

Project Abstract

For the Period Ending June 30, 2020

PROJECT TITLE: Early Detection, Forecasting and Management for *Halyomorpha halys*

PROJECT MANAGER: Dr. Bill Hutchison

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FUNDING SOURCE: Environment and Natural Resources Trust Fund

LEGAL CITATION: \$490,000 in 2015 is from the environment and natural resources trust fund for the Invasive Terrestrial Plants and Pests Center requested under this act, including a director, graduate students, and necessary supplies. This is a onetime appropriation and is available until June 30, 2022. \$970,000 from the environment and natural resources trust fund appropriated in Laws 2011, First Special Session chapter 2, article 3, section 2, subdivision 9, paragraph (d), Reinvest in Minnesota Wetlands Reserve Acquisition and Restoration Program Partnership, is transferred to the Board of Regents of the University of Minnesota for the Invasive Terrestrial Plants and Pests Center requested under this act, including a director, graduate students, and necessary supplies and is available until June 30, 2022.

APPROPRIATION AMOUNT: \$420,535

AMOUNT SPENT: \$404,242

AMOUNT REMAINING: \$16,293

Project Team: William Hutchison, Bob Koch, Peter Snyder, Tracy Twine

Post-doctoral training: Byju Govindan (Entomology), Stephan Liess (Soil, Water, and Climate)

Researcher: Eric Burkness (Entomology)

Sound bite of Project Outcomes and Results

This project provided new knowledge that will benefit MN agro-ecosystems, via a new App for rapid identification of Midwest stinkbugs, a proactive forecasting model so farmers can anticipate infestations and use less insecticide, a substantially improved trap for monitoring, and quantified faster stinkbug development & egg-lay rates, as influenced by a warming climate.

Overall Project Outcome and Results

Just prior to the detection of the Brown Marmorated Stink Bug (BMSB) in Minnesota (2010), this invasive pest had caused ~\$35million in damage to the Apple industry in Pennsylvania and Atlantic coast states. At the time, we knew very little of its biology, how to monitor this pest, how fast it could spread, and to what extent it could damage MN fruit, vegetable and field crops; a total of at least 12 major MN crops are at risk. With this project we were able to achieve several goals. To support early, more efficient detection of BMSB, we helped evaluate a new "Dual-lure" bait and sticky trap, that was a huge improvement over previous traps. Likewise, to better forecast BMSB infestations we developed and tested a "heat-unit" or degree-day model. DD models are based on the fact that insects cannot regulate their body temperature (cold-blooded). The DD model therefore tracks and accumulates daily heat above a threshold (57.2F for this bug), that allows us to predict when adults become active in the spring, and when peak activity occurs. Our DD model was tested for 3 years at Wyoming MN, where we have an active population. We found the model works well for predicting when overwintered adults will emerge in spring and start laying eggs (predicted at 135 DDs), while the observed time for emergence averaged 123 DDs (or +/-3.3 days of predicted). The model also shows that the first summer adults emerge 1100 DDs later, usually by Aug. 1st (the DD model, with 7-day forecasts was made available to growers via the *VegEdge* web page). With 4 years of data, we found BMSB does not build to high numbers until late summer, Aug 1 to Sept 30. This information is critical for understanding BMSB risk as a concern for many late-season high-value crops (sweet corn, tomatoes, raspberries, apples, wine grapes). Moreover, we found that the MN-acclimated

BMSB has a faster developmental rate (egg to adult) and females produce nearly 30-40% more eggs/female than previously studied populations in the eastern U.S. Results from our overwintering study resulted in a cold-stress model, where the lowest temperature that does not cause chill mortality, is ~25F. The model predicted immediate mortality at ~9.5F. Finally, the BMSB modeling data have been combined with the climate change models, summarized by Dr. Peter Snyder's team (Soil, Water & Climate, UMN), to assess BMSB change over time. In addition to Snyder's work for this project, he used the WRF model to downscale data from 9 modern global climate change models and project climate change for MN in the 21st century for two emissions scenarios. This includes high-resolution datasets (~10 km grid); these datasets will be available for all other MITPPC projects going forward.

Project Results Use and Dissemination

A diversity of outreach and dissemination methods were used to deliver research results from this project to a variety of audiences, including farmers of field crops and fruits and vegetables, crop consultants, the general public, and to researchers at professional conferences (examples shown below).

Media (primarily to public, farmers):

StarTribune, Oct. 26th, 2019 (front page): New crop of pests invades: Warmer, wetter climate attracts invasive insects to Minnesota's orchards and fields.

<https://www.startribune.com/a-new-crop-of-invasive-bugs-threatens-minnesota-s-orchards-and-fields/563385312/>

StarTribune, Aug. 18th, 2018: <http://www.startribune.com/keep-an-eye-out-for-the-brown-marmorated-stink-bug-and-yes-there-s-an-app-for-that/491132461/>

Selected Extension/Outreach publications (farmers, crop consultants):

Hutchison, W.D. & S. Wold-Burkness. 2017-2020. Brown Marmorated Stink Bug web resource:

<https://www.fruitedge.umn.edu/pests/bmsb>

(New BMSB fact sheet published in 3 additional languages: Hmong, Somali, Spanish)

Hanson, A., B. Govindan & W.D. Hutchison. 2020. Degree-day Model forecasts for Midwest Insects: BMSB.

VegEdge web site: <https://www.vegedge.umn.edu/bmsbdd>

(released spring 2020, following validation; automated web site updated daily during growing season)

Shanovich, H., R. Koch, E. Burkness, & A. Klodd. 2019. BMSB in MN Apple Orchards and Varietal Impacts.

FruitEdge: <https://www.fruitedge.umn.edu/bmsbapplefact>

Koch, B., R Aita & N. Hoidal. 2019. Keep an Eye Out for Brown Marmorated Stink Bug, MN Fruit & Veg. News:

<https://blog-fruit-vegetable-ipm.extension.umn.edu/2019/08/keep-eye-out-for-brown-marmorated.html>

Cira, T., B. Hutchison & B. Koch. 2018. New Midwest Stinkbug App, MN Crop eNews:

<https://blog-crop-news.extension.umn.edu/2018/04/new-app-for-mn-farmers-consultants.html>

Fruit Grower, Vegetable Grower News, National outlet, May 10, 2018. Sparta, MI (major U.S. outlet)

<https://fruitgrowersnews.com/news/app-helps-identify-invasive-stink-bug-before-it-hurts-crops/>

<https://vegetablegrowersnews.com/news/help-identify-an-invasive-species-before-it-spreads-to-crops/>

Koch, B. & D. Pezzini. 2016. BMSB Detected in MN Soybeans (first report for MN), MN Crop eNews:

<https://blog-crop-news.extension.umn.edu/2016/08/brown-marmorated-stink-bug-detected-in.html>

(Primary UMN Ext. Newsletter to Crop Farmers: 17,000 subscribers)

Ambourn, A. 2016-2020. Minn. Dept. of Agric., BMSB Map for MN (Project cooperator).

<https://mnag.maps.arcgis.com/apps/webappviewer/index.html?id=b05b08ade4934353a8c4047d067feb7a>

(data from the MITPPC project are submitted to Ambourn, and MDA shares data with the research team)

Peer-reviewed publications:

Govindan, B. N., & W.D. Hutchison. 2020. Effect of Temperature on Age- Stage, Two-Sex Life Tables for a Minnesota Acclimated Population of the Brown Marmorated Stink Bug, (*Halyomorpha halys*). *Insects*.

<https://doi.org/10.3390/insects11020108> (over 1100 full article reads since 2/8 publication date)

Acebes-Doria, A.L., A.M. Agnello, B.R. Blaauw, G. D. Buntin, D.G. Alston, E.H. Beers, J.C. Bergh, T.E. Cottrell, R. Bessin, S. Chen, K.M. Daane, S. Fleischer, C. Guédot, L.J., Gut, G.C. Hamilton, R. Hilton, K.A. Hoelmer, E.C. Burkness, W.D. Hutchison, et al. 2020. Season-long monitoring of the Brown Marmorated Stink Bug, *Halyomorpha halys* Stål, throughout the United States using commercially available traps and lures. *J. Econ. Entomol.* 113(1): 159–171. <https://doi.org/10.1093/jee/toz240> (Feb.).

Govindan, B. N., & W.D. Hutchison. Modeling the Time-Temperature Relationship in Cold Induced Mortality of a Minnesota Acclimated Population of Brown Marmorated Stink Bug, *Halyomorpha halys*, (in prep). *Entomol. Exp. Applicata*.

Govindan, B. N., & W.D. Hutchison. Phenology and Population Dynamics of a Minnesota Acclimated Brown Marmorated Stink Bug (*Halyomorpha halys*) under Fluctuating Temperatures in the Lab and Ambient Semi-field Conditions, (in prep). *Environ. Entomol.*

Snyder, P., T. Twine, et al. Environmental Quality Board--working with state agencies involved in assessing Minnesota's water resources. Results of our downscaled work will be featured in the State of Minnesota's Water report, published by the EQB, in 2020 (in prep.)

Conference Presentations:

1. Govindan, B. N., Koch, R. L., Ambourn, A., & Hutchison, W. D. 2019. *Fitness parameters of Minnesota Acclimated Brown Marmorated Stink Bug (Halyomorpha halys) at constant lab and ambient semi-field temperature conditions, using two-sex life tables*. 74th Annual Meeting of Entomological Society of America– North Central Branch, Cincinnati, Ohio. March 17-20.
2. Govindan, B. N., Hutchison, W. D., Koch, R. L., Twine, T. E., Snyder, P. K. & Abrahamson, M. 2018. *Life-table studies and modeling time-temperature relationships in cold-induced mortality of the Brown Marmorated Stink Bug (Halyomorpha halys)*. Upper Midwest Invasive Species – North American Invasive Species Management Association Joint Conference, Mayo Civic Center, Rochester, Minnesota, October 15-18.
3. Govindan, B. N., Burkness, E. C., Hutchison, W. D., Koch, R. L., Philips, C. R., Twine, T. E., Snyder, P. K. & Abrahamson, M. 2017. *Phenology and Life Table Studies of a Minnesota Acclimated Population of the Brown Marmorated Stink Bug*. Ann. Meeting of Entomological Society of America, Denver, CO. November 5-8.
4. Hutchison, W. D., Govindan, B. N., Koch, R. L., Philips, C. R., Twine, T. E., Snyder, P. K. & Abrahamson, M. 2016. *The Invasive Continues: Getting a Leg up on a Growing Six-Legged Problem*. Minnesota Invasive Terrestrial Plants and Pests Center: Research Updates and Management. Fifth Biennial Upper Midwest Invasive Species Conference, La Crosse Center, La Crosse, Wisconsin, October 16-19, 2016.

Selected publication citations are enclosed (separate files).