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Title: Utilizing the Samurai Wasp as a Potential Control Tool against brown marmorated stink bug

Submitted to: Patti Keller

patti@acnursery.com

State Horticultural Association of Pennsylvania

480 Mountain Rd

Orrtanna, PA 17353

Submitted by: Grzegorz Krawczyk

717-677-6116

gzk13@psu.edu

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AUTHORIZED UNIVERSITY OFFICIAL

Kelley Benninghoff DATE 12/15/17

Kelley Benninghoff
Research Administrator - Pre-award
College of Agricultural Sciences
107 Agricultural Administration Building
University Park, PA 16802-2602
Tel: 814-865-5419
Fax: 814-865-0323
Email: L-AG-contgrts@lists.psu.edu

John W. Harold DATE 12/15/17

John W. Harold
Assoc. VP for Resresearch
Office of Sponsored Programs
The Pennsylvania State University
110 Technology Center Building
University Park, PA 16802-2602
Tel: 814-865-1372
Fax: 814-865-3377
Email: osp@psu.edu

EIN: 24-60000376

DUNS No: 00-340-3953

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Title: Utilizing the Samurai Wasp as a Potential Control Tool against brown marmorated stink bug

Personnel: Greg Krawczyk
Pennsylvania State University, Department of Entomology
Fruit Research and Extension Center, Biglerville, PA

Duration of Project: April 01, 2018 - March 31, 2019
Year 1 of the two year proposal.

Justification:

Due to the severe outbreak of the brown marmorated stink bug (BMSB) *Halyomorpha halys* (Stål) (Heteroptera - Pentatomidae) in Pennsylvania fruit orchards in 2010, IPM programs which were successful for other orchard pests were disrupted. Research on several monitoring tactics to understand BMSB life history in relation to fruit damage levels has helped decrease the number of insecticide sprays throughout the season. The most effective insecticides for BMSB control continue to be broad spectrum, which often leads to outbreaks of secondary pests, such as wooly apple aphid or San Jose scale. The effect of these insecticides on natural enemies of BMSB, which may offer alternative control strategies, have not been thoroughly investigated. Much like the importance of monitoring tactics to understand where and when BMSB populations are located throughout the season, it is important to understand the same for natural enemies to create strategies that may aid their populations in BMSB control.

Effective biological control of BMSB is likely to come from several natural enemies over different life stages. Research throughout the mid-Atlantic has shown both native predatory and parasitic insects and spiders attacking BMSB. Generalist predators of BMSB nymphs include damsel bugs (*Nabis* spp.), assassin bugs (Reduviidae), and the predatory stink bug (*Podisus maculiventris* (Say)). Generalist predators of BMSB eggs include grasshoppers (Acrididae), lady bugs (*Coccinella* sp.) and jumping spiders (Salticidae). While generalist predators are important to have in agricultural ecosystems, they do not provide specific control of one pest species and often can attack one another, highlighting the importance of research on more specific natural enemies as well.

A candidate for more specific control of BMSB are parasitoid wasps, which attack the eggs of stink bugs, effectively killing bugs before they hatch and become resident pests. Across the U.S., parasitoid wasps which attack native stink bug species have demonstrated the ability to also attack and kill BMSB eggs (*Anastatus* spp., *Telenomus* spp., and *Trissolcus* spp.). In addition to this, populations of the samurai wasp (*Trissolcus japonicus* Ashmead), a highly successful parasitoid of BMSB in Asia, have recently been found in several U.S. States. During the 2016 and 2017 field seasons in Pennsylvania, we found these same three genre of native egg

parasitoids attacking BMSB in small numbers, and found the samurai wasp for the first time in the state. Interestingly, this detection was during August in a fruit orchard, specifically on a cherry tree. With the samurai wasp being present in Pennsylvania fruit orchards, it is now a candidate to be a potential control method for BMSB alongside its native “cousins.”

Although numbers of parasitoids found with sentinel egg masses have generally been low, it is promising that these wasps are able to attack BMSB, as research has shown that parasitoid species often prefer the host which they emerged from. Over generations, therefore, it is possible that some native species will be able to further adapt to BMSB. Pennsylvania provides a unique situation to study this, due to it likely being the earliest location where BMSB arrived, providing native parasitoids the longest amount of time to adapt. Understanding how these native parasitoids may adapt in the presence of the highly adapted samurai wasp, provides an even further interesting dynamic. It is currently unknown if the samurai wasp will be able to outcompete native parasitoids, or if it will only attack BMSB in specific landscapes, leaving open other landscape categories for native wasps.

To research these dynamics, specifically if native parasitoids are adapting well and if the small adventive population of the samurai wasp will survive in Pennsylvania, it is important to know *where* and *when* they can be found. Some studies have begun to discover that different parasitoid wasps trend towards different landscapes – some are found in higher numbers in soy, others in the woods, for example, but due to overall low captures of these wasps, population presence throughout the season continues to be an area that is not understood well. Additionally, investigation of *how* these different species find BMSB throughout the landscape may aid in the understanding of *why* species may reside in these different landscapes. During this project, research emphasis will be on further landscape specific detections of parasitoid wasps attacking BMSB through classic and new methods, with the specific priority of determining differences between the native and introduced parasitoid species. With this information, we plan to determine how best to promote the survival of these potentially promising BMSB control agents in the landscape.

This proposal directly addresses the current SHAP Research Committee 2018 priorities of brown marmorated stink bug management, alternative insect control strategies, and furthering the understanding of a new and emerging insect.

Objectives:

1. Work to further detect the new and emerging population of the well adapted BMSB parasitoid, the samurai wasp (*Trissolcus japonicus*).

2. Evaluate the location and movement of populations of native parasitic wasps under Pennsylvania conditions attacking BMSB and native stink bug eggs over the entire growing season.
3. Establish colonies of native parasitoid wasps to determine the potential to adept to BMSB, as well as the potential shift in preferences over several generations.

Procedures:

1. *Furthering detections of the samurai wasp...* - Yellow sticky cards (Alpha Scents, Inc.) baited with BMSB pheromone lures (Trécé, Inc.) will be deployed at week long intervals in commercial orchards with historically high levels of BMSB across different regions of Pennsylvania. Yellow sticky cards will be placed throughout the landscape, including fruit trees, known BMSB host plants bordering orchards, and wooded plots to determine landscapes where these parasitoids can be found. To eventually inform growers where and when the wasp might be found throughout the season, data will be collected at these locations every week during the entire egg-laying period for BMSB (mid-June through early September). In addition to yellow sticky cards, surveys will be conducted throughout the season for any naturally laid egg masses by both BMSB and native stink bug species. Egg masses will be identified for stink bug species, and reared in the lab for any parasitoid emergence.
2. *Evaluate the location and movement of populations of native parasitic wasps...* - Freshly laid and frozen BMSB egg masses from the colony kept in Krawczyk's laboratory at the PSU Fruit Research and Extension Center in Biglerville, PA will be deployed in commercial orchards. Eggs will be affixed to white cards, and deployed across the landscape as described for the yellow sticky cards. Surveys will also be conducted to search for naturally laid stink bug eggs. We will also attempt to explore creating a more "natural" sentinel egg mass deployment system, with the ultimate goal of having eggs laid directly on host plants. All egg masses utilized and collected during this project will be reared for at least six weeks to allow parasitoid emergence. BMSB populations will be surveyed throughout the season at all sites with baited monitor traps, with the goal of understanding relationships in movement between parasitoids and hosts.
3. *Establish colonies of native parasitoid wasps...* - Any native parasitoid wasps which emerge from both deployed and found stink bug egg masses will immediately fed with a solution of honey and water. Fresh and frozen BMSB egg masses will be given to these wasps. To understand the biology of these wasps, observations will be made on attempts at parasitism, and success rate along with development time will be closely monitored . The next generation of parasitoids which successfully develop will be given an increased

number of egg masses, with the goal of creating lab based colonies. These colonies will be ultimately utilized for chemical ecology-based research to determine why certain species may be better at detection and attack of BMSB.

Budget - Year 1:

<i>Hourly wages</i> (14 weeks of part time summer assistance at \$10.00 per hour)	\$ 4,200
<i>Fringe benefit @ 7.9%</i>	\$ 333
<i>Travel</i> (3 months of fleet operation vehicle at \$748/month, in Pennsylvania only)	\$ 2,244
Total for the first year of the project:	\$ \$6,777

Other Support: The graduate student time and supplies are paid by the combined funding from the USDA-NIFA SCRI 2016-51181-25409 and USDA ARS BMSB Area-Wide Project grants.