Journal of Extension

Volume 54 | Number 4 Article 11

8-1-2016

Brown Marmorated Stink Bug in the Mid-Atlantic States: Assessing Grower Perceptions, Economic Impact, and Progress

Theresa A. Dellinger
Virginia Tech, tdelling@vt.edu

Eric R. Day
Virginia Tech, idlab@vt.edu

Douglas G. Pfeiffer
Virginia Tech, dgpfeiff@vt.edu

Journal of Extension
www.joe.org

August 2016
Volume 54
Number 4
Article # 4RIB4
Research In Brief

Brown Marmorated Stink Bug in the Mid-Atlantic States: Assessing Grower Perceptions, Economic Impact, and Progress

Abstract

Attendees at mid-Atlantic grower meetings were surveyed in 2012 and 2014 regarding their knowledge of the invasive brown marmorated stink bug (BMSB) and its impact. Responses to individual questions were paired and analyzed for independence between survey years. Despite a large-scale effort by Extension to inform growers and others about BMSB, there remains a clear need for more training on the identification of BMSB nymphs. Respondents also want more information on effective chemical options, scouting methods for BMSB, and BMSB biology, and they prefer to receive this information from Cooperative Extension.

Theresa A. Dellinger
Collections Manager, Virginia Tech Insect Collection
tdelling@vt.edu

Eric R. Day
Insect Identification Lab Manager
idlab@vt.edu

Douglas G. Pfeiffer
Professor and Extension Fruit Specialist
dgpfeiff@vt.edu

Virginia Tech
Blacksburg, Virginia

Introduction

Brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål), is a key agricultural pest, feeding on a wide range of fruit, vegetable, and field crops (Hamilton, 2009; Kuhar et al., 2012; Leskey et al., 2012). It also is a pest of ornamental plants and invades homes in the fall, when adults seek sheltered places to overwinter (Aigner & Kuhar, 2014). BMSB was first reported in the United States in 1996 in Pennsylvania and has since spread throughout the mid-Atlantic region, across the United States, and into Canada (Stop BMSB, 2015). BMSB is now a major pest of corn, soybean, apples, peaches, and tomatoes in Pennsylvania, Virginia, West Virginia, New Jersey, Maryland, and Delaware. Control of BMSB relies on aggressive, repeated pesticide applications of broad spectrum insecticides, which has disrupted integrated pest management (IPM) practices by killing beneficial insects (Leskey, Short, Butler, & Wright, 2012; summary in Rice et al., 2014). This situation has been particularly challenging for organic growers who find that their usual management tactics are ineffective at reducing BMSB populations below damaging levels.

An interdisciplinary team of researchers formed the BMSB IPM Working Group in 2010 to coordinate research and outreach efforts. There has been a widespread educational effort to inform growers through fact sheets, presentations, workshops, and the Stop BMSB website (www.stopbmsb.org). Because IPM is dependent on knowledge about a pest and a grower's willingness to adopt new control tactics, the BMSB IPM Working Group developed an impact survey to measure changes in grower perceptions and the economic impact of BMSB between 2012 and 2014. The survey also provided a means of evaluating the success of Extension programming.

Materials and Methods

The BMSB IPM Working Group developed a six-page survey with color images. The handout consisted of 20 questions, mostly multiple choice, designed to gauge the audience's knowledge of BMSB identification, feeding injury symptoms, economic impact, and pest management. An electronic copy of the survey form and the collected data is available from idlab@vt.edu.

The survey was administered in 2012 and 2014 to attendees at regional horticultural conferences in the mid-Atlantic region. Commodities represented by attendees at these meetings included tree fruits, small fruits, vegetables, field crops, and ornamentals. Respondents remained anonymous, providing no associated personally identifiable information with the survey. The same survey questions were used in 2014 as in 2012 to assess changes in pest knowledge and economic impact over time, but no attempt was made to resurvey the same individuals from 2012. However, pesticide recertification at these meetings runs on a 2-year cycle, so some of the 2012 survey respondents likely returned in 2014 for recertification. Not all participants completed the survey, but any completed questions from incomplete surveys were accepted for data analysis. Responses from all states were pooled for the analysis of individual questions between surveys. Data for individual questions were analyzed using the chi-square test for independence (Preacher, 2001) between survey years, with Cronbach's alpha equal to 0.05 set for statistical significance. Unless otherwise indicated, data were independent of survey year and are presented as combined from both surveys.

Results and Discussion

Demographics

Overall, the majority of respondents worked in Virginia, with the second largest proportion being from Pennsylvania (Table 1). Most respondents identified themselves as growers. The occupational categories "farm worker," "farm manager," and "other" also were strongly represented.

Table 1.

Demographics of Respondents

Demographic variables	***n***	**%** [a]
Work location by state		
Maryland	83	6
New Jersey[b]	44	3
Pennsylvania	476	32
Virginia	893	60
Occupation		
Consultant/advisor	61	4
Extension educator	37	2
Farm manager	189	11
Farm worker	271	15
Grower/farmer	986	56

Other occupation	188	11
Researcher	30	2

[a]Total may not equal 100% due to rounding. [b]No respondents from NJ participated in 2012 due to inclement weather; thus, the NJ data were dropped from the analysis of work location. Respondents working in NJ in 2014 represented only 3% of the total respondents.

Recognition of BMSB

Most respondents (90%, *n* = 1,339) correctly identified a picture of an adult BMSB compared to the 10% (*n* = 154) who did not. In contrast, only 40% of respondents (*n* = 594) correctly identified a BMSB nymph, whereas 60% (*n* = 899) did not. Furthermore, nearly all respondents (97%, *n* = 1,451) indicated that they could identify a BMSB correctly, whereas only 3% (*n* = 43) indicated that they did not know how to identify a BMSB. Most respondents recognized that southern green stink bug (*Nezara viridula* [L.]) and leaf-footed bug (*Leptoglossus phyllopus* [L.]) are not BMSB (89%, *n* = 1,334, and 91%, *n* = 1,357, respectively). Only 11% (*n* = 160) and 9% (*n* = 137) misidentified southern green stink bug or leaf-footed bug as BMSB, respectively.

Respondents most frequently used a combination of characteristics to identify BMSB, followed by a single characteristic, such as color pattern, shape, or the presence of white bands on the antennae (Table 2). Only 4% of respondents indicated that they did not know what BMSB looked liked, which is lower than the true rate of misidentification as discussed above.

Table 2.
Characters Used to Identify Brown Marmorated Stink Bug

Identification character	***n***	**%[a]**
White bands on antennae	285	16
Alternating spots on back edge	137	8
Color pattern	347	20
Shape	328	19
All of the above	659	38
I do not know what a BMSB looks like	81	4

[a]Total does not equal 100% due to rounding.

Respondents successfully distinguished BMSB adults from other similar pests but largely failed to recognize BMSB nymphs. These results suggest that Extension programming has focused too much on the recognition of adult BMSB and not enough on the nymphs. Some of the characters used to teach growers how to identify BMSB (e.g., color pattern or alternating spots on the back edge of the body) (Kamminga, Herbert, Malone, Kuhar, & Green,

2009) apply only to BMSB adults. Growers' failure to recognize the nymphs may allow BMSB populations to build and cause economic damage before IPM can be implemented. Extension should put more emphasis on the identification of BMSB nymphs so that growers can more accurately monitor BMSB populations in their crops. This approach is of particular importance for fruit growers, as BMSB nymphs are more likely to be found damaging fruit than nymphs of other stink bug species early in the season (Kamminga et al., 2009).

Experience with BMSB

Reported occurrence of feeding injury by BMSB was related to survey year in field and sweet corn, apple or other tree fruit, pepper or tomato, and soybean or green beans (see Table 3). Relationships between feeding injury and survey year likely resulted from the general trend of fewer respondents reporting in 2014 that they had never seen feeding damage in the specified crop (see Table 3). This trend was expected, given the spread of BMSB and increased awareness of BMSB through Cooperative Extension programming. Also there were increases in the proportion of respondents reporting that they did not grow the indicated crop, but the numbers of these responses did not vary widely between survey years and should not necessarily be interpreted to mean that crops were discontinued as a direct result of increased BMSB pest pressure in 2014.

Table 3.

Feeding Injury by Brown Marmorated Stink Bug as Reported in 2012 and 2014 Surveys

Crop, survey year	Never saw injury *n* (%)	Saw injury 2 years ago *n* (%)	Saw injury last year *n* (%)	Saw injury both years[a] *n* (%)	Did not grow this crop *n* (%)
Field and sweet corn (χ^2 = 29.56, df = 4, p = 6.02 x 10-6)					
2012	241 (32%)	49 (7%)	109 (14%)	99 (13%)	261 (34%)
2014[b]	141 (23%)	49 (8%)	60 (10%)	122 (20%)	249 (40%)
Apple or other tree fruit (χ^2 = 19.44, df = 4, p = .0006)					
2012[b]	98 (13%)	52 (7%)	115 (15%)	286 (37%)	223 (29%)
2014[b]	73 (12%)	50 (8%)	51 (8%)	231 (37%)	224 (36%)
Pepper or tomato (χ^2 = 19.89, df = 4, p = 0.0005)					
2012	154 (20%)	37 (5%)	115 (15%)	149 (20%)	300 (40%)
2014[b]	92 (15%)	30 (5%)	66 (11%)	125 (20%)	312 (50%)
Soybean or green beans (χ^2 = 54.72, df = 4, p = .0000)					
2012[b]	165 (22%)	83 (11%)	30 (4%)	104 (14%)	352 (48%)
2014	96 (15%)	23 (4%)	56 (9%)	126 (20%)	321 (52%)

[a]2010 and 2011 or 2012 and 2013, depending on survey year. [b]Percentage within row does not equal 100% due to rounding.

Economic Losses due to BMSB

Economic losses due to BMSB indicated in both percentages and dollars were related to survey year (Table 4). The highest proportion of respondents selected "Don't know or can't say" when asked to estimate economic loss due to BMSB as either a percentage of profit or in dollars. For each survey year, less than or equal to 20% of respondents answered that they had no losses in profit due to BMSB when asked about percentage profit loss. Approximately a third of the respondents for each year estimated a profit loss of less than 33% or a loss of less than $10,000 due to BMSB. A very small percentage of respondents for each year indicated that they had greater than 67% loss in profit or losses between $25,001 and $50,000 or more.

Respondents were not asked to estimate profit loss relative to a specific time frame, and their answers may have included losses beyond the most recent 2 years. These answers suggest that estimating profit loss is an area for which growers need more tools and information. Nonetheless, respondents clearly have suffered economic loss due to BMSB, mostly as less than 33% loss of profit or less than $10,000, with a few respondents for each year (≤16%) reporting higher losses as either a percentage of profit or in dollars (Table 4).

Table 4.

Estimated Losses in Profit due to Brown Marmorated Stink Bug

Indicator	2012 *n* (%)	2014 *n* (%)[a]
Profit loss in percentages ($\chi^2 = 11.95$, $df = 4$, $p = .0177$)		
No loss	131 (20%)	98 (15%)
<33% loss in profit	192 (30%)	216 (34%)
33–66% loss in profit	79 (12%)	60 (9%)
>67% loss in profit	14 (2%)	8 (1%)
Don't know or can't say	235 (36%)	263 (41%)
Profit loss in dollars ($\chi^2 = 15.40$, $df = 5$, $p = .0088$)		
<$10,000	203 (35%)	182 (32%)
$10,000–$25,000	53 (9%)	35 (6%)
$25,001–$50,000	24 (4%)	13 (2%)
>$50,000	18 (3%)	7 (1%)
Don't know or can't say	261 (44%)	286 (51%)
Did not grow crops last year	27 (5%)	38 (7%)

[a]Percentages may not equal 100% due to rounding.

Grower Stress Related to BMSB

Grower stress caused by BMSB was dependent on survey year ($\chi^2 = 6.73$, $df = 1$, $p = .0095$). Respondents in 2012 were evenly split between experiencing stress related to BMSB (50%, $n = 316$) and not experiencing stress

related to BMSB (50%, *n* = 319). In 2014, more respondents reported not being stressed by BMSB (58%, *n* = 330) than being stressed (42%, *n* = 242). As previously discussed, awareness of this pest has grown, and increased familiarity probably contributes to the decline in reported stress.

Management Response to BMSB

Most respondents (73%, *n* = 915) indicated that they practiced IPM, with only 27% not practicing IPM (*n* = 338). The majority (66%, *n* = 858) also indicated that they scouted for BMSB regularly, with 30% not scouting (*n* = 385) and 4% selecting "Do not know" (*n* = 57).

High levels of IPM adoption and active scouting are always desirable, but no effort was made to define IPM or scouting in the survey, and not all respondents may follow what constitutes good IPM practices. The efficacy of scouting performed by the respondents is dubious, given that most respondents (60%) did not recognize a BMSB nymph even though nymphal feeding contributes to overall crop damage. Again, the results of the survey suggest that growers may benefit from a more rigorous scouting program designed to monitor all stages of BMSB throughout the season.

Tactics used to manage BMSB differed by survey year (see Table 5). Most notably, the percentage of respondents reporting that they had BMSB but did not need to treat it or that they had not needed to control BMSB rose from less than 1% in 2012 to 12%–13% in 2014. However, the practice of applying sprays specifically for BMSB in addition to normal spray schedules differed by survey year and increased to 55% by 2014, up from 49% in 2012 (Table 5).

The increase over time in the use of target sprays illustrates that BMSB remains a key pest in the mid-Atlantic region despite the increased percentage of respondents indicating that they do not need to control BMSB. These somewhat conflicting responses may reflect a number of factors, including fluctuating pest pressure over various crops and locations, the need to spray in BMSB "hot spots," and possibly an inadequate recognition of pest populations or crop damage. Again, respondents may benefit from Extension programming that emphasizes proper scouting for BMSB, including population estimation and damage recognition.

Table 5.

Management Tactics Used Against Brown Marmorated Stink Bug by Survey Year

Tactic	**2012 *n* (%)**	**2014 *n* (%)[a]**
Management tactic (χ^2 = 157.37, df = 6, p = .0000)		
Traps	65 (11%)	47 (7%)
Netting	24 (4%)	24 (4%)
Biological controls	36 (6%)	24 (4%)
Sprays	406 (71%)	400 (59%)
Have not used anything yet but have BMSB	3 (<1%)	87 (13%)
Have not needed to control BMSB	3 (<1%)	81 (12%)
Other methods	32 (6%)	12 (2%)
Sprays targeting BMSB (χ^2 = 4.70, df = 1, p = .0301)		

Sprayed specifically for BMSB	309 (49%)	331 (55%)
Did not spray specifically for BMSB	324 (51%)	271 (45%)

[a]Percentages may not equal 100% due to rounding.

Requested BMSB Information and Preferred Sources of Information

Not surprisingly, with regard to desired information, respondents indicated that they are most interested in insecticide choice for BMSB control, followed by how to scout for BMSB and then BMSB biology (Table 6). Respondents were least interested in learning about organic control choices or other topics.

Table 6.

Requested Subjects for Information on Brown Marmorated Stink Bug

Topic of information	***n* (%)[a]**
Biology	509 (15%)
Scouting (how to sample BMSB)	580 (17%)
Trapping (how to trap BMSB)	449 (13%)
Current location of BMSB	362 (10%)
Insecticides (effectiveness and how to apply)	967 (28%)
Nonchemical methods of control	383 (11%)
Organic control choices	200 (6%)
Other	20 (<1%)

[a]Does not equal 100% due to rounding.

Respondents' preferred sources of BMSB information did change slightly with survey year, but only by a few percentage points (Table 7). Most respondents preferred to receive information in person at meetings, followed by through publications from Cooperative Extension and then from Extension educators. This finding is a strong indication of the high regard growers hold for Cooperative Extension and its programming. Respondents were least interested in receiving information about BMSB from private consultants, TV, newspaper and grower print media, other growers, or other sources of information.

Table 7.

Preferred Sources of Information on Brown Marmorated Stink Bug

Source of information (χ^2 = 25.65, *df* = 9, *p* = .0023)	**2012 *n* (%)**	**2014 *n* (%)**
In person at meetings	417 (22%)	392 (25%)
University personnel (Extension educators)	315 (16%)	269 (17%)
Private consultants	113 (6%)	94 (6%)
Cooperative Extension publications	407 (21%)	326 (21%)
Internet/websites	238 (12%)	156 (10%)
Email and email lists	210 (11%)	197 (12%)
TV	17 (1%)	20 (1%)
Newspaper and grower magazines	139 (7%)	70 (4%)
Growers	58 (3%)	43 (3%)
Other	11 (1%)	16 (1%)

Summary

Overall, the survey revealed a few areas that merit consideration by Cooperative Extension for future programming:

- Most respondents correctly recognized a BMSB adult but not a BMSB nymph. More emphasis needs to be placed on the identification and awareness of BMSB nymphs so that growers can accurately assess BMSB populations for effective IPM.
- The highest proportion of respondents did not know or could not state their economic losses due to BMSB as either percentages profit or dollar estimates. Growers could benefit from tools and information relating to estimating economic losses.
- Respondents reporting economic losses due to BMSB indicated that these losses are mostly less than 33% loss of profit or less than $10,000. BMSB remains a key pest with a broad impact on agriculture in the mid-Atlantic region.
- Respondents' interest in information relates mostly to insecticide choices for BMSB control, followed by scouting techniques for BMSB and then BMSB biology. Timely information on these subjects will be needed for growers to remain resilient as BMSB continues to expand its range and impact.

Lastly, the surveys revealed that respondents prefer to learn about BMSB from grower meetings, Extension publications, and Extension educators. Cooperative Extension remains a trusted source of valuable, timely information regarding BMSB.

Acknowledgments

This project was supported through U.S. Department of Agriculture National Institute of Food and Agriculture Specialty Crop Research Initiative grant #2011-51181-30937. Carrie Koplinka-Loehr (retired co-director of the

Northeastern IPM Center), Yasamin Miller (Cornell University), and Flaxen D. L. Conway (Oregon State University) provided constructive comments and guidance on the preparation of the survey.

References

Aigner, J. D., Jr., & Kuhar, T. P. (2014). Using citizen scientists to evaluate light traps for catching brown marmorated stink bugs in homes in Virginia. *Journal of Extension* [online], *52*(4) Article 4RIB5. Available at: http://www.joe.org/joe/2014august/rb5.php

Hamilton, G. C. (2009). Brown marmorated stink bug. *American Entomologist*, *55*, 19–20.

Kamminga, K., Herbert, D. A., Malone, S., Kuhar, T. P., & Green, J. (2009). *Field guide to stink bugs of agricultural importance in the upper southern region and mid-Atlantic states.* Virginia Cooperative Extension. Retrieved from http://pubs.ext.vt.edu/444/444-356/444-356_pdf.pdf

Kuhar, T. P., Kamminga, K. L., Whalen, J., Dively, G. P., Brust, G., Hooks, C. R. R., . . . Herbert, D. A. (2012). The pest potential of brown marmorated stink bug on vegetable crops. *Plant Health Progress*. doi:10.1094/PHP-2012-0523-01-BR

Leskey, T. C., Hamilton, G. C., Nielsen, A. L., Polk, D., Rodriguez-Saona, C., Bergh, J. C., . . . Wright, S. E. (2012). Pest status of the brown marmorated stink bug, *Halyomorpha halys,* in the USA. *Outlooks on Pest Management*, *23*, 218–226. doi:10.1564/23oct07

Leskey, T. C., Short, B. D., Butler, B. R., & Wright, S. E. (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 2012*, 535062. doi:10.1155/2012/535062

Preacher, K. J. (2001). Calculation for the chi-square test: An interactive calculation tool for chi-square tests of goodness of fit and independence [Computer software]. Retrieved from http://quantpsy.org

Rice, K. B., Bergh, C. J., Bergmann, E. J., Biddinger, D. J., Dieckhoff, C., Dively, G., . . . Tooker, J. F. (2014). Biology, ecology, and management of brown marmorated stink bug (Hemiptera: Pentatomidae). *Journal of Pest Management*, *5*(3), D1–D11. doi:http://dx.doi.org/10.1603/IPM14002

Stop BMSB. (2015). Where is BMSB? State-by-state, 6/11/2015 [Illustrated map of BMSB populations, state by state]. Retrieved from http://www.stopbmsb.org/where-is-bmsb/state-by-state/