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Asian Soybean Rust[1]

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Asian Soybean Rust

Asian soybean rust (ASR) has been found in most of the soybean producing areas in the world including Australia, Brazil, China, Japan, Paraguay, Taiwan, and Zimbabwe. The disease was first detected on soybeans in the United States in Baton Rouge, Louisiana on November 6th, 2004. Long distance movement of the pathogen was is suspected to have occurred from Central America via Hurricane Ivan. Since then, ASR has been found as far north as Indiana and Illinois (www.sbrusa.net). ASR can cause severe losses in soybean yield due to premature defoliation, poor pod fill, and production of low quality seed (Fig. 1). Crop loss estimates range from 10-90% depending on the growing region, time of epidemic initiation, and environmental conditions.

Figure 1. Aerial photograph of soybean rust fungicide trials in Quincy, Florida at the North Florida Research and Education Center. Note green plots (treated w/fungicide) and brown plots (untreated) with severe Asian Soybean Rust (ASR) infection. Credits: Marois

Symptoms

Symptoms of ASR are characterized by tan to brown volcano-like pustules (uredinia) on the lower surface

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and chlorotic flecking on the upper surface of infected leaves (Fig. 2). Pustules (83 x 309µm) contain slightly oblong urediniospores (a type of spore produced exclusively by rust fungi ~15 X 18µm) that are light brown to hyaline and are echinulate (spiny) (Fig. 3). Rust pustules are most commonly found on the leaves, but they also occur on the stems, pods, and cotyledons of heavily infected plants. Telia (~50-150µm) contain teliospores (a thick-walled resting spore produced by rust and smut fungi), that are dark brown to black at maturity. Telia are produced on the underside of infected kudzu leaves among uredinia (Fig. 4). Teliospores are densely packed in layers within the telium and are pale brown to yellow (Fig. 5).

Figure 2. Top and bottom views of ASR-infected soybean leaflets exhibting chlorosis, necrotic spots and rust-colored pustules (uredinia). Credits: Jurick

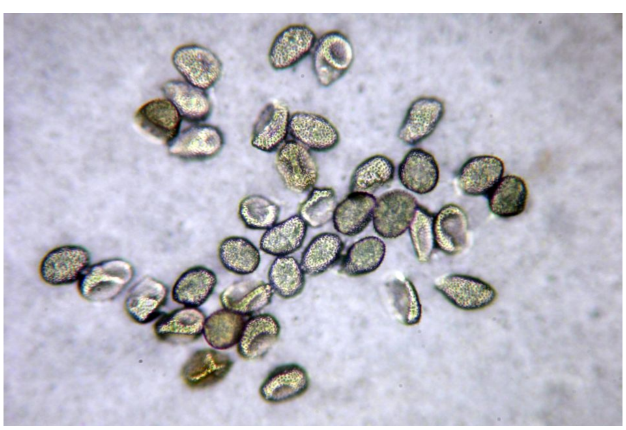

Figure 3. Multiple echinulate urediniospores of *Phakopsora pachyrhizi*. (Harmon, UF) Credits: Harmon

Figure 4. The bottom of a kudzu leaf showing multiple telia (black) among uredinia Pustules. Credits: Harmon

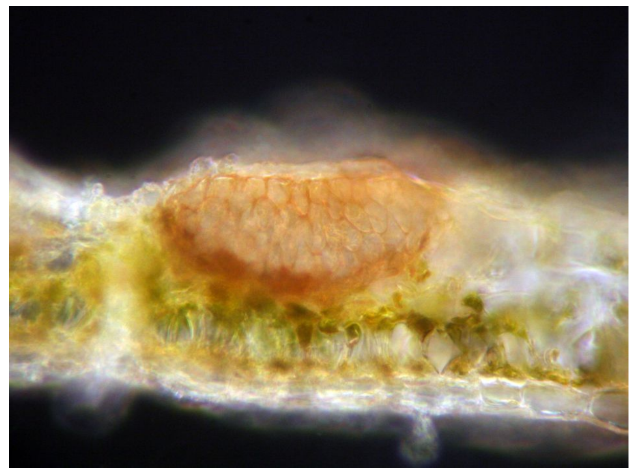

Figure 5. Cross section through a young telium showing multiple layers of teliospores. Credits: Harmon

Causal Organism

ASR is caused by the filamentous fungal plant pathogen, *Phakopsora pachyrhizi*. Soybean rust also is caused by a less aggressive New World species, *Phakopsora meibomiae*, which is not present in the Continental U.S. and is primarily restricted to Puerto Rico and the Caribbean basin. *Phakopsora pachyrhizi* is capable of direct penetration through the host cuticle (the waxy top layer of the leaf surface), other rust fungi typically infect through natural openings in the plant (i.e. stomata). Most rusts exhibit a high degree of host specificity. However, *P. pachyrhizi* affects a wide range of cultivated and weedy legumes that currently encompass 31 species in 17 genera in the field, and 60 species in 26 genera under controlled conditions (i.e. greenhouse) (Sinclair and Hartman 1996). In inoculated field trials, soybean was the only host of several legume crops evaluated that was shown to support an ASR epidemic in North Central Florida (Harmon et al. 2006).

Disease Cycle and Epidemiology

In Florida, ASR is found primarily as the repeating or uredial stage. Masses of urediniospores are produced by asexual reproduction and are transmitted on wind currents. Telia have been found (rarely) in Florida on infected kudzu leaves during the winter but this is believed to represent a biological “dead end” because no alternate host is currently known. In general, environmental factors (rainfall, temperature, leaf wetness, relative humidity, and dew point etc.) affect the establishment and development of plant disease epidemics caused by ASR. Data obtained from field and greenhouse conditions have shown that long dew periods (6 hrs and greater) and temperatures from 15-29°C are optimal for ASR. The amount of rainfall during a growing season has been also been correlated with ASR disease development (Del Ponte et al., 2006). Data pertaining to estimates of inoculum viability, pathogen survival and establishment in temperate regions, inoculum production on alternative hosts, and the ability to over winter are limited. However, it appears that kudzu will be an important over wintering host for ASR in Florida. How far north it over winters may be determined by the severity and

frequency of frost – generally requiring at least 4 hours below 28^{o} F. Research efforts are currently underway at the University of Florida to address these questions.

Diagnosis

ASR is diagnosed by visual inspection with a hand-lens or a dissecting microscope. The occurrence of erumpent, volcano-like pustules (uredinia) containing urediniospores is the key diagnostic feature (Fig. 6). However, when sporulating pustules are not evident or to determine the species of rust pathogen, PCR (polymerase chain reaction) can be used (Fig. 7). ELISA (Enzyme-Linked Immunosorbent Assay) can be implemented to confirm an uncertain visual diagnosis but is not species-specific. Non-sporulating and early symptoms of ASR can be confused with other fungal and bacterial diseases such as brown spot (*Septoria glycines*), downy mildew (*Peronospora manshurica*), frogeye leafspot (*Cercospora sojina*), and bacterial blight (*Pseudomonas syringae*), so sample incubation in a moist chamber at room temperature overnight is recommended to encourage pathogen development and sporulation. Bacterial pustule (Xanthomonas axonopodis pv glycines) viewed at low magnification looks very much like non-sporulating symptoms of ASR. Bacterial pustule can be differentiated at higher magnification by cracks in the host tissue and the lack of urediniospores after incubation. Bacterial pustule has occurred within breeder plots in Florida, but does not typically occur in commercial soybean varieties due to genetic resistance.

Figure 6. The underside of an ASR-infected kudzu leaf with multiple sporulating uredinia. Credits: Harmon

Figure 7. The bottom of an ASR-infected kudzu leaf showing a non-sporulating ASR pustule. Credits: Harmon

Management

Data from fungicide trials conducted in Georgia (Sconyers et al. 2006) and Florida (Harmon et al. 2006) have shown that ASR management options include applications of strobilurins (pyraclostrobin, azoxystrobin, trifloxystrobin), triazoles (tebuconazole, propiconazole), and tank mixes of strobilurins and triazole compounds. Yield increases of 20 bu/A have been noted with fungicides as compared to non treated plots. Current efforts seek to determine treatments that maximize yield while minimizing economic costs to soybean producers by investigating fungicide selection and application timing. Long-term research goals include the development of resistant soybean cultivars, improving disease risk assessment tools, and optimizing available fungicide options.

Web-Based Information Sources

The Pest Information Platform for Extension and Education (PIPE) website contains a wealth of information on soybean rust in a user-friendly format. It offers information on management recommendations, identification of the pathogen, scouting tools, and yield loss prediction (www.sbrusa.net). Soybean rust detection and scouting data for the United States is also available on this website which allows one to determine if ASR has been found in their area. One can also sign up on this website for Email alerts for a specific region and state. The soybean rust information site (http://www.usda.gov/soybeanrust) is another webpage containing a variety of information including: ASR identification, fungicide information, and links to other websites pertaining to various aspects of soybean rust.

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