

Soybean Rust: Detection and Diagnosis in the US

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ABSTRACT:

Asian and New World soybean rusts are caused by *Phakopsora pachyrhizi* and *P. meibomia*, respectively. *P. pachyrhizi* was on the USDA's List of Selected Agents in 2002, but was de-listed in 2005 once the fungus had become established in the southern U.S. Reclassification of *P. pachyrhizi* was the result of requests by scientists to be able to work with the pathogen in light of its widespread distribution in the U.S. and its potential to significantly impact U.S. agriculture. Prior to the first U.S. detection of soybean rust, NPDN diagnosticians were trained to identify this pathogen at APHIS training sessions, by viewing preserved spores and infected leaves, and via teleconference with a PPQ Mycology identifier. Funds were secured to purchase real-time PCR capability for each region, enabling the detection of the pathogen prior to symptom development. Research efforts in 4 regions in conjunction with ARS scientists determined the early detection limits of this technology. Additional research compared microscopic, serological and PCR methods. First detectors were trained in all 5 regions to scout and properly collect samples. The NPDN and its partners have contributed to a wealth of information and resources, such as scouting guides and the real-time reporting of the PIPE project, that support the national effort to protect U.S. legumes from soybean rust.

Authors:

Detection of the disease in the U.S.:

Soybean rust was detected in Louisiana in November of 2004. Since that time, states across the southern U.S. and into the Midwest have also detected the disease. Real-time mapping of the disease reports occurs through a partnership with university specialists and the Legume Pest Information Platform for Extension and Education (PIPE). Maps, commentary by state extension specialists, and other relevant information can be found on the website at <http://www.sbrusa.net>.

Biology of the pathogen:

P. pachyrhizi and *P. meibomia* have a large number of hosts. *P. pachyrhizi* is capable of infecting 31 species of legumes in 17 genera and *P. meibomia* can infect 42 species of legumes in 19 genera. *P. pachyrhizi* is also able to infect an additional 60 species in 26 other genera while *P. meibomia* can infect 18 species in 12 other genera (Friedrick et al. 2002). The two pathogens have an overlap in plant hosts of 24 species that occur in 19 genera. A number of host plants occur in the United States besides *Glycine max* (soybean) – a major agricultural crop. These host plants include: *Alysicarpus glumaceus* (alyce clover), *Melilotus officinalis* (yellow sweet clover), *Pachyrhizus erosus* (yam bean, jicama), *Phaseolus lunatus* (butter bean, lima bean), *Sesbania exaltata* (Colorado River hemp), *Vicia dasycarpa* (wooly-pod vetch), and *Vigna unguiculata* (cowpea, black-eyed pea). Another host, which is common in the southeastern U.S., is the southern soybean (Kudzu) (NPAIG 2002). Urediniospores require free moisture on the surface of the host or at least 6-12 hours and temperatures of 8-28 °C (46 – 82 °F) for germination. Soybean rust differs from most other rusts by the direct penetration of host epidermal cells, which occurs when an appressorial peg penetrates through the cuticle. The majority of other rust pathogens penetrate host cells after they have entered through a stomatal opening (Miles et al. 2003 and Hartman et al. 1999). Five to eight days after infection uredinia can develop on the plant and may continue to develop for 4 weeks after the initial infection. Development of secondary uredinia may occur along the margin of the infection for 6 more weeks. Approximately 9 days after infection the uredinia may begin to produce urediniospores. During the growing season spore cycles can occur numerous times and the spores are easily spread by wind. When fields are heavily infected with rust, clouds of spores may be visible in the air. Late in the season the telia and teliospores may be produced. The morphological differences in the telia and teliospores are part of the basis for the establishment of two species, *P. pachyrhizi* and *P. meibomia*. Teliospores can be germinated and produce basidiospores within the laboratory. However, this part of the life cycle has not been characterized because the alternate host has not been found. In soybean *P. pachyrhizi* and *P. meibomia* are not seedborne. These pathogens currently over winter in the United States on an alternative host plant (NPAIG 2002, Miles et al. 2003, Hartman et al. 1999, and United Soybean Board. 2002). (Excerpted from the NPDN SOP, Version 1.9, shown at right)

Symptoms:

Early symptoms of soybean rust may be confused with bacterial pustules, brown spot and bacterial blight. Infected plants initially develop symptoms on their lower leaves. Yellowing of the leaves followed by defoliation usually occurs. Early maturation of the plant may occur when the infection is severe. A reduction in the number of pods, seeds, and seed weight is common. Lesions may be present on the leaves, petioles, pods, and stems. Lesions are typically 2 to 5 mm² and the color may appear to be dark red-brown or tan, but the development of grey-green lesions are also possible. Rust lesions contain multiple globular erumpent uredinia. Urediniospores are released through a round ostiole on the uredinia and are found throughout the season. Late in the season the less common telia and teliospores may be found. The telia are waxy, dark and erumpent. Teliospores will germinate and produce basidiospores in the lab. *P. pachyrhizi* and *P. meibomia* telia and teliospores are morphologically different. However, Real Time PCR must be used to determine the species (United Soybean Board 2002, Miles et al. 2003, and Palm 2004). (Excerpted from the NPDN SOP)

Diagnosis:

Suspect plant material should be placed in a moist chamber for 24 hours to promote spore production. Microscopic identification of the genus *Phakopsora* is based on morphological characteristics. In the continental United States no species of *Phakopsora* are known to occur on legumes. If the sample is determined to be *Phakopsora* spp. it is necessary to identify the specimen to species level. The distinction between species based on morphology can only be determined by comparisons of teliospores. However, since teliospores are not commonly found, identification to species levels will be accomplished using Real-Time or conventional PCR by one of the regional facilities or USDA-APHIS-PPQ-CPHST. Immunological methods such as ELISA are also commercially available. (Excerpted from the NPDN SOP)



Urediniospores of *P. pachyrhizi*. Photo: H. Dankers



Cross-section of a telium of *P. pachyrhizi* and the leaf surface of kudzu. Photo: P. Harmon



The underside of a soybean trifoliate leaf, showing lesions and pustules caused by *Phakopsora pachyrhizi*. Photo: C. Harmon



Dark, glossy telia and erumpent tan to reddish uredinia, some showing ostioles, with tan to white urediniospores scattered across the leaf surface. Photo: P. Harmon

Pre-Detection Activities:

- Real-time PCR obtained for all five hub labs
- Expert-level training from APHIS at Beltsville, MD
- Nation-wide training by teleconference for university and department of agriculture diagnosticians
- SBR detection exercises in all SPDN states and many states nationally
- State response plans in place for all Gulf-coast states and several other states

Post-Detection Activities:

- Expert-level training for diagnosticians at APHIS Beltsville location
- Exercises with SBR detection in more NPDN states
- Diagnosis-level training at FL and other locations
- First-detector level training across the country
- Scouting and diagnostics for the disease on hosts beyond soybean and kudzu, such as dry beans.



Uredinia of *P. pachyrhizi* (arrows) on kidney bean from a host-susceptibility trial in Florida. Note the grains of sand to the left. Photo: P. Harmon



Field inspection of common beans in Colorado. Photo: H. Schwartz

USDA United States Department of Agriculture

Getting Started

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National Commentaries

- ID/Scouting Tools
- Not sure if it is Rust?
- Other SBR Sites
- Hurricane Annamaria
- Cooperation Annamaria
- Pathways
- Professional Decisions

Pest Information Platform for Extension and Education

SB Rust Observation - 2005-12-31

Map of the United States showing SB Rust observations with a color-coded legend: Recently scouted, not found (green); Scouted, confirmed (red); Confirmed, no longer found (orange).

National Soybean Rust Commentary (update 12/15/06)

Soybean rust has been reported on hosts in two additional eastern Louisiana parishes - Tangipahoa and St. Landry. Overall rust has been found in 28 states across 231 different counties in 10 states: AL, AR, FL, GA, IL, IN, KY, LA, MS, MO, NC, SC, TN, TX, and VA. Including reports on hosts, there is a total of 274 counties in 15 states with rust this year including 28 in Alabama; 24 in Florida; 21 in South Carolina; 26 in Louisiana; 15 in Georgia; 7 in Texas; 4 in Missouri; 6 in Tennessee; 2 in Mississippi; and 1 in Kentucky.

Sign Up For Alerts Dec 31, 2006

Legumes/Kudzu Soybean Rust

SB Rust Observations

SB Rust State Update

Chronology of Previous Detections

SBR Forecast Click For Details

Management Toolbox

- Facts - USA
- Guidelines - USA
- QEP Tool
- Inspection Data
- Commentary Clinic

www.sbrusa.net, USDA and Zedco, Inc. A real-time tracking and mapping website for use by soybean scouts, specialists, producers, consultants and the public. Many of the samples that were processed in NPDN laboratories across the country were the basis for the colors that appear on the map.