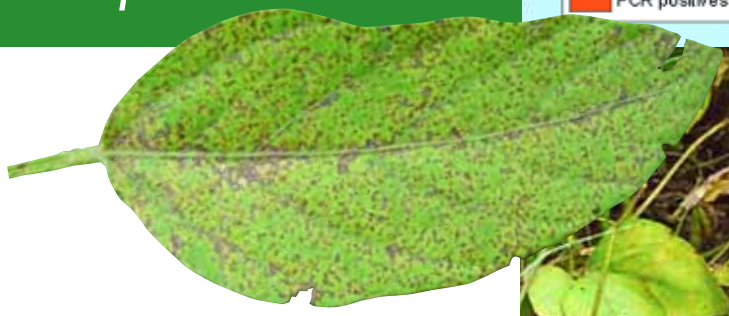
Soybean Asian Rust

Research Update



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We have several advantages

*By **Jerry Wyse***
Soybean grower & NCSRP vice chair
Haven, Kan.

Having found Asian rust last November gives us a six-month heads-up on our crop. The same holds true for the chemical companies to get fungicides into position.

Another thing we have going for us is two years of preplanning. The North Central Soybean Research Program (NCSRP) and the United Soybean Board (USB) have been working together with land-grant universities, USDA-ARS, APHIS and CSREES, laying the groundwork to overcome this disease.

Producers need to know that we're tackling this problem as a team. The NCSRP and USB have been leveraging the dollars you invest to get the proper people in positions to address this disease with the least amount of damage.

Here's another big advantage: We knew it was coming, the Brazilians didn't. We have time to prepare. There will be workshops all winter—for producers, Extension agents, crop consultants—and we'll all be much better educated when we have to deal with rust.

Remember, this disease has been around for a long time. People in Asia and South America have dealt with it and learned how to control it, just like we learned to control wheat leaf rust. And eventually we'll develop resistant varieties. There are always opportunities in every plague.

Greg Shaner, Purdue

For more information, visit www.planthealth.info, part of NCSRP's Plant Health Initiative.

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Cover photos and graphics:
Photo of three men courtesy of Mark Claesgens, LSU AgCenter; photos of infested soybean field and infected leaf courtesy of Loren Giesler, UN; map courtesy of USDA-APHIS Aerobiological Risk Analysis for Soybean Rust – https://netfiles.uiuc.edu/ariatti/www/SBR/maps.htm

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Be informed, not alarmed

*By **Ike Boudreaux***
Soybean grower & USB director
Lebeau, La.

Asian rust came a little sooner than anyone anticipated. In fact, it was confirmed on land all around my farm. But this disease can be easily controlled through early detection and proper application of fungicides. As soybean growers, we need to be informed, but not alarmed.

Producers also need to know that the entire industry is working together – checkoff organizations, different USDA agencies, land-grant universities and chemical companies – doing everything we can to give farmers every possible tool to manage rust. From grower education efforts to an early monitoring system in all soybean-growing states, from fungicide trials to variety screening, we're throwing everything we can at this disease.

Admittedly, there are still a lot of "ifs" with rust. The South is going to be more vulnerable because our growing season is longer, so we'll have to protect the crop for a longer time.

Regardless of where you farm, we'll all need to pay close attention to our operations – but not to the extent that we don't plant beans. I may wind up planting all soybeans in 2005.

The soybean industry is vital to animal agriculture, and we need to continue providing a good product to livestock producers, as well as meeting the needs of the human food and export markets.

So scout your fields regularly, every couple of days. If you think you see rust, get in touch with your county agent or university. Early detection and proper application of fungicides are definitely the keys to controlling this disease.

It's here. Don't panic. You can manage rust.

Scientists call it *Phakopsora pachyrhizi*, and it's the most aggressive species of soybean rust. Its spores likely hit the Gulf Coast in mid-September 2004, by hitching a ride on Hurricane Ivan.

Asian rust is here, and researchers believe it's likely to survive the winter along the southern tip of Texas and south Florida, depending on winter temperatures. This could mean spores (also called inoculum) building up prior to May, and blowing North during the growing season.

Chances are it also could overwinter in Mexico and the Caribbean, and head our way this spring. In fact, USDA is planning to send "SWAT teams" to both areas to hunt for rust.

Now what?

It's not the end of the world

"Don't panic," says Anne Dorrance, Extension soybean research pathologist at The Ohio State University. "This is a manageable disease with one to two fungicide sprays. Growers are smart—they managed aphids quickly. And there's time to make educated decisions."

Monte Miles agrees. "The sky is not falling," says the research plant pathologist at USDA-ARS and the National Soybean Research Center. "All of the fungicides already registered or on Section 18 exemptions can be used to manage soybean rust."

Miles admits that Asian rust will change the way soybean producers manage their programs. "But producers who do manage this well will see benefits that should outweigh what soybean rust will cost. Look at what happened in Brazil. They started managing their crop, and good producers are getting higher yields now than they were before rust."

His recommendation: "Manage your soybean crop to maximize your yield. That includes planting dates, seeding density, row width, fungicides and insecticides. This way, if you need to use a fungicide, you already have high yields, and you're protecting a high-yield crop rather than a moderately yielding crop."

In Mississippi, for example, producers have doubled yield in a decade by improving how they manage production. "The last state average was 39 bushels to the acre—twice what it was 10 years ago," Miles notes.

One option: Don't plant poor ground

Raymond Schneider, professor of plant pathology at the Louisiana State University AgCenter, says the situation down South is a little different than Midwestern growers are facing. "We already have diseases here that we use fungicides on.

"At least 25 percent of soybean acreage in Louisiana is already sprayed. Of course, now we're looking at 100 percent, because we're Ground Zero. I feel for growers. With two applications, they're looking at more than $40 an acre in treatment costs."

Schneider believes that Louisiana growers just won't plant the poor ground. "Anything less than 30 to 35 bushels per acre won't be planted. That's probably the strategy most will adopt."

Mark Claesgens, LSU AgCenter

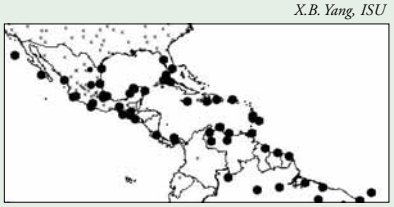
"What we've learned down here is that when we spray fungicides, we get better yield even though there's no apparent disease being controlled," says Raymond Schneider, plant pathologist at the LSU AgCenter. "Some fungicides are very effective against rust, but they may not be effective against other foliar diseases we've been fighting. That's a question we need to answer for Southern growers."

Predicting the future

In an attempt to predict where and how spores travel, X.B. Yang at Iowa State University (ISU), along with Zaitao Pan and Bob Pasken at St. Louis University and Shimon Pivonia (formerly at ISU, now in Israel), developed a short-term climate model that integrates weather, plant pathology and diseases. "We can predict weather and likely spore trajectories four months ahead of time," says Yang.

In January 2004, for instance, they predicted—during the early growing season in Brazil—that spores released in Brazil would travel to Cali, Colombia, and Argentina's soybean growing regions. They did. (While public officials have not confirmed this, ag company representatives say there is rust in Colombia.)

X.B. Yang, ISU



Likely year-round rust survival locations in North and Central America.

Using that information, Yang's team made another prediction. "On August 7, we projected that for the next 40 days, the frequency of spores moving north had a clear pathway to Mexico and Louisiana. We also saw a low-frequency pathway of spores heading to Georgia's east coast." Right again.

Now they're adapting the model to predict spore spread from southern to northern states every spring. Asked to make predictions about 2005, Yang says, "We have to wait until spring, because it will depend on whether—and how much—rust overwinters in the southern United States."

Chris DiFonzo, MSU

What stage?

According to Iowa State University's X.B. Yang, "We recommend that growers not spray before R1 flowering time or after R5."

Martin Draper, Extension plant pathologist at South Dakota State University, agrees. "I think it's reasonable to suggest that in a lot of places in the United States, R3 might be the best stage. In other parts of the country, say farther north or west, it may be R5."

"If rust blows in late, say at R6, the beans will already be made," says Anne Dorrance, Extension soybean research pathologist at The Ohio State University. "At that point, late fungicide applications don't do enough to protect enough yield. There's also the problem of pre-harvest intervals."

Geography also may help determine whether you'll need one application or two. Says Draper: "If you live farther north or west—or if the pathogen arrives later in the growing season—you might get protection through grain fill with a single application.

"In general, I'd say treatment before canopy closure is probably unnecessary," he adds. "We think canopy closure is critical, because that allows dew to stay in the canopy for a long period of time."

When to spray

"Although it's difficult when you don't have the real disease to work with, we have been doing some fungicide trials and sprayer trials," says Martin Draper, Extension plant pathologist at South Dakota State University. "We're looking at any other possible side effects of fungicides and tank mixes, whether it's controlling other diseases or having an effect on yields."

While all the data aren't in yet, "We saw no crop injury associated with tank mixing with any of the already-labeled Section 3 fungicides or Section 18 products on the soybean varieties tested," Draper says. "What we don't know is if, in the presence of rust, there will be any antagonism between tank mix partners that will reduce performance against target pests.

"We've learned that we can go ahead and tank mix insecticides and fungicides, and we'll use similar application methods, including a lot of water and smaller droplets," he says.

Draper explains that coverage is key, because fungicides aren't nearly as mobile as herbicides. "We're comfortable with how to apply Roundup®, where we use low carrier volumes and large droplets. With fungicides, we'll need to do just the opposite.

"We need to cover the leaf, so more water and smaller or medium droplets are preferable," Draper says. "However, if you're tank mixing with a herbicide, you're going to have to make compromises.

"Growers also are going to have to make some compromises based on

Loren Giesler, UN

According to Greg Shaner, plant pathologist at Purdue University, "It's conceivable that rust could attack soybeans before R1, especially in the South." He urges producers to rely on the disease incidence and severity guidelines and sentinel plot results, rather than on a specific plant stage.

Aerial vs. ground applications

USDA researchers and Extension plant pathologists are currently studying aerial vs. ground application methods, evaluating canopy penetration using different water volumes with different fungicides. The ground application studies will compare coverage and canopy penetration with different volumes and nozzle types—both within and above the canopy.

"The numbers I've seen from South America suggest that both aerial and ground spraying works fine," says Loren Giesler, University of Nebraska Extension plant pathologist.

"We've been looking at how different nozzle types affect canopy distribution, and that data should be out fairly soon."

As for water rates, "In our ground application studies, we've been using 10- to 20-gallon volumes. In Brazil, they're using the three-gallon rate or higher for aerial applications," he says.

"One of the great unknowns is chemigation," Giesler adds. "There's no added expense of treating, but a lot of the product runs off. We just don't know whether it works yet, but we'll be studying it this year."

product availability," he continues. "And again, because we haven't had the disease here yet, we don't have local data on efficacy. We need to use Brazil's experiences to gain knowledge, but we can't expect that it's all completely portable to the United States."

Spray recommendations

Plant pathologists have developed guidelines for fungicide use. "It's really a four-point program," says Draper. While these may change as researchers learn more about how rust behaves in the United States, current recommendations are:

1. **If there's no threat of disease in your area, don't treat.**
2. **The potential for the disease is high.** It's moving toward your area, but you don't have it yet. "This would truly be a preventive treatment, where we'll use a chloronitrile, a strobilurin or premix," says Draper.
3. **You have a low level of disease in the lower canopy, but probably not greater than 10 percent incidence.** "This means you won't see more than 10 leaves in 100 that have pustules present," Draper explains. "Basically, if you find any low level of disease, you should treat with a preventive fungicide."
4. **It's in your beans, and the disease has been established in the middle third of the canopy.** "At this point, product performance may not be satisfactory, and an economic return is less certain. Therefore, no treatment may be appropriate," he adds. "However, if a treatment is made, only triazoles or premix products should be used."

Note: These spray recommendations apply from R1 to R6.

Product	Class	Manufacturer	Jan. 05 Status
Quadris®	Strobilurin	Syngenta Crop Protection	Registered
Bravo Weather Stik®	Chloronitrile	Syngenta Crop Protection	Registered
Echo® 720	Chloronitrile	Sipcam Agro USA, Inc.	Registered
Echo® 90DF	Chloronitrile	Sipcam Agro USA, Inc.	Registered
Echo® ZN	Chloronitrile	Sipcam Agro USA, Inc.	Registered
Headline®	Strobilurin	BASF Corporation	Registered
Pristine®	Strobilurin + Carboxamide	BASF Corporation	Registration Expected
Tilt®	Triazole	Syngenta Crop Protection	Section 18
PropiMax™	Triazole	Dow AgroSciences	Section 18
Bumper®	Triazole	Makhteshim-Agan	Section 18
Folicur®	Triazole	Bayer CropScience	Section 18
Laredo® EC	Triazole	Dow AgroSciences	Section 18
Laredo® EW	Triazole	Dow AgroSciences	Section 18
Stratego®	Strobilurin & Triazole	Bayer CropScience	Section 18
Domark™	Triazole	Isagro, Inc.	Section 18
Quilt™	Strobilurin + Triazole	Syngenta Crop Protection	Awaiting Section 18

Strobilurin = preventive; Chloronitrile = preventive; Carboxamide = preventive; Triazole = curative

Note: Section 18 labels may have different requirements and restrictions. Consult your local land-grant university personnel for the most appropriate, up-to-date information.

Lorem Gielder, UN

Overwintering

Besides kudzu and soybeans, Asian soybean rust is known to infect more than 95 plant species, including legume crops such as lima beans, black-eyed peas, kidney beans and green beans. "Crimson clover is another one we're concerned with, because we don't know much about it," says Monte Miles, USDA-ARS research plant pathologist.

There also was one erroneous report out of Uruguay suggesting it was found on alfalfa.

The trouble with kudzu (and some of the other alternative hosts) is that it has been known to survive Southern winters.

"Spores can't reproduce without green tissue," says Glen Hartman, plant pathologist at USDA-ARS and the National Soybean Research Center at the University of Illinois. "So in the temperate North, the spores are all going to die. But in Southern areas where you might have some green tissue, they could overwinter on those hosts. As long as alternative hosts are green, the fungus will continue to sporulate."

"To minimize pathogen resistance development, we want to have as many chemistries available as possible," says Kent Smith, USDA-ARS Office of Pest Management Policy. "So once we confirmed that Asian rust was here, all approved Section 18s were released. All 26 states that have requested it have been given authority to release these chemicals." But, Smith cautions, "Each state now decides when they want to release the chemicals, and what the conditions or requirements might be, so check with your ag Extension agent or crop consultant."

Loren Giesler, UN

Scout! Scout!

"Scouting is going to be the most important thing when it comes to Asian rust," says Martin Draper, South Dakota State University Extension plant pathologist. "We can't play catch-up with this disease. We have to catch it early. And that means thorough scouting. If you blow it off, it'll blow you away."

Draper says there are a lot of similarities to scouting for white mold and rust. "Look for areas that are likely to hold dew for longer periods. Areas protected by windbreak, areas near kudzu."

Asian rust symptoms usually first appear on the soybean plant's lower leaves as water-soaked spots. These progress to reddish-brown lesions that contain pustules, which look like "little pink volcanoes." The majority of pustules will appear on the underside of leaves.

"This is going to require a level of vigilance that we're not used to," says Raymond Schneider, plant pathologist at the LSU AgCenter. "Spraying has to begin when there are just traces of rust in the field."

Keeping track of Asian rust

From "sentinel plots" to climatology models to USDA-APHIS "SWAT teams" monitoring Asian rust in the Caribbean and Mexico, soybean producers should be able to keep track of where rust is in 2005—as well as where it's likely to head.

The key is to be vigilant.

An early warning system

"Sentinel plots will serve as an early warning system for soybean producers," says Loren Giesler, Extension plant pathologist at the University of Nebraska. Basically, the program will consist of test plots scattered throughout soybean-producing states, and monitored regularly by Extension agents, crop consultants or other ag cooperators.

The goal: provide soybean growers with real-time information about what's happening in every plot.

Currently, the protocol for the sentinel plot system is still taking shape and funding decisions are still being hammered out, but there will be some form of the program during the 2005 growing season in virtually every soybean-producing state. In fact, some states already have developed their own programs.

Up early in Nebraska

"We actually initiated a sentinel monitoring program in 2004," Giesler says. "And sentinel plots have been used in South America for years."

Giesler's program uses ag educators, crop consultants and other ag cooperators distributed throughout Nebraska's main soybean production areas. "We'll be expanding the program in 2005, especially in the southeast corner of Nebraska, where we have kudzu."

Forecasting rust's arrival

Nationally, the sentinel plot program is one element of what researchers hope is a three-pronged effort to accurately predict spore and disease movement. The second prong is the climate models funded by checkoff funds and USDA-APHIS: Both X.B. Yang's climate model

"Based on historical data from other rusts, Asian soybean rust disease can probably travel about 20 miles a day, possibly faster," says X.B. Yang, plant pathologist at Iowa State University. "Spores, on the other hand, can travel hundreds of miles a day if the wind's blowing. They just ride on the air current. But keep in mind that spores need the right ground conditions for infection to occur. For spores to attack the plant, they need a minimum of six hours of free moisture and temperatures between 60° and 80° F."

Monte Miles, USDA-ARS

Raymond Schneider, LSU AgCenter

that predicts weather and spore movement four months ahead of time (see story, page 3), and the daily forecast model that Scott Isard and his team have developed.

It's called IAMS (integrated aerobiology modeling system), and it'll be used to predict the arrival of Asian rust spores to various U.S. regions. "We want to provide daily risk maps online for farmers," says Isard, an aerobiologist at Penn State University. "How good they'll be ultimately will depend on how good our information is on pathogen distribution in the Caribbean basin and the southern U.S."

The good news is: "There's a major emphasis by the USDA to develop a monitoring network that will obtain these data in a timely manner," Isard notes.

This information gathering is the third element in the effort to predict spore movement. Researchers also are looking at air and rain monitoring off the Gulf Coast, to alert Southern producers when spores are on the move.

R. Frederick, USDA-ARS

"Spore transport and severity of the disease are both highly dependent on weather conditions," says Scott Isard, aerobiologist at Penn State University. "In drier years, you can expect to have fewer problems." What is the optimum condition for spores? "Basically the optimum conditions for soybean growth. Warm and moist." Isard believes U.S. farmers shouldn't worry as much about rust riding in on hurricanes, because they're a late-season phenomenon. He's more concerned with the pathogen overwintering in the Caribbean basin.

Come rain or come shine

"A heavily infested field can produce 1,000 trillion spores per hectare per day," says Scott Isard, professor of aerobiology at Penn State University. "Only a small fraction escape from the field, but that's plenty."

Spores are released during rain showers, as the wind and rain knock the soybean plant around, but they don't get far because rain also knocks them out of the atmosphere. "So rain redistributes spores locally, and provides the conditions for the pathogens to flourish," Isard explains. "These cases are associated with inner-field spread."

In the absence of rain, spores tend to be released in the middle of the day, "Because that's the best time to escape from the canopy. The leaves are dry, the dew's evaporated, the wind is blowing," he says. "Maybe 15 percent of spores escape the canopy under typical, sunny conditions." However, spores are very sensitive to solar radiation.

"We know they can last a few hours in the sunshine, but they can't travel long distances," he notes. "So in the middle of a sunny day, 99 percent of the spores that make it out of the canopy and high into the atmosphere die. But 1 percent of 1,000 trillion is a lot."

Oddly enough, it's that 1 percent of surviving spores released during sunny conditions that are participating in the long-distance movement. "But to go far they need cloud cover," Isard notes. "They can only move long distances with storm systems. That's why hurricanes are perfect. Here again, once a spore gets into a rain band associated with a hurricane, it'll be washed down onto fields."

Isard and other USDA-CSREES-funded researchers are in Paraguay this winter, studying environmental factors that govern the aerial movement of Asian rust spores and disease progression in soybean fields.

Monte Miles, USDA-ARS

Killing spores

What does it take to kill a spore? Scientists aren't completely sure, but here's what they think they know so far:

- Spores die in 6-7 days when temperatures are under 32° F
- Spores can survive off a host for about 50 days in ideal lab conditions
- Spores don't thrive at temperatures above 100° F
- A combination of hot, dry and sunny weather is deadly

Other studies suggest that UV radiation may be more deadly to spore survival than extended exposure to very cold temperatures or very dry weather.

Current and future weapons in the war

Checkoff organizations, land-grant universities and several government agencies have been working to give soybean producers as many tools as possible to manage Asian rust. In fact, some of this research started almost three years ago, in anticipation of rust's arrival. Here's a topline summary of what scientists are working on:

Variety screening—More than 20,500 cultivars and accessions (including everything in the USDA germplasm collection and many U.S. commercial varieties) have been screened using four different rust isolates. Researchers found approximately 800 that they're interested in further evaluating, because they've shown fewer lesions or are slower rusting. "We've also short-listed approximately 80 out of the 800," says Glen Hartman, plant pathologist at USDA-ARS and the National Soybean Research Center in Urbana, Ill. "We've had to jump-start some of what we've planned, because rust is here and we need to know now. Hopefully, we'll get these out to some locations where there's rust, and see how they do in 2005."

Fungicide trials—These have been going on since 2002 in Zimbabwe and Paraguay, where USDA scientists have tested 15 different products, all of which worked well. USDA and Extension pathologists also have been working on a multi-state study of tank mixes and application methods, and these data should be analyzed and released before planting.

Genetic mapping—"We're trying to develop a library of the genes of the organism," says Kent Smith, USDA-ARS Office of Pest Management Policy. "Once we determine the genetic make-up, we can use that information to help develop resistant varieties."

In-field detectors—Scientists are working to develop grower-friendly detection methods that will rapidly identify rust in the field. One possibility is a quick-strip test similar to a home pregnancy test. Another is a hand-held sensor.

Genetic engineering—USDA-ARS researchers have found five varieties of common beans that show much higher resistance to Asian rust than soybeans do. Scientists hope to clone the resistance genes in those beans and genetically engineer them into soybeans.

Proteins and peptides—USDA-ARS scientists are trying to identify plant proteins involved in disease resistance. They're also searching for peptides that can block infection or spore germination.

The life cycle: It's creepy

Once a spore lands on a soybean leaf, and if the environmental conditions are right—warm temperatures and at least six hours of moisture—the spore begins to germinate.

It sprouts a germ tube, which penetrates the leaf. Once inside, the fungus, an obligate parasite, draws its nutrients from living plant cells. Initially, infection appears as tan spots, usually on the underside of the leaf.

Lesions (dead spots) appear five to eight days later as leaf tissue is destroyed. Within mature lesions, pustules form, which look like tiny volcanoes. Inside the pustules, new spores can develop in as little as nine days after the initial infection.

Spore production can continue for up to three weeks, and they can remain viable for almost two months if humidity is high and ultraviolet radiation exposure is low.

Greg Shaner, Purdue