map of distribution in NC. <http://www.ces.ncsu.edu/fletcher/programs/apple/entomology/BMSB/index.html>

Oregon State University BMSB website: <http://BMSB.hort.oregonstate.edu>. The website was initiated in June has had ca. 1,037 page views from all 50 states and 17 countries.

PSU based web site: stinkbug-info.org to track BMSB populations PSU Department of Entomology, BMSB factsheet - 166,280 page views 138,650 were page views by first time viewers.

Kuhar, T. 2012. Peer-reviewed Webcast. "Pest Threat of the Invasive Brown Marmorated Stink Bug to Tomatoes in the U.S.". Focus on Tomatoes Webcast, Plant Management Network, International, June 2012. <http://www.plantmanagementnetwork.org/edcenter/seminars/Tomato>

Pfeiffer, D.G. 2012. Brown marmorated stink bug, *Halyomorpha halys* (Stål). Component of Virginia Fruit web site. <http://www.virginiafruit.ento.vt.edu/BMSB.html>

Rutgers BMSB Iphone/Ipad AP <http://www.pestmanagement.rutgers.edu/IPM/Vegetable/Pest%20Maps/maparchive.htm#2011> <http://njaes.rutgers.edu/stinkbug/>

Raupp, M. Bug of the Week. To eat a stink bug, part 4 – They eat dead things, Brown Marmorated Stink Bug, *Halyomorpha halys*, becomes a meal for the European paper wasp, *Polistes dominulus*. September 26, 2011. http://www.bugoftheweek.com/BugOfWeek_39F.html

Raupp, M. Bug of the Week. To eat a stink bug, part 3 – Bug vs. Bug, Brown Marmorated Stink Bug, *Halyomorpha halys*, meets the wheel bug, *Arilus cristatus*. September 19, 2011. http://www.bugoftheweek.com/BugOfWeek_38F.html

Raupp, M. Bug of the Week. To eat a stink bug, part 2 – Homegrown hospitality, Brown Marmorated Stink Bug, *Halyomorpha halys* meets the black and yellow garden spider, *Argiope aurantia*. September 12, 2011. http://www.bugoftheweek.com/BugOfWeek_37F.html

Raupp, M. Bug of the Week. To eat a stink bug, part 1 – A curious reunion, Brown Marmorated Stink Bug, *Halyomorpha halys* and Chinese praying mantis, *Tenodera sinensis*, September 6, 2011, http://www.bugoftheweek.com/BugOfWeek_36F.html

Raupp, M. Bug of the Week. Exodus underway: Brown Marmorated Stink Bug, *Halyomorpha halys*, March 19, 2012, http://www.bugoftheweek.com/BugOfWeek_12G.html

Raupp, M. You tube. Brown Marmorated Stink Bug Control: Keeping Stink Bugs out of your House http://www.youtube.com/watch?v=9Wp8cd_VQBA September 1, 2011 – August 31, 2012. 13,000 visits.

Raupp, M. Home and garden plant and pest page: Stink bugs. <http://growit.umd.edu/plantandpestproblems/StinkBug.cfm>. 3117 visits.

Extension Workshops, Field Days, Trainings and Talks

The extension outreach efforts of all institutes were combined to summarize all workshops, field days, training, and talks covering BMSB in specialty crops.

Cornell	17 outreach/education events reported
NC State	12 outreach/education events reported
Northeastern IPM Center	2 outreach/education events reported
OSU	18 outreach/education events reported
Penn State	33 outreach/education events reported
Rutgers	11 outreach/education events reported
UDEL	3 outreach/education events reported
UMD	60 outreach/education events reported
USDA-ARS	14 outreach/education events reported
VT	18 outreach/education events reported
WA State	42 outreach/education events reported

Extension and Outreach Publications

- Brust, G. J. Whalen, T. Kuhar, S. Fleischer, J. Ghidui. 2012. New updates on BMSB chemical control. Commercial Vegetable Production Recommendations, EB-236. Mid-Atlantic Region. Rutgers Press.
- Brust, G.E. and K. Rane. 2011. Transmission of the yeast *Eremothecium coryli* to fruits and vegetables by the Brown marmorated stink bug. UME Fact Sheet found at: www.agnr.umd.edu/Extension/agriculture/mdvegetables/files/yeasttransmissionbyBMSBinvegetables.pdf
- Cornell "Grower Alerts" to Hudson Valley pome fruit growers (7 alerts sent to 317 Hudson Valley growers and extension staff in 6 states via email throughout the 2012 growing season, plus 2 additional more detailed "Pest Alerts" sent to growers and put onto ENY BMSB website).
- Cornell Scaffolds article, "Update on the BMSB in the Hudson Valley" 25 June 2012.
- Cornell Tracking Invasive Insects Using Your iPhone: Join the BMSB Citizen Science project. CCE News. 12 Oct 2012. <http://cce.cornell.edu/Documents/iPhoneCitizenScienceProject%20Jentsch.pdf>
- Day, E. 2012 Brown Marmorated Stink Bug. Virginia Cooperative Extension publication number 2902-1100, <http://pubs.ext.vt.edu/2902/2902-1100/2902-1100.html>
- Gonzales, C. 2012. Native Parasitoids Hold Promise in Stink Bug Defense. Northeastern IPM Center, Ithaca, NY. Published online at <http://www.stopbmsb.org/stink-bug-bulletin/native-parasitoids-hold-promise-in-stink-bug-defense/>. Summary: Researchers teach workshop participants to recognize natural enemies of brown marmorated stink bug, part of the strategy to control the invasive insect.
- Gonzales, C. 2012. Researchers Discover the Brown Marmorated Stink Bug's Winter Hideout. Northeastern IPM Center, Ithaca, NY. Published online at <http://www.stopbmsb.org/stink-bug-bulletin/researchers-discover-the-brown-marmorated-stink-bug-winter-hideout/>. Summary: New insights into the invasive pest's behavior could help growers protect farms located near woodlands.
- Gonzales, C. 2012. Scientists Draw Maps to Stop Stink Bug Pirates. Northeastern IPM Center, Ithaca, NY. Published online October 2012 at <http://www.northeastipm.org/about-us/publications/fall-2012/>. Summary: An integrated pest management program running since the 1980s has led to fresh insights about a new invader. Scientists are deploying maps to aid the fight.
- Hedstrom, C., N. Wiman, V. Walton, P. Shearer, S. Rondon, J. Lee. 2012. Identifying Brown Marmorated Stink Bug, Oregon State University Extension document (In Publication).
- Krawczyk, G., and L.A. Hull. 2012. Management options against brown marmorated stink bug in Pennsylvania fruit orchards- 2012 perspective. PA Fruit Times Newsletter, May 2012.
- Kunkel, B, Ornamentals Hotline Issue 24, 2012. Brown marmorated stink bugs. Delaware Nursery Landscape Association.
- Murray, T., C. Looney, E. LaGasa and P. Shearer. 2012. Pest Watch: Brown Marmorated Stink Bug. FS079E. <http://cru.cahe.wsu.edu/CEPublications/FS079E/FS079E.pdf>.
- Pfeiffer, D. G. (Bulletin Coordinator since 1988), J. C. Bergh, R. D. Fell, C. R. R. Hooks, G.M. Peck, C. S. Walsh, K. S. Yoder, A. R. Biggs, J. B. Kotcon, J. F. Derr, R. S. Chandran, M. J. Weaver, A. Brown and J. Parkhurst. 2012. 2012 Spray Bulletin for Commercial Tree Fruit Growers. Va. Coop. Ext. Serv. Publ. 456-419. A regional manual for VA, WV and MD.
- Pfeiffer, D. G., C. Johnson, K. S. Yoder and C. Bergh. 2012. Commercial Small Fruits: Disease and Insects. p. 2-1 – 2-16. In: 2012 Pest Management Guide for Horticultural and Forest Crops. Va. Coop. Ext. Pub. 456-017.

- Pfeiffer, D. G., A. B. Baudoin, J. C. Bergh and M. Nita. 2012. Grapes: Diseases and Insects in Vineyards. p. 3-1 – 3-18. In: 2012 Pest Management Guide for Horticultural and Forest Crops. Va. Coop. Ext. Pub. 456-017.
- Polk D,F. 2012. The Plant and Pest Advisory - Fruit Edition. Fruit IPM articles with BMSB recommendations: Vol 17, numbers 3,4,5,7,10,11,12,13,14,15,16,17,18,19,20,21,24. Rutgers Cooperative Extension.
- Rodriguez-Saona, C., Polk, D.F. 2012. The Blueberry Bulletin. Insect management articles with BMSB recommendations: Vol 28, numbers 11,12,13,15,16,17,18,19.
- Shearer, P. Brown Marmorated Stink Bug. Pacific Northwest Pest Management Handbook, 2012. researchers-educators-team-up-against-bmsb/.
- Shrewsbury, P.M. Brown Marmorated Stink Bug: What can you do about those stinkers? Pest Control Technology Magazine, September issue 2011
- Walton, V., P. Shearer, N. Wiman, B. Miller, D. Dalton, C. Hedstrom. Brown Marmorated Stink Bug In. Pacific Northwest Pest Management Guide for Wine Grapes.
- Woodsen, M. 2011. A Stinker of a Pest: IPM Researchers, Educators Team Up Against Brown Marmorated Stink Bug. Northeastern IPM Center, Ithaca, NY. Published in print and online at <http://www.northeastipm.org/about-us/publications/ipm-insights/a-stinker-of-a-pest-ipm->

New Leveraged/Complementary Resources

- Cornell. Apple Research Development Program grant. "Tree Host Survey, Monitoring and Management Strategies for the Invasive Brown Marmorated Stink Bug, *Halyomorpha halys* (Stål): (*Pentatomidae*), Along Borders of NY Tree Fruit. \$14,000.
- OSU. Oregon State University Agricultural Research Foundation. "Accelerated Testing of Non-Target Species For Establishing Biological Control of *Halyomorpha halys*, the Invasive Brown Marmorated Stink bug." 2012: \$12,500. J.C. Miller.
- PSU. State Horticultural Association of Pennsylvania. Understanding biology and behavior of brown marmorated stink bug as a basis for development of management programs in fruit orchards. \$24,922.
- PSU. Pennsylvania Apple Marketing Board. 2012. Late season injury on fruit caused by brown marmorated stink bug: monitoring, management and prevention. \$25,000)
- Rutgers. Whole-farm Organic Management of BMSB and *Endemic Pentatomids* Through Habitat Manipulation. USDA-NIFA Organic Research and Extension Initiative. \$2.6M. A. Nielsen, PD.
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Stakeholder Advisory Panel

More than 30 independent growers, association directors, and business leaders from across the United States are working in our Stakeholder Advisory Panel. This group reviews project accomplishments, provides feedback on research plans, and guides the execution of objectives.

Member Name, Affiliations, and State

George Behling, Tree Fruit Grower and Owner, Nob Hill Orchards, WV
Robert Black, Fruit and Vegetable Grower, Catoctin Mt. Orchards; Treasurer, Maryland State Horticultural Society, MD
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Brad Hollabaugh, Tree Fruit Grower, General Manager and Co-Owner, Hollabaugh Bros, Inc., PA
Rick Hood, Organic Grower, Summer Creek Farm, MD
Doug Inkley, Senior Scientist, National Wildlife Federation, MD/DC
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