Investigating the role of invasive tree-wooded borders on brown marmorated stink bug infestations in soybeans and residual efficacy of insecticides

Virginia Soybean Board

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By

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1 year proposal, Amount requested = $7088

Problem Statement:
The brown marmorated stink bug (BMSB), *Halyomorpha halys* (Stål), was introduced to North America from east Asia probably in the late1990s near Allentown, Pennsylvania. By 2010, the insect could be found throughout most of Virginia, and had become a serious nuisance pest in houses and other manmade structures. In addition to being a conspicuous nuisance pest, this insect also caused serious damage to tree fruit, vegetables, and other crops. Since 2010, BMSB damage (often depicted as "stay green syndrome") has occurred to soybean fields in MD, DE, PA, and in the northern Piedmont of VA. In most of the cases, it has been edges of fields that have been infested by the bug populations, and usually the edges are a wooded border with the invasive tree-of-heaven (TOH), *Ailanthus altissima*, which is one of the most successful introduced plant species in North America. Introduced from China over two centuries ago, the tree can now be found in virtually every state in the continental U.S., and has become the dominant tree species along highways in Virginia. While conducting host plant surveys for BMSB in southwest Virginia in 2011, we observed more BMSB on TOH than any other plant species (T. Kuhar, *unpublished data*). In November of 2012, when the vast majority of BMSB populations had already found their winter shelters and were not typically observed on plants, significant numbers of BMSB nymphs were found in the samara (seed) clusters of large TOH that had been cut down. Furthermore, in other regions such as the Hudson Valley of New York and Ontario, Canada, the first BMSB infestations that were observed in the field were detected on TOH. Thus, there is strong evidence that TOH is likely serving an important ecological role for BMSB populations. To our knowledge, this association between TOH and BMSB has not been documented or previously studied.

A better understanding of the relationship between the BMSB and TOH could help the management strategies of the bug in soybeans. In 2011 and 2012, several soybean growers that had BMSB infestations sprayed the field edges only for BMSB, and achieved effective control of the bug in the whole field (Herbert, unpublished data). It might be possible to scout for the bug in the wooded sections and focus management in those areas of fields.

Since 2011, we have evaluated the efficacy of insecticides on BMSB and have shown that several pyrethroids, organophosphates, and neonicotinoids are toxic to BMSB (see Kuhar et al. 2012. Performance of Insecticides on Brown Marmorated Stink Bug on Vegetables. Virginia Cooperative Extension Publication No. ENTO-28NP.). The next important question is how long these insecticides remain effective in the field after spraying.

Objectives:
Our objectives are to:
1. Assess the seasonal occurrence of BMSB on TOH.
2. Determine the importance of TOH-wooded borders to BMSB infestation levels in soybeans.
3. Evaluate the residual efficacy of various insecticides on BMSB.

Methods:
Obj. 1. Seasonal occurrence of BMSB on TOH. More than10 sample sites consisting of an area that contains a wooded tree line with TOH will be sampled weekly from May until October. At each sample location and date, all BMSB life stages will be counted and recorded per 3-minute visual inspections per tree. At least 5 sets of visual inspections will be completed per tree species. BMSB densities and relative proportions of each life stage will be determined over the season, and differences between TOH and various native tree species will be analyzed using ANOVA. An estimate of the seasonal peaks in BMSB egg laying and occurrence of nymphs will also be gleaned from the sampling. This information will be useful for developing pest scouting procedures.

Obj. 2. Importance of wooded borders with TOH to the infestation levels of BMSB in soybeans. This research will be conducted in central Virginia or wherever we detect BMSB on farms. At least 10

soybean fields and bordering wooded areas will be surveyed for BMSB from July to October. Densities of BMSB will be recorded from field edges and field middles using 3-minute timed visual counts. A relationship between the presence of a wooded border with TOH or other tree species and the density of bugs in soybean field edges and middles will be determined using regression analysis. BMSB feeding damage to pods will also be assessed on field edges versus field middles by evaluating a subsample of >100 pods at five or more locations.

Obj. 3. To evaluate the residual efficacy of various insecticides on BMSB.

- A small-plot experiment will be conducted on soybeans at the Kentland Research Farm, near Blacksburg, VA where BMSB populations are well established.
- EXPERIMENTAL DESIGN: Five treatments arranged in a RCB design with 4 replicates.
- TREATMENTS: 1) λ-cyhalothrin (Karate Z) 1.92 oz/A; 2) zeta-cypermethrin (MustangMaxx) 4.0 oz/A; 3) bifenthrin (Brigade) 6.4 oz/A; 4) acephate (Orthene 97) 1 lb/A; and 5) untreated control).
- PLOT SIZE: 2 rows x 20 ft. (2 ft. row centers); no guard rows.
- All plots will be maintained according to standard commercial practices.
- All foliar treatments will be applied at R2 growth stage. To best simulate a typical grower spray, we will use a CO2-pressurized backpack sprayer at 14.3 gpa and 18 psi through four 8002VS nozzles spaced 18-in apart on a 6-ft spray boom.
- At 2 d, 5 d, 10 d, 14 d and 21 d after application, BMSB nymphs and/or adults will be exposed to the treated foliage and developing pods. In order to be sure that we are sampling leaf tissue that was present when the sprays were applied, we will mark fully expanded trifoliates with flagging tape at the time of the treatment and make sure that all samples will be taken from those.
- At least 20 bugs will be tested per treatment per sample date. Mortality of bugs will be assessed after 72 hrs of exposure.

Proposed Budget

Item	**Cost**
A summer wage assistant is requested to assist with the project 417 hours x $12/hr = $5000. Fringe benefits at 7.75% = $388.	$5388
Travel for fieldwork (central VA: 222 miles per week x 10 wk at $0.45/mile ~ $1000)	$1000
Supplies: Carrots, beans, and peanuts (food) for rearing stink bugs; mesh field cages; soybean seed, fertilizer, field stakes, notebooks, etc…	$700
TOTAL	$7088

Budget Justification:

Wages: A summer wage assistant is requested to assist with the project 417 hours x $12/hr = $5000. Fringe benefits at 7.75% = $388. The technician will establish and maintain the stink bug colony and assist with sampling TOH and BMSB and conducting the insecticide efficacy trial.

Travel: Travel to field soybean field locations (approx. 222 miles per week x 10 wk at $0.45/mile = $1000).

Supplies: Soybean seed, fertilizer, field stakes ($500)
Field collecting supplies (notebooks, cages, Petri dishes, produce for feeding stink bugs in colony ($200)

The research described in the grant has not been funded by any other source, and 100% of this project will be funded by the Virginia Soybean Board check-off funds.

Dr. Thomas P. Kuhar

EDUCATION
1987-1992, Towson University, MD. Major- Biology; B.S. *(cum laude) 1992.*
1992-1996, Virginia Tech, Blacksburg, VA Major-Entomology; M.S. 1996.
1996-2000, Virginia Tech, Blacksburg, VA Major-Entomology; Ph.D. 2000.

SPECIALIZATION AND AREAS OF INTEREST
Dr. Kuhar is responsible for the development and assessment of novel approaches for managing arthropod pests of vegetables in Virginia. His research areas include integrated pest management, population ecology, biological control, and insecticide resistance management. He has more than 17 years experience conducting applied research on agricultural crop pests. He has published >60 peer reviewed journal articles related to agricultural pest management including 8 papers on stink bugs.

PROFESSIONAL EXPERIENCE
2007-present, Associate Professor, Department of Entomology, Virginia Tech, Blacksburg, VA
2001-2006, Assistant Professor, Entomology, Virginia Tech Eastern Shore AREC, Painter, VA
2000-2001, Postdoctoral Research Associate, Department of Entomology, Cornell University, Ithaca, NY

PROFESSIONAL SERVICE
Associate Editor, *Journal of Integrated Pest Management;* Senior Editor, *Plant Health Progress* scientific journal*;* Associate Editor, *Arthropod Management Tests* journal

AWARDS
Virginia Tech CALS Award for Research Excellence in Applied Research, 2010; Virginia Tech CALS Distinguished Recent Alumnus, 2007; Gamma Sigma Delta Faculty Research Award of Merit, 2006; Sigma Xi Doctoral Research Award, 2000

SELECTED RELEVANT PEER-REVIEWED JOURNAL PUBLICATIONS
Total: Journal articles = 65; Book Chapters = 4

Kuhar, T., K. 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.

Kamminga, K. L., A. L. Koppel, D. A. Herbert, Jr., and T. P. Kuhar. 2012. Biology and management of the green stink bug. J. Integrated Pest Management: 3(3); 2012; C1-C8(8). DOI: http://dx.doi.org/10.1603/IPM12006.

Koppel, A. L., D. A. Herbert, Jr., T. P. Kuhar, and K. Kamminga. 2009. Survey of stink bug (Heteroptera: Pentatomidae) egg parasitoids in wheat, soybean and vegetable crops in Southeast Virginia. Environ Entomol. 38: 375-379.

Kamminga, K., T. Kuhar, A. Wimer and D. A. Herbert. 2012. Effects of the insect growth regulators novaluron and diflubenzuron on the brown marmorated stink bug. Online. Plant Health Progress doi:10.1094/PHP-2012-1212-01-RS.

Kamminga, K., D. Herbert, T. Kuhar, S. Malone, and H. Doughty. 2009. Toxicity, feeding preference and repellency associated with selected organic insecticides against *Acrosternum hilare* and *Euschistus servus* (Hemiptera: Pentatomidae. J. Econ. Entomol. 102: 1915-1921.

Kamminga, K., D. Herbert, T. Kuhar, and C. Brewster. 2009. Predicting black light trap catch and flight activity of *Acrosternum hilare* (Hemiptera: Pentatomidae) adults. Environ. Entomol. 38: 1716-1723.

Koppel, A., D. Herbert, T. Kuhar, S. Malone, and G. Arrington. 2011. Efficacy of selected insecticides against eggs of Euschistus servus (Say) and Acrosternum hilare (Say) (Hemiptera: Pentatomidae) and the egg parasitoid, *Telenomus podisi* Ashmead (Hymenoptera: Scelionidae. J. Econ. Entomol. 104: 137-142.

Curriculum Vitae

Name, Rank, and Contact Information:

David Ames Herbert, Jr.
Professor, Department of Entomology
Tidewater Agricultural Research and Extension Center
Tel. 757-657-6450, ext. 122 Fax 757-657-9333
herbert@vt.edu

Education:

Ph.D., Entomology, Auburn University, Auburn, AL, 1985.
M.S., Entomology, Auburn University, Auburn, AL, 1975.
B. S., Biology, Johnson State College, Johnson, VT, 1971.

Professional Experience:

Professor, Dept. of Entomology, Tidewater Agric. Res. and Ext. Center, Virginia Tech, Suffolk, VA, 2002-present.
Associate Professor, Dept. of Entomology, Tidewater Agric. Res. and Ext. Center, Virginia Tech Suffolk, VA, 1994-2002.
Adjunct Associate Professor, Dept. of Entomology, North Carolina State University, Raleigh, NC, 1995-present.
Assistant Professor, Dept. of Entomology, Tidewater Agric. Res. and Ext. Center, Virginia Tech, Suffolk, VA, 1988-1994.
Postdoctoral Fellow, Dept. of Plant Pathology, Auburn Univ., Auburn, AL, 1986-1988.
Research Associate, Dept. of Entomology, Auburn, Univ., Auburn, AL, 1979-1986.

Honors and Awards (since 2002)

Research awards and recognition

Received the Andy Swiger Land-Grant Award, Virginia Tech College of Agriculture and Life Sciences, Blacksburg, VA, 2008.
Received the Award for Excellence in Integrated Pest Management, awarded by the Entomological Society of America, Eastern Branch, Ocean City, MD, 2002.

Extension and public service awards and recognition

Received the Extension Service Award for Outstanding Service to Virginia's Agribusiness Industry, awarded by the Virginia Agribusiness Council, Warsaw, VA, 2010.
Received the Extension Award of Merit, Gamma Sigma Delta,VPI&SU Chapter. Blacksburg, VA, 2006.
Alumni Association Award for Excellence in Extension, Virginia Tech Alumni Association. Blacksburg, VA, 2006.

State IPM Coordinator—1997-present
Extension Project Leader—Department of Entomology, College of Agriculture and Life Sciences, 1994-present
Refereed Scientific Journal Articles—60 total
Extension Publications—133 total
Graduate Student Committees—PhD, 3 Chair, 2 Co-Chair; MS, 6 Chair, 1 Co-Chair, 10 Member

Additional research personnel included:

In addition to the four PIs listed, additional researchers that will assist in this project will include:

- **Mr. Chris Philips**, a technician in Dr. Kuhar's lab who will assist with the field sampling in obj. 1. A portion of his salary is included in the budget.

- **Mr. Jamie Hogue**, who is a 1500-hr wage technician located in central Virginia who works primarily for Drs. Herbert and Kuhar. Jamie will assist with the field sampling involved obj. 3.