Northeastern IPM Center Partnership Grants Program
Critical and Emerging Issue Project Report

A. Grant Data

- Title: An Observational Early Warning System for Detecting Soybean Rust Incursions into the Northeast Region
- Type: Critical and Emerging Issues
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- Team members: **Scott A. Isard**, Professor of Aerobiology, Departments of Plant Pathology and Meteorology, Pennsylvania State University; **Elwin Stuart**, Professor, Department of Plant Pathology, Pennsylvania State University; and **Leonard J. Francl** – deceased.
- State(s) involved: Delaware, Maryland, New York, Ohio & Pennsylvania
- Funding Year(s): April 1, 2005 – June 30, 2006
- Funding amount: $25,000.

B. Nontechnical Summary.

The USDA, land-grant universities, check-off organizations, agro-industries, and producers have been anticipating the incursion of soybean rust into U.S. soybean fields. The pathogen first appeared in 2004 and here-to-fore has been confined to the southeast U.S. It was blown from South America to Louisiana by Hurricane Ivan and during 2005 and 2006 became established along the Gulf of Mexico from Florida to Texas. It is generally believed that during years when the spring weather in the south is wet, allowing the disease to flourish, spores may be blown to the major soybean producing areas in the Midwest and Northeast states. Fortunately, the weather during May 2005 and again in 2006 in the overwintering areas along the Gulf coast was too dry to allow the disease to flourish and spread northward into the major U.S. soybean production regions.

This one-year project was aimed at developing and deploying an early warning system to provide Northeast producers with information on soybean rust incursions into their fields so that they could decided whether or not fungicide applications would be cost-effective, and if so, when to spray. It was part of an integrated USDA led effort to survey and monitor for soybean rust and to validate the Soybean Rust Aerobiology Prediction System forecasts of spore transport to the region.

During 2005, we built and deployed rainwater spore traps in Delaware, Maryland, New York, Ohio and Pennsylvania. Samples from these sites were collected weekly and analyzed using PCR assays. Fortunately, no soybean rust spores were detected and there were no reports of soybean rust in the region. Although this was good news for growers, it did not allow us to validate the early warning system and the aerobiology forecast model. For this reason, the location of the research effort to develop and evaluate the accuracy of the early warning system has been shifted in 2006 to Florida where collectors have been deployed throughout the state in areas where soybean rust is found. This effort has fostered collaborations with researchers in the USDA rust lab who were also working on tracking soybean rust spores in rainwater. The combination of these efforts has lead to a national monitoring effort for soybean rust

C. Introduction.
Soybean rust has the potential to be the most destructive foliar disease of soybean in the U.S. due to the rapid aerial spread of pathogen, *Phakopsora pachyrhizi* and the high risk of severe yield losses caused by this pathogen. Growers in the Northeast Region plant more than 1.3 million acres of soybean annually that yield ca. 44 million bushels with a production value of $131 million. If soybean rust caused a 5-10% loss to the soybean crop, such as Brazil experienced in the past years, this would have a major economic impact on agriculture in the Northeast Region.

Should soybean rust arrive in the region, fungicides would be the primary method for reducing crop losses. Foliar fungicides require frequent applications when environmental conditions are favorable for soybean rust, and thus could add significantly to production costs. The goal of this project was to develop an early warning system to estimate the likelihood that soybean rust spores had been blown into the region before disease symptoms could be detected. This risk assessment of soybean rust incursion could be used by growers to decide whether or not fungicide applications would be cost-effective, and if so, when to spray.

USDA has established a coordinated network to survey and monitor for soybean rust in North America. The network focuses on the southeastern region of the U.S., Mexico, and Caribbean basin, likely sources of *P. pachyrhizi* spores that may be transported to major soybean growing regions in the U.S. continental interior and the Northeast Region. The strategic plan also calls for an effort to compare and evaluate soybean rust sampling protocols and early detection tools for efficacy of application. Symptoms of the disease are usually first visible 2-3 weeks after infection and often indicate that the disease is well established in a crop. Polymerase Chain Reaction (PCR) assay can successfully detected soybean rust spores suspended in water. Spores in rainwater are relatively easy to collect/concentrate and thus potentially this technology could be used to detect incursions of soybean rust into soybean fields prior to symptom expression on plants.

USDA is funding a predictive modeling effort to create daily risk assessments of *P. pachyrhizi* transport to soybean growing areas**.** The forecasting system provides daily assessments of potential deposition of *P. pachyrhizi* spores at 10 km^2 spatial resolution throughout the U.S. Prediction accuracy has increase dramatically over the 2005 and 2006 seasons but is still highly dependent on daily assessments of *P. pachyrhizi* distribution and disease severity in North America.

Although the effort and cooperation among USDA agencies, land-grant universities, check-off organizations and industry to prepare for this invasive species is unprecedented, Northeast Region soybean producers will still face tremendous uncertainty regarding how to best protect their crop from soybean rust over the next few years. Predictive modeling coupled with extensive surveillance of likely source regions shows great potential to identify periods of *P. pachyrhizi* spore transport to the region; however, currently a program to validate these predictions with field observations of spores prior to symptom expression is lacking. Growers need the earliest possible confirmation of soybean rust presence in the Northeast Region to prompt them to intensify their field scouting efforts and prepare for timely fungicide applications.

D. Objectives. The goal of the project was to evaluate the potential for an observational Soybean Rust Early Warning System (SREWS) to identify aerial incursions of *P. pachyrhizi* into

the Northeast Region. The work was integrated with the USDA effort to survey and monitor for soybean rust and the USDA forecasts of *P. pachyrhizi* spore transport to the region. The goal was to provide stakeholders in the Northeast Region with enough lead time to decide whether or not fungicide applications would be cost-effective in their soybean fields during 2005, and if so, when to spray.

The specific objectives of this project were to:
1) Build and distribute gauges that collect and filter rainwater to cooperators in the major soybean growing areas in the Northeast Region.

Rainwater spore collection guages were constructed and deployed in Delaware (Dr. R. Mulrooney), Maryland (Dr. A. Grybauskas), New York (Dr. G. Bergstrom), Ohio (Dr. Dorrance), and Pennsylvania.

2) Develop a communication protocol to alert cooperators when to collect spores in rainwater.

Cooperators replaced the collection filters in the traps after each significant rain event during the 2005 summer growing season. The filters were shipped in special mailers overnight to the Department of Plant Pathology, PSU for analysis.

3. Use PCR assays to detect whether or not P. pachyrhizi spores are present in rainwater collections.

Real-time PCR was employed to detect the presence of *P. pachyrhizi* urediniospores on each of the filters submitted by the cooperators. No soybean rust spores were detected in the samples during the 2005 season.

E. Approach.

Spore collection from rainwater sampling network. Samplers for collecting and filtering rainwater were built from PVC tubing after Roelfs et al (1970). A 40-50 mesh debris screen was placed inside a (8- to 2-inch) reducing coupler to catch large particles. The coupler sits on a 1 foot in length, 2-inch in diameter PVC pipe. A threaded male PVC coupler is affixed to the end of the pipe. A nylon membrane filter with an 8-μm pore size sits inside a threaded female PVC coupler that is easily screwed on/off the sampler to change the filter. The filter rests on a circular piece of fiberglass support screening stretched tightly across a circular PVC spacer. The spacer fits snuggly inside the female PVC coupler. When the threaded couplers are screwed together, the spacer and outer edges of the filter are held tightly in place so that all the rainwater must pass through the filter. The sampler design allows the addition of a PVC coupler fitted with a pre-screen of larger pore size (e.g., 100-μm) to remove unwanted particles. The filter and urediniospores (also other particles) trapped by the rainwater spore sampler were removed after each precipitation event and placed in an unbreakable plastic petri dish. The sealed dish was immediately shipped to PSU in a pre-addressed/pre-stamped mailer. The rainwater spore sampler was rinsed out and the filter changed between rainfall events.

Real-time PCR detection of *P. pachyrhizi* in collections. A Cepheid Smart cycler (Cepheid, Inc., Sunnyvale, CA), used for conducting real-time PCR, was employed to detect the presence of *P. pachyrhizi* urediniospores collected in rain water samples using the specific primers and TaqMan probe published by Frederick et al. (2002). The Cepheid Smart cycler is a portable, fast and reliable instrument that yielded results within two to three hours including sample preparation and PCR run time.

F. Progress. All the objectives of the 1-year proposed project were completed on time.

G. Results. In 2005, soybean rust was not detected by the early warning network that included stations in Delaware, Maryland, New York, Ohio, and Pennsylvania. There were no substantiated reports of soybean rust in the Northeast Region during the same period. This was fortunate for growers, but did not allow us to evaluate the utility of deploying a rainwater spore collection network to provide early warnings of soybean rust incursions into the region. In 2006, we are deploying a similar rainwater spore sampling network throughout Florida to evaluate the methodology in area where the disease is endemic. Funding for the ongoing work is provided by the USDA Soybean Rust Monitoring Activity for the National Legume Risk Management Tool Development Project.

H. Impacts. Many million of U.S. soybean acres that would have received at least one fungicide application remained untreated for soybean rust in 2005 due to the USDA coordinated network to survey and monitor for the disease and the resulting information that was disseminated through the Soybean Rust Information System website. The information provided by the system increased U.S. producers' profits by between $11 to $299 million at a low cost of between $2.6 and $5 million (USDA ERS 2006). The early warning system deployed in the Northeast Region was an important part of this coordinated network and contributed to the success of the overall effort.