















# A Complex Disease

# How SDS

## Two stage disease

"SDS has two stages, the seedling stage early, then foliar symptoms later," says George Bird, nematologist at Michigan State University. "You can have reduced stands due to seedling disease."



Courtesy of Palle Pedersen, Iowa State University

Several scientists conducting checkoff funded research are exploring how *Fusarium virguliforme*, the fungal pathogen that causes sudden death syndrome (SDS), infects soybean plants. "We have a lot to learn yet about the relationship between the root and foliar phases of the disease," says Iowa State University Plant Pathologist Leonor Leandro.

"Several other *Fusarium* species cause root rot, but this one also produces toxins," she adds. One of Leandro's colleagues, X.B. Yang, found that the pathogen needs to colonize the vascular system of the plant for these toxin(s) to be transported to the leaves where they cause leaf symptoms. "If the fungus is only in the outer root tissues, it is possible to get root rot, but not leaf symptoms," Leandro says.

## Infection occurs quickly

When researchers studied how quickly the

fungus could cause infection in the root, they discovered the SDS pathogen can infect the plant within days of seed germination. "The greater the number of fungal spores that are in contact with the root, the faster the root rot appears, and the more foliar symptoms you see," Leandro explains.



▲ **SDS symptoms** can be seen even on young seedlings.

## Younger plants are more susceptible

"Seedlings are very susceptible to infection," Leandro explains. "There's a decrease in susceptibility as plants get older. It's related to the ability of the fungus to penetrate the plant's vascular system."

## Warmer soil is better

Leandro's team also found that soybeans were most likely to show symptoms when planted in cooler soils. "In cooler soils the roots are susceptible for a longer period of time. Whatever the plant is doing to resist



# infects soybean

infection happens much more quickly in warm soil," she adds. "For growers, this means that delayed planting can reduce SDS, but it doesn't prevent it if infection occurs on young seedlings."

## What happens around flowering?

According to Leandro, scientists don't know yet whether the soybean plant becomes susceptible again later in the season. "There may be another stage of infection that occurs after flowering," she explains.

Additional research led Leandro to conclude that flowering seems to trigger the expression of foliar symptoms. "The more we delayed flowering, the later the disease appeared," she continues.

However, Leandro says researchers at the University of Illinois inoculated soybean plants with the SDS pathogen at flowering, and plants got the disease. In contrast, researchers also have managed to produce foliar symptoms – without a fungal infection – by exposing the plants to toxins.

Despite all the new knowledge on SDS, Leandro concludes that "there's still a lot more to learn about the infection process of this fungus."



Courtesy of Palle Pedersen, Iowa State University

▲ **"If SDS comes in after R5 or R6, your yields are so close to being made that the impact is minimal,"** says Jason Bond, plant pathologist at Southern Illinois University. **"If it shows up at flowering you are in trouble."**



Courtesy of Palle Pedersen, Iowa State University

## ▲ **Is there a connection between SDS and row width?**

Jason Bond, Southern Illinois University plant pathologist and Palle Pedersen, Iowa State University Extension soybean specialist agree: "No. We studied 15-inch and 30-inch rows. Because it's a soilborne issue, it's more related to where the pathogen is in the field vs. planting or row width."

# SDS Research



*Courtesy of Silvia Cianzio, Iowa State University*

**Checkoff-funded researchers throughout the North Central region are working hard to crack the sudden death syndrome (SDS) genetic code for soybean producers. Ongoing research includes:**

- 1 Mapping the genes responsible for SDS resistance in the soybean plant**
- 2 Breeding SDS-resistant varieties for early maturity groups**
- 3 Sequencing the genome of *Fusarium virguliforme*, the pathogen that causes SDS**
- 4 Studying how the SDS pathogen infects the soybean plant**
- 5 Exploring interactions between SDS, soybean cyst nematode and brown stem rot**

# Finding so

**T**he good news is: "There seem to be many different sources of SDS resistance, even within our elite varieties," says Brian Diers, soybean breeder at the University of Illinois. "The problem is, we don't have a good understanding of what resistance genes are in different resistant varieties and how many resistance genes are needed to achieve a high level of resistance."

"As part of the North Central Soybean Research Program (NCSRP) project, we've mapped two specific genes responsible for SDS resistance, and we've bred them into different soybean varieties," Diers adds. "We will now test how much we improve resistance in these different backgrounds. The genetic markers used in mapping genes should help breeders increase their speed in developing SDS-resistant varieties."

## **SDS is a tough research subject**

Diers explains that one of the challenges in breeding for SDS resistance is that field tests are difficult. "There's a lot of variability, because the soil environment is more complex in the field than in the greenhouse."

"It's a tough pathogen to control in a complex environment," says Jason Bond, a plant pathologist from Southern Illinois University. But through an NCSRP project that began in 2000, researchers have improved field inoculation techniques and developed new screening protocols for growth chambers and greenhouse tests.



*Courtesy of Brian Diers, University of Illinois*

**▲ Planting resistant varieties (left) is the best management practice to manage SDS.**



# Solutions for farmers

"These are necessary tools to help public and private companies develop better SDS-resistant varieties," Bond says. "At the end of the day, farmers benefit from improved SDS resistance."

"We've made a lot of progress in nine years," says Silvia Cianzio, a soybean breeder at Iowa State University. "The new procedures allow for efficient, repeatable screening results. In developing new sources of SDS resistance, we're relying on screening, so we need to be quite confident."

## New genetics

Cianzio recently released a new breeding line with improved resistance to SDS in maturity group 2. "Private companies are licensing the line to breed into their elite cultivars," she explains.

"In our program, we're using five or six different resistance sources," Cianzio continues. "We also have a number of breeding lines in our pipeline, and our hope is that every year, we'll be able to release new germplasm."

"It's extremely important that from now on, even though we have good sources of resistance, we continue to look for new ones," Cianzio adds, "because resistance only lasts as long as it takes for the fungus to find a way to overcome it."

Another reason SDS is so challenging: "We may be dealing with two completely different resistance mechanisms; one in the roots, and one controlling foliar symptoms. Researchers found that not all cultivars with infected roots show foliar symptoms," says Cianzio.

According to Bond, "The resistance in 99.9 percent of varieties is the type that protects against foliar symptoms. The pathogen still infects the root, but it's unable to produce toxins. Or even if it does produce toxins, it doesn't harm the soybean plant."

Bond believes there's root resistance in older cultivars, and an interesting debate among geneticists about which type of resistance to use.

"The easiest type to work with is the resistance against foliar symptoms. Root resistance is harder to get – the donor varieties are agronomically poor. You're



*Courtesy of Iowa State University*

stepping back 20 years in yield progress," he explains. "But there's also the argument that you shouldn't let the SDS pathogen build up in the roots, because you're increasing the pathogen load in the soil."

There's no argument among geneticists, however, about the need to develop better SDS-resistant varieties – especially for farmers in northern growing areas. That's the goal of the NCSRP, United Soybean Board and several state soybean boards. For years, they've been working in partnership to provide soybean growers with SDS solutions that yield.

For more information on managing for higher yields log on to [www.planthealth.info](http://www.planthealth.info). Here you will find the latest science-based information on best management practices to increase yield through variety selection, seeding rates, tillage practices, disease and insect management and more.

Your soybean checkoff. Delivering results.



[www.planthealth.info](http://www.planthealth.info)

---

## Acknowledgements

This publication produced in cooperation with the following contributors:

- George Bird, Michigan State University
- Jason Bond, Southern Illinois University
- Silvia Cianzio, Iowa State University
- Shawn Conley, University of Wisconsin
- Brian Diers, University of Illinois
- Paul Esker, University of Wisconsin
- Leonor Leandro, Iowa State University
- Dean Malvick, University of Minnesota
- Palle Pedersen, Iowa State University
- X.B. Yang, Iowa State University

