PennState
College of Agricultural Sciences

PROPOSAL TRANSMITTAL

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Title: Utilizing the Samurai Wasp as a Potential Control Tool Against Brown Marmorated Stink Bug

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Title: Utilizing the Samurai Wasp as a Potential Control Tool Against Brown Marmorated Stink Bug

Personnel: Greg Krawczyk
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Duration of Project: April 01, 2019 - March 31, 2020
Year 2 of the two-year proposal. The first year included surveys in five counties in Pennsylvania to detect populations of the samurai wasp, an investigation of the egg parasitoids attacking both BMSB and native stink bug egg masses in two Pennsylvania fruit orchards, the evaluation of a new egg mass deployment strategy, and the creation of a colony of egg parasitoids.

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 region 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., *Ooencyrtus* spp. and *Trissolcus* spp.). During the 2016, 2017, and 2018 field seasons in Pennsylvania, we found these same four genre of native egg parasitoids attacking BMSB in small numbers. 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 2017 field season, the samurai wasp was detected in low numbers on yellow sticky cards in fruit orchards in two counties (Adams and Lancaster). During the 2018 field season, it was detected on yellow sticky cards in fruit orchards in Adams and Lancaster counties, and three additional counties (Centre, Berks, and Allegheny), and in deployed sentinel egg masses for the first time in Adams and Lancaster county, suggesting an increase in the population present. 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 2019 priorities of brown marmorated stink bug management, alternative insect control strategies, and furthering the understanding of a new and emerging insect.

Objectives:

Completed during the Year 1:

1. Worked to further detect the new and emerging population of the well adapted BMSB parasitoid, the samurai wasp (*Trissolcus japonicus*).
2. Evaluated 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. Established colonies of native parasitoid wasps to determine the potential to adapt to BMSB, as well as the potential shift in preferences over several generations.

Year 2

1. Continue to survey for populations of the samurai wasp (*Trissolcus japonicus)* to determine if populations are increasing.
2. Resume the evaluations of the populations of native egg parasitoids attacking BMSB and native stink bug eggs.
3. Proceed to use established colonies of egg parasitoids to determine the rates at which egg masses will be attacked over several generations.

Procedures:

1. *Continuation of surveys for the samurai wasp…* - Yellow sticky cards (Alpha Scents, Inc.) baited with BMSB pheromone lures (Trécé, Inc.) will be deployed at varying 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. *Resume evaluations of 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. Deployment methods will include fresh

eggs affixed to cards, fresh eggs deployed having been laid directly onto colony food plant leaves, and frozen eggs affixed to cards. All eggs will be deployed across the landscape categories as described for the yellow sticky cards. Surveys will also be conducted to search for naturally laid stink bug eggs. 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. *Proceed to use established colonies of egg parasitoids …*- During the 2018 field season, colonies of the native egg parasitoid species *Anastatus reduvii, Ooencyrtus* sp., and *Telenomus podisi,* as well as a colony of the adventive *Trissolcus japonicus* were established from emergences from both sentinel egg masses and collected naturally laid egg masses of native stink bugs. To understand the biology of these wasps, observations of results from giving fresh and frozen BMSB egg masses will continue to be made on attempts at parasitism, success rate, development time, and the ratio of males to females emerging from egg masses. These rates have been and will continue to be tracked as subsequent generations of parasitoids are laid throughout the year in the growth chamber. These data will inform us of potential changes when parasitoids develop from the same species of stink bug over several generations.

Budget - Year 2:

Grad student summer salary	$	*7,378*
Fringe benefit @ 7.81%	$	*576*
Travel and supplies(partial)	$	*2,000*
Total for the second year of the project:	$	*$9,954*

Other Support: The summer assistant time, travel and supplies are paid by the combined funding from the USDA-NIFA SCRI 2016-51181-25409 and USDA ARS BMSB Area-Wide Project grants. Pending funding from USDA NIFA predoctoral grant.