ISA Final Contract Research Progress Report

Project Title: The role of thrips and host ranges in the disease of cycle of soybean vein necrosis virus in Iowa

Principle Investigator and Co-PIs:

Daren Mueller (E-mail: dsmuelle@iastate.edu)

Department of Plant Pathology

351 Bessey Hall

Iowa State University

Ames, IA 50011

Co-Principal Investigators - Steve Whitham

Department of Plant Pathology

Progress report (max 5000 characters)

* We monitored and identified thrips species on soybean that carries SVNV by placing yellow sticky cards in five ISU research farms; Sutherland (NW), Armstrong (SW), Ames (central), Nashua (NE) and Crawfordsville (SE) from 2014 to 2015. Four cards were placed at each farm and swapped out weekly throughout the growing season. In 2015 we collected nearly 400 sticky cards of insects. We completed analyzing those cards from 2014 and 2015. We collected thrips data from across the state and determined the numbers of total thrips and soybean thrips. The assemblage of species present in all site-years, revealed that *Neohydatothrips variabilis* (Beach), a vector of Soybean vein necrosis virus, and other known vectors of tospoviruses were a relatively small proportion of the total thrips captured. Distinct seasonal trends were not detected based on regionality, as originally hypothesized, and thrips populations varied significantly among locations and between years. These results suggest that thrips populations may be overwintering in northern climates instead of relying solely on migrations to colonize northern soybean fields. A manuscript submitted to Journal of Economic Entomology analyzing the data collected in Iowa and Wisconsin states has been published.
* Field studies were conducted during 2013, 2014, and 2015 to determine the effect of SVNV on soybean yield and seed quality. Incidence of SVNV was recorded as the percentage of leaves exhibiting symptoms. Yield and yield components including seeds per pod, pods per plant, and 100-count seed weight, were assessed from plants or seeds collected from research and commercial production fields. Protein and oil concentration were also obtained from samples collected. Results suggested that soybean yield was not impacted by SVNV; however, seed quality was affected. Oil concentration decreased by 0.11% as disease incidence increased by 1%. Changes in fatty acid profiles of seed were also observed; linolenic, linoleic and stearic acids decreased between 0.5 and 0.15% in some locations. We submitted a manuscript to Canadian Journal of Plant Pathology analyzing the data collected in 2013 and 2014 in Iowa and other collaborating states investigating SVNV’s impact on yield.

* We evaluated 25 plant species found in Iowa to see if they are hosts to this virus. This study investigated the ability of specialty and cover crops that were commonly present in Iowa to serve as alternative hosts for SVNV. Eighteen cover crops and seven specialty crops were tested using mechanical and direct thrips inoculations. Cover crop species that were tested were annual ryegrass, winter wheat, oat, winter rye, triticale, pearl millet, sorghum, winter pea, hairy vetch, winter canola, brown mustard, false-flax, crimson clover, turnip, red clover, alfalfa, daikon radish, buckwheat. Specialty crops tested were Amaranth, sunflower, melon, basil, pepper, tomato, and egg plant. Plants were inoculated with both methods on the first true leaves. Both the original inoculated leaf and also from the youngest leaves were sampled at 30 days post inoculation for all broadleaf species at 14 days post inoculation for grass species. Presence of SVNV was determined with ELISA and PCR. Systemic infection of buckwheat and melon and possible local infection of winter pea were found. Symptoms were observed on buckwheat and melon and PCR also confirmed the presence of SVNV on buckwheat and melon. Alfalfa, buckwheat, crimson clover and red clover had the highest levels of thrips feeding damage and also had adults and juveniles present. Soybean thrips preferred alfalfa, buckwheat, crimson clover, and red clover; although they were able to feed on all plant species tested if no other food was presented. These data suggest that other crops may harbor SVNV and be a source of inoculum. After experimenting with different methods, we are able to successfully maintain the virus and colonies of soybean thrips under growth chamber conditions, allowing us to test the potential host plant species under controlled conditions without dependence of SVNV presence in the field for a source of inoculum.

Final project results (Layman’s terms for all audiences)(limit 20000 characters)

* Soybean vein necrosis is transmitted by soybean thrips. Thrips species that carry SVNV on soybean was identified and regularly monitored in the summer of 2014 and 2015 in Iowa. We collected thrips data across the state and determined the numbers of total thrips and soybean thrips. Thrips species were monitored in five Iowa State university research farms, Sutherland (NW), Armstrong (SW), Ames (central), Nashua (NE) and Crawfordsville (SE). These data provide a picture of how thrips are moving within the state during the growing season. Thrips that vector soybean vein necrosis virus was a relatively small proportion of the total thrips captured. Thrips population varied across the locations and years but distinct seasonal trends were not detected based on regionality suggesting that the thrips populations might be overwintering in northern climates instead of relying solely on migrations to colonize northern soybean fields.
* Soybean vein necrosis did not impact on yield; however, seed quality was affected. Field studies that were conducted from 2013 – 2015 to determine the effect of SVNV on soybean yield and seed quality in Iowa and other states with SVNV. Results suggest that soybean yield was not affected by SVNV but oil concentration decreased by 0.11% as per percent disease incidence increased. SVNV incidence was scored on percentage of plant showing SVNV symptoms. In some locations, fatty acid profiles of seed were also changed; linolenic, linoleic and stearic acids decreased between 0.5 and 0.15%.
* Some other crops harbor SVNV and may be a source of inoculum. Soybean vein necrosis virus systemically infected buckwheat and melon and possible locally infected winter pea. Soybean thrips prefer alfalfa, buckwheat, crimson clover, and red clover; although they were able to feed on all plant species tested if no other food was presented. Eighteen cover crops and seven specialty crops were tested using mechanical and direct thrips inoculations. Plants were inoculated at the first true leaves. The species that were tested were annual ryegrass, winter wheat, oat, winter rye, triticale, pearl millet, sorghum, winter pea, hairy vetch, winter canola, brown mustard, false-flax, crimson clover, turnip, red clover, alfalfa, daikon radish, buckwheat, Amaranth, Sunflower, melon, basil, Pepper, tomato, egg plant.
* We developed/standardized a protocol to successfully maintain the virus and colonies of soybean thrips under growth chamber conditions and inoculate the plants, allowing us to test the potential host plant species under controlled conditions without dependence of SVNV presence in the field for a source of inoculum. Thrips inoculation has a higher success rate but will only work for plants that soybean thripswill feed on. Mechanical inoculation has lower success rate but can infect the plants that thrips do not feed on.

Benefit to soybean farmers (limit 5000 characters)

Soybean vein necrosis is considered the most widespread soybean viruses in North America but there was limited information about its impact on yield and quality of soybean, its transmission, host range etc. This study provided very valuable information. The result from this study will directly benefit soybean farmers in Iowa and neighboring states and also establish a foundation to address future research and management questions. Some key highlights are below.

In this study, we studied the impact of soybean vein necrosis on soybean yield and quality of grain. Data analyzed from Iowa and other states suggests that SVN was not yield limiting, perhaps because of the timing of symptom development; however, seed quality was affected. Soybean oil concentration decreased by 0.11% as per percent disease incidence increased. Currently, no any management strategies are recommended/available but farmers are advised to scout for disease since it resembles other foliar diseases of soybean.

Alternate hosts of soybean vein necrosis besides the soybean were determined. Results suggested that soybean farmers should be aware that SVN can be harbored by other crops and may overwinter in northern climates. SVNV can successfully infect buckwheat, melon, and winter pea. The presence of SNV in the these crops was confirmed by ELISA and PCR. Results suggested that host range of the SVN should also be considered.

Soybean vein necrosis is transmitted by soybean thrips. The proportion of thrips was relatively less compare to the total thrips in the study period however it is not static. Farmers should keep eyes on thrips population in their soybean field. Soybean thrips prefer alfalfa, buckwheat, crimson clover, and red clover; although they were able to feed on all plant species tested if no other food was presented.

Performances metrics (limit 4000 characters)

A manuscript summarizing Seasonal dynamics of thrips population in Iowa and Wisconsin has been published.

Bloomingdale, C., Irizarry, M. D., Groves, R. L., Mueller, D. S., Smith, D. L. 2016. Seasonal populations dynamics of thrips (Thysanoptera) in Wisconsin and Iowa soybean fields. Journal of Economic Entomology. doi: 10.1093/jee/tow242

A master’s student working on this project, Melissa Irizarry, finished her thesis and graduated in spring 2016. She is now working on a Ph.D. at the University of Florida.

Impact of soybean vein necrosis on grain yield and seed quality was studied for three years. We submitted a manuscript to Canadian Journal of Plant Pathology.

Irizarry, M. D. Anderson, N. R., Bloomingdale, C. A., Smith, D. L., Bradley, C. A., Delaney, D. P. Kleczewski, N. M. Sikora, E. J. Mueller, D. S., and Wise, K. A. 2017. Effect of soybean vein necrosis on yield and seed quality of soybean. Submitted to Canadian Journal of Plant Pathology.

Host range of soybean vein necrosis in cover crops and specialty crops and thrips feeding preference was determined. We are finished analyzing data and are now working on the manuscript. We will submit a manuscript in a peer-reviewed journal in a couple months.

The findings from this study has been included in several winter meetings, field days, and media interviews.

Data from these studies were also included in an Extension bulletin published through the Crop Protection Network, and posted on the SRII website.