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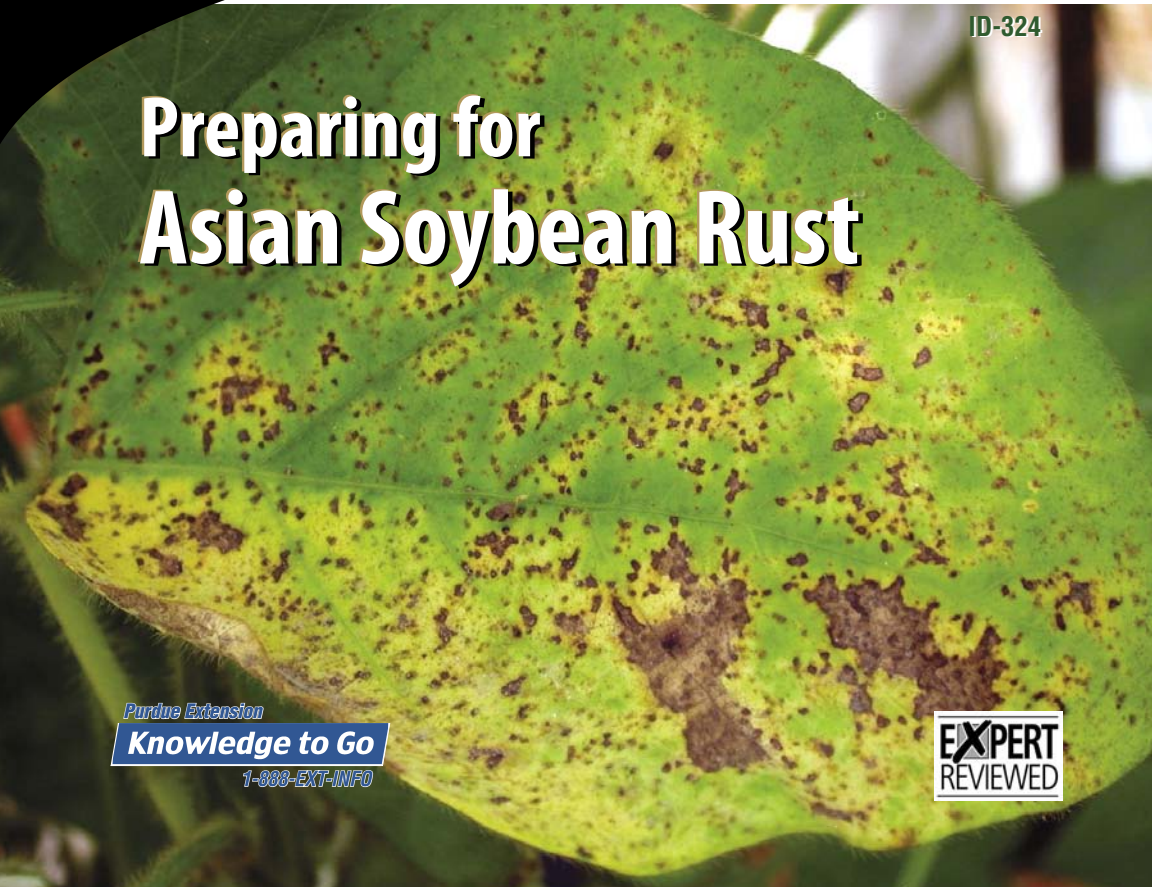
Preparing for Asian Soybean Rust



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What is Asian soybean rust?

Asian soybean rust was first discovered in the continental United States in November 2004. This foliar disease is caused by the fungus *Phakopsora pachyrhizi*. Soybean rust is capable of destroying a soybean crop if it becomes established in a field early and weather conditions favor the spread of infection. The fungus is an obligate parasite, which means it can grow and reproduce only in living plant tissue. The fungus uses nutrients manufactured in soybean leaves to support its growth and reproduction. As a result, this drain on soybean plants can substantially reduce yields.

Photo by Shawn P. Conley, Purdue University.

A field heavily infected with Asian soybean rust in Mato Grosso, Brazil, February 2005.

An ongoing concern

As its name suggests, this fungus is native to Asia and was first detected in the Western hemisphere in Paraguay and southern Brazil in 2002, where it spread and caused widespread crop damage. In late 2004, it was found for the first time in the continential United States in Louisiana and several other southern states. It is impossible to predict how often the disease will afflict soybean in Indiana, but based on our typical summer weather conditions, we could see it in 7 out of 10 years. Now that the fungus is in the United States, producers must deal with the possibility of soybean rust every year. This guide will help readers identify soybean rust symptoms, describe how the disease spreads, and how it can be controlled.

Photo by Alvaro Almeida, Embrapa Soja, Londrina, Brazil.

Asian soybean rust pustules on the underside of a leaf.

Photo by Shawn P. Conley, Purdue University.

A soybean leaf heavily infected with Asian soybean rust.

What does it look like?

About nine days after infecting a plant, Asian soybean rust develops into pustules with masses of tan spores that rupture through the leaf epidermis. These pustules develop mainly on the underside of leaves.

Photo by Shawn Conley, Purdue University.

Photo by Kevin Black, GROWMARK

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(Left) The underside of a leaf shows heavy soybean rust infection. (Top) Cone-shaped soybean rust pustules (magnified 40-50 times) develop primarily on the underside of leaves. (Bottom) Eventually, spore masses erupt from these pustules.

Can resemble other diseases

Soybean rust symptoms may superficially resemble lesions caused by other diseases such as bacterial pustule, bacterial blight, downy mildew, or brown spot. But a 10-20x hand lens helps distinguish soybean rust from these other leaf diseases. Spores cannot be individually distinguished at these magnifications, but the mass of spores gives soybean rust lesions a powdery or granular appearance.

Diagnosing soybean rust infections at an early stage is challenging, but critical for timely management. Like many other soybean foliar diseases, young soybean rust infections appear as very small spots that are best seen on backlit leaves. A diagnostic feature to look for before pustules have developed is small brown spots with no surrounding chlorosis. Leaves with suspect spots can be sealed in a plastic bag with a moist towel (inflate the bag by blowing in it before sealing). If soybean rust is responsible for the spots, sporulating pustules will usually develop within two or three days.

However, to confirm soybean rust, please send a sample to the Purdue Plant and Pest Diagnostic Laboratory. See page 14.

Photo by Gail E. Ruhl, Purdue University.

Septoria brown spot produces symptoms that look similar to soybean rust. Note the conspicuous yellowing around brown spots.

How does it spread?

Spores cause new infections

Soybean rust is a polycyclic disease, meaning that infections increase in the field as the fungus goes through its short life cycle (about nine days) many times. The initial infections that develop from spores that first land in a soybean field will not be numerous enough to cause damage. However, once established in a field, soybean rust can spread rapidly. Each pustule can produce hundreds of spores every day for many days. And each spore is capable of causing new infections. When weather conditions are conducive, infections can increase exponentially.

Photo by Shawn P. Conley, Purdue University.

Early soybean rust symptoms are best viewed on backlit leaves. Note the small, brown specks with no surrounding chlorotic (yellow) tissue on this infected leaf.

Weather an important factor

In the presence of dew, each spore on a leaf can produce a germ tube, a slender thread that grows over the leaf surface. After about six hours, the germ tube penetrates the leaf and the fungus begins to grow internally. A dew period of about six hours is sufficient for infection; longer dew periods are even more favorable. Rust develops best when temperatures are 59-86° F.

Once the germ tube penetrates a leaf, water on the leaf surface is no longer essential and the fungus grows inside the leaf as a parasite, drawing water and nutrients from its host. About seven days after infection, the fungus begins to produce spores just beneath the epidermis on the lower side of the leaf. As more spores are produced, they burst through the epidermis. This is why the rust lesion

is called a pustule. Spores that have ruptured the epidermis are exposed to the wind, which can transport them over long distances at high elevations. Spores do not seek out soybean or other host plants, but simply land by chance. Those landing on susceptible hosts can cause new infections.

Disease can be spread over long distances

Most rust spores probably land close to the pustules that produced them, but many are picked up by the wind and carried high into the air. There, they can be carried for many miles. Although desiccation, cold, and intense light may be fatal to some spores, many will remain viable. Airborne spores settle out of the air during still conditions, or are scrubbed out of the air by rain. The chance that a spore will be carried for long distances, land on a susceptible plant, and still be viable may be low. However, because a single acre of rusted soybean can produce more than 400 billion spores per day, the number of spores in the air over a healthy soybean field can be substantial, and an unlikely event becomes a near certainty.

Photo by Shawn P. Conley, Purdue University.

Soybean rust spores collect like dust over plastic bags covering the front weights of a tractor in Mato Grosso, Brazil.

Surviving winters and growing on other hosts

Phakopsora pachyrhizi cannot survive in crop residue. Spores may survive on their own for about 40 days, but it is unlikely that spores on residue would survive an Indiana winter. Like other rust fungi, soybean rust requires a living host to grow and reproduce. To the best of our knowledge, soybean rust will only survive North American winters in southern regions where host plants retain green foliage. It can infect many other legume species, most of which are tropical or subtropical; many occur in Florida, but some occur in the Midwest. Among these are yellow sweetclover (*Melilotus officinalis*), butter and lima bean (*Phaseolus lunatus*), kidney and green bean (*Phaseolus vulgaris*), crown-vetch (*Coronilla varia*), and kudzu (*Pueraria lobata*). Kudzu and other perennial legume hosts in the South will probably be important for soybean rust's winter survival. The actual area where the fungus will survive in North America remains to be seen, but best current estimates include southern Florida and Texas, Mexico, and the Caribbean islands.

How can it be managed?

All U.S. soybean varieties are probably susceptible to rust to some degree. Assessing a cultivar's susceptibility in its area of adaptation is not possible until the disease occurs in that area. Cultural practices — such as planting date, row width, and crop rotation sequences — will have little or no effect on soybean rust (see page 12). Consequently, fungicides are the only option for managing soybean rust until resistant varieties are developed.

Fungicides labeled for use against soybean rust

Note: fungicides, like other pesticides, have a common name and one or more trade names. Below, common names are used, with trade names in parentheses.

Currently, three fungicides effective against rust are fully registered for use on soybean in the United States: chlorothalonil (Bravo®, Echo®), azoxystrobin (Quadris®), and pyraclostrobin (Headline®). Several other fungicides have emergency use exemptions (known as Section 18 exemptions) granted by the EPA.

Photo by Gregory E. Shaner, Purdue University.

A sprayer applies fungicide to a soybean field in Mato Grosso, Brazil.

Carefully read fungicide labels before treating soybean fields for rust control. Fungicides with Section 18 exemptions will not contain soybean rust control information on their standard labels. Applicators using any of these specially labeled products must have both the standard label and the Section 18 label in their possession when applying the material.

The standard and Section 18 labels for the various triazole and strobilurin fungicides specify the maximum number of sequential applications before applicators must discontinue using them and switch to a fungicide with another mode of action. Switching prevents the rust fungus from developing fungicide resistance.

PDF files of labels for fungicides with Section 18 exemptions and a complete list of available fungicides can be found on the Purdue Plant and Pest Diagnostic Laboratory Web site: **www.ppdl.purdue.edu**.

Early application most effective

Effective soybean rust control requires that fungicides be applied at the earliest stage of disease, before many infections have a chance to develop. Fungicides are more effective at preventing an epidemic than stopping one. Failure to control rust can lead to yield loss of up to 90 percent. Since specific infection predictions are not that reliable, growers will need to make the first application when rust is known to be in nearby regions south of their fields. If growers defer treatment until rust appears in their fields, it is important to apply fungicide while incidence (the percentage of leaves with pustules) is still low — that is, fewer than five leaves in 100 with rust pustules. If growers wait to apply the first treatment until most plants have several pustules, it may be impossible to stop the disease before substantial yield loss has occurred.

Photo by Shawn P. Conley, Purdue University.

Test plots show the importance of timely fungicide application. The unsprayed plot (foreground) has the most soybean rust damage.

Tracking its spread

To assist growers in determining treatment timing, Purdue Extension personnel will monitor soybean and kudzu plants throughout the state, and will be in daily contact with colleagues in states to the south. Any sighting of rust in Indiana, or its confirmed presence in adjacent states, will be reported to farmers via the Purdue Plant and Pest Diagnostic Lab Web site (**www.ppdl.purdue.edu**), by direct e-mail notification to Purdue Extension county offices, and to farm news broadcasters.

Multiple applications may be needed

Whether a field requires more than one fungicide application depends on how early in the season rust arrives and whether conditions (dew periods, temperatures) are favorable for continued disease development. The fungicides available for rust control have residual activity periods of 14 to 21 days. Leaves that develop after a fungicide application will not be protected. Fungicide may need to be applied as early as beginning bloom (growth stage R1). At this time, indeterminate cultivars such as those grown in Indiana have only about half their ultimate number of nodes. Fungicides, even those absorbed by the plant, have limited movement into new growth. If weather conditions remain favorable for infection, new leaves will need to be treated with another fungicide application to protect them.

How should fungicides be used?

Coverage is critical for effective soybean rust control with fungicides. This means fungicides must thoroughly cover not only the upper leaves, but lower leaves as well. When rust infects plants before all their leaves have emerged, the plant will have added new leaves before symptoms appear on the infected leaves. These lower leaves must be targeted during the first fungicide application.

For this reason, spray volumes (gallons per acre) and spray pressures (psi) must be higher, and droplet diameters must be smaller for fungicide applications than they are for most herbicide applications.

Small droplets vital for control

Each leaf should be covered uniformly with spray droplets for effective soybean rust control. Smaller droplets provide greater coverage. For example, for a spray volume of 15 gallons per acre (gpa), droplets measuring 200 micrometers (µm) will result in 2,100 droplets being deposited per square inch, whereas 400 µm droplets will deposit only 270 droplets per square inch. Droplet sizes are controlled by nozzle choice and application pressure. Nozzle manufacturers provide information on droplet size that can be achieved with various nozzles for various spray pressures and volumes.

For the most effective control, experience with soybean rust in Brazil suggests that droplets should be fine- to medium-sized (a volume median diameter of about 200 µm). Of course, such tiny droplets have a greater potential to drift than large droplets (the size commonly used for herbicides). Fungicide drift may not cause obvious symptoms in nontarget plantings (unlike herbicide

Photo by Shawn P. Conley, Purdue University.

The yellow areas in this field show areas of fungicide sprayer skips, resulting in soybean rust infection.

drift), but may still result in less effective disease control in the target crop and could result in illegal residues on nontarget crops. There also may be phytotoxic effects on nontarget crops. For example, Quadris® is toxic to certain apple varieties. Plus, there is concern about human and animal exposure to fungicide drift and surface water contamination. Many fungicide labels recommend application when wind speeds are 2-10 mph.

Tank mixing not recommended

Most labels for soybean herbicides and fungicides either say nothing about tank mixing, or state that it should not be done. At this time, Purdue Extension weed scientists and plant pathologists do not recommend that growers mix these products.

Aside from chemical compatibility problems, the timing for applying herbicides and fungicides may not correspond. Herbicides generally need to be applied much earlier than we anticipate needing to apply fungicides. This timing issue is even more evident when one uses contact herbicides, the application windows for which are smaller and earlier than for glyphosate. Moreover, herbicides are applied at a lower spray volume and nozzle pressure, creating larger droplets than the small droplets needed for effective fungicide application. In other words, the application technology that is right for one product will be wrong for the other.

Photo by Shawn P. Conley, Purdue University.

Opening the canopy reveals soybean rust infection on the lower leaves due to poor fungicide penetration.

Photo by Shawn P. Conley, Purdue University.

Proper nozzle selection is critical for effective soybean rust control.

Can cultural practices help?

Early planting ineffective

Planting soybean crops earlier than normal is not considered an effective soybean rust management technique. This is because planting dates have a limited effect on maturity dates. The initiation of soybean's reproductive growth stages (i.e., flowering) depends on photoperiod and temperature. So, planting early may result in your soybean crops developing a few days earlier, but will not significantly affect maturity date. Early soybean planting will, however, increase the risk of soilborne diseases such as sudden death syndrome and *Phytophthora* rot.

Early-maturity varieties carry risks

Switching to early-maturity soybean varieties will not reduce soybean rust damage. Early-maturity varieties typically have lower yield potential than full-season varieties because there is an increased risk of negative environmental factors — such as not capturing late August rains to compensate for drought. It is in the grower's best interest to plant full-season soybean varieties to maximize yield potential. Then, if rust appears, manage the disease with fungicides.

Soybean growth and development

Accurately identifying soybean crop growth stages is critical to facilitate timely fungicide applications. Once at stage R7 (beginning maturity) fungicide applications are not recommended. The table below defines soybean reproductive growth stages.

Crop growth stage[1,2]	Definition	Average number of days between R growth stage		Range of days between each growth stage[3]
R1	Beginning bloom	—	—	—
R2	Full bloom	R1-R2	4	0-7
R3	Beginning pod	R2-R3	10	5-15
R4	Full pod	R3-R4	9	5-15
R5	Beginning seed	R4-R5	9	4-26
R6	Full seed	R5-R6	15	11-20
R7	Beginning maturity	R6-R7	18	9-30
R8	Full maturity	R7-R8	9	7-18

[1]W.R. Fehr and C.E. Caviness et al. 1971. Stage of development descriptions for soybeans, *Glycine max.* (L). Merrill. Crop Science 11:929-931.

[2]P. Pedersen. 2004. *Soybean Growth and Development*. Iowa State University Extension publication PM 1945.
[3]Range based on planting date and environmental variability within a given year.

Will crop insurance cover my losses?

Soybean rust's arrival has implications for producers using crop insurance. Naturally occurring soybean rust is a covered cause of loss with crop insurance.

Producer-based products require 'good farming practices'

Many acres are covered under individual producer-based products like Actual Production History (APH), Crop Revenue Coverage (CRC), Revenue Assurance (RA), or Income Protection (IP). Under these products, indemnities are paid if a producer's yield/revenue falls below the guarantee level. However, producers are expected to use "good farming practices."

Good farming practices mean that producers making soybean rust-related claims will be covered only if they attempt to spray recommended fungicides at correct application rates regardless of cost. Unavailability of fungicides and/or custom applicators may also be covered. However, producers must document when rust was first detected in their fields and all their control activities.

Critical questions insurers will ask producers making soybean rust-related claims will be:

- Could the producer have applied the recommended fungicides in a timely manner?
- Were fungicides applied at recommended rates for optimal control regardless of cost?

Photo by Shawn P. Conley, Purdue University.

Plants with inadequate fungicide protection prematurely defoliated by soybean rust.

Producers should work closely with their crop insurance agents if soybean rust-related claims are possible.

County-based plans use 'triggers'

County-based insurance products — including Group Risk Plan (GRP) and Group Revenue Insurance Plan (GRIP) — are based on county average yields/revenues, not individual producers' yields/revenues. Under such products, indemnities would be paid if county yields/revenues fall below the "trigger" yield/revenue. An individual producer may have a loss caused by rust or other insured peril, yet would receive no indemnity unless county yields/revenues are below trigger yields.

What if I suspect I have soybean rust?

Where to look

Early disease detection is the basis of a successful control program. Fields or areas of fields where dew tends to persist longer have a higher likelihood of showing symptoms first. Evaluate at least 10 plants from each of 20 at-risk locations in a field. Scout low as you go, paying close attention to the undersides of leaves on the lower portions of plants as well as top growth.

What to collect

If you suspect Asian soybean rust:

- Collect at least 20 leaflets with suspect symptoms.
- If symptoms occur in distinctly different areas in the field collect separate samples from those areas, record identifiable collection location information on the bags, and submit different samples with separate forms.

How to package

To prepare a sample to send to the Purdue Plant and Pest Diagnostic Laboratory:

- Flatten leaves and place between dry paper towels.
- Place towels with pressed leaves between stiff cardboard, if available.
- Place towels with pressed leaves in a self-sealing plastic bag and seal it.
- Clearly label the bag with your name and date of collection with a permanent marker.
- Place this bag inside a second self-sealing plastic bag, being careful that the outside of the second bag does not become contaminated with spores.
- Complete a separate "P&PDL Soybean Rust Sample Submission Form" for each sample and attach the completed form to the outside of the bag. Download a copy of the form by visiting **www.ppdl.purdue.edu**.
- Place the bagged sample into a mailing envelope and seal securely.

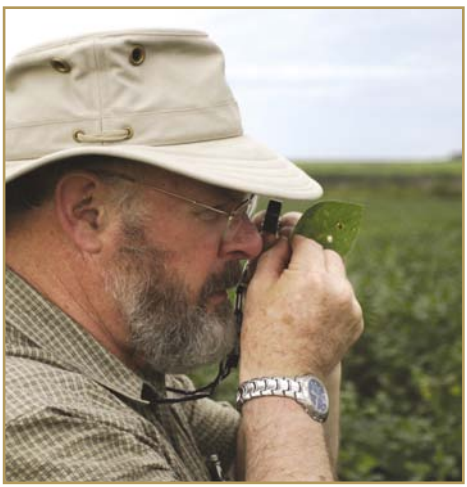

Photo by Shawn P. Conley, Purdue University.

Greg Shaner inspects a soybean leaf with a 20x lens in Mato Grosso, Brazil, February 2005.

How to ship

Ship samples as soon as possible after packaging via overnight delivery or hand delivery to:

Plant and Pest Diagnostic Lab
LSPS, Room 101
Purdue University
915 W. State Street
West Lafayette, IN 47907-2054

When possible, call the P&PDL at (765) 494-7071 to let them know a sample is on the way. Maintain records of shipping numbers so packages can be tracked.

Where can I find more information?

- **Purdue Plant and Pest Diagnostic Laboratory**
  www.ppdl.purdue.edu
  This is Purdue Extension's main outlet for information on Asian soybean rust and other soybean pests. The site is updated frequently and contains links to Purdue Extension publications, forms for submitting samples, and links to other resources. Ê
- ***Ag Answers***
  www.aganswers.net
  Find timely soybean rust news and other problem-solving advice, strategies, and reminders. *Ag Answers* is updated at least twice weekly with information from Extension specialists in Indiana and Ohio. Ê
- **Purdue Agriculture Soybean Rust News**
  www.agriculture.purdue.edu/soybeanrust
  Find the latest news and research about soybean rust's spread and impact.
- **USDA Soybean Rust site**
  www.usda.gov/soybeanrust
  This site contains news, a map that tracks the spread of the disease, and other information.
- **USDA Regional IPM Centers Section 18 Fungicides**
  www.ipmcenters.org/NewsAlerts/soybeanrust/quarantine.cfm
  This site includes state-by-state listings for all fungicides receiving emergency use (or Section 18) exemptions from the EPA.

Photo by Shawn P. Conley, Purdue University.

Backlighting reveals soybean rust lesions on the top of a leaf.

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INDIANA SOYBEAN BOARD

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