

DISEASES OF SOYBEAN

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Sudden Death Syndrome

*Andreas Westphal, Lijuan Xing, T. Scott Abney, and Gregory Shaner
Department of Botany and Plant Pathology, Purdue University and USDA-ARS*

Sudden death syndrome (SDS) is one of the most important diseases of soybean in the Midwest. First discovered in Arkansas in 1971, SDS has spread throughout most of the North Central Region, including Illinois, Indiana, Iowa, Kansas, Kentucky, Minnesota, Mississippi, Missouri, Nebraska, Ohio, and Tennessee. SDS is most severe when soybean is planted early into cool, wet soils and when heavy midsummer rains saturate the soil. The fungus that causes SDS is now present in nearly all Indiana soybean fields, placing plants in high moisture areas of fields at risk for the disease (Figures 1 and 2).

Symptoms

The first noticeable symptoms of SDS are yellowing and defoliation of upper leaves (Figures 3 and 4). When symptoms first appear in a field, they may be confined to a few small areas or strips in the field, often in wetter or compacted areas, such as turn rows. Over the following two or three weeks, affected areas may enlarge, and other areas in the field may show symptoms. Because the SDS fungus can overwinter in soil, areas of a field that show symptoms of the disease often grow larger with each growing season until most of the field is affected.

In disease development, early symptoms are mottling and mosaic of the leaves. Later, leaf tissue between the major veins turns yellow, then dies and turns brown. Soon after, the leaflets die and shrivel. In severe cases, the leaflets will drop off, leaving the petioles (leaf stalks) attached.



Figure 1. A field infested with sudden death syndrome.



Figure 2. This photo shows soybean plants with aborted leaves on a water-saturated slope in a field that has a history of SDS.

Examining the interior of the lower stem and taproot provides a more diagnostic symptom (Figure 5). When split, the lower stem and taproot of a plant infected with SDS will exhibit a slightly tan to light brown discoloration compared to a healthy plant. The pith (the central portion of the stem) will remain white or slightly cream-colored.

It is important to look for these stem symptoms because other diseases (such as brown stem rot) or chemical burn can produce foliar symptoms similar to SDS (although in other diseases dead leaflets tend to remain attached to the petioles). For example, brown stem rot darkens the pith, but there is little discoloration of the cortex. If a plant with advanced foliar symptoms of SDS is dug up when soil is moist, there may be small, light blue patches on the taproot's surface near the soil line (Figure 5c). These patches are blue spore masses of the fungus that causes SDS. As the plant dries, the blue color will fade, but these blue spore masses, seen in conjunction with the other symptoms mentioned above, are strong indicators of SDS.

Causal Agent

SDS is caused by the soilborne fungus *Fusarium solani* f. sp. *glycines*, synonym: *Fusarium virguliforme*. This fungus grows slowly in culture and is difficult to isolate from diseased plants. Once pure cultures are obtained, blue spores and other cultural characteristics distinguish it from other *Fusarium* species that can infect soybean roots (Figure 6a).

Disease Cycle

Presumably, *Fusarium solani* f. sp. *glycines* survives the winter as chlamydospores in the crop residue or freely in the soil (Figure 6b). The thick-walled chlamydospores develop in the soil and on soybean roots during disease development and thereafter. The fungus also can survive in cysts of the soybean cyst nematode. Chlamydospores can withstand wide soil temperature fluctuations (including freezing) and resist desiccation. As soil temperatures rise in the spring, chlamydospores near soybean roots are stimulated to germinate, then infect soybean roots.

The fungus may infect roots as early as one week after crop emergence, but aboveground symptoms of SDS rarely appear until mid-July, when soybean plants start to flower. Heavy rains during reproductive stages often are critical for SDS symptom development. When the soil is wet the fungus produces toxins in the roots that are translocated to the leaves. These toxins are what cause foliar symptoms; the fungus does not invade the stems above a few inches of the soil line. It does not invade leaves, flowers, pods, or seeds.

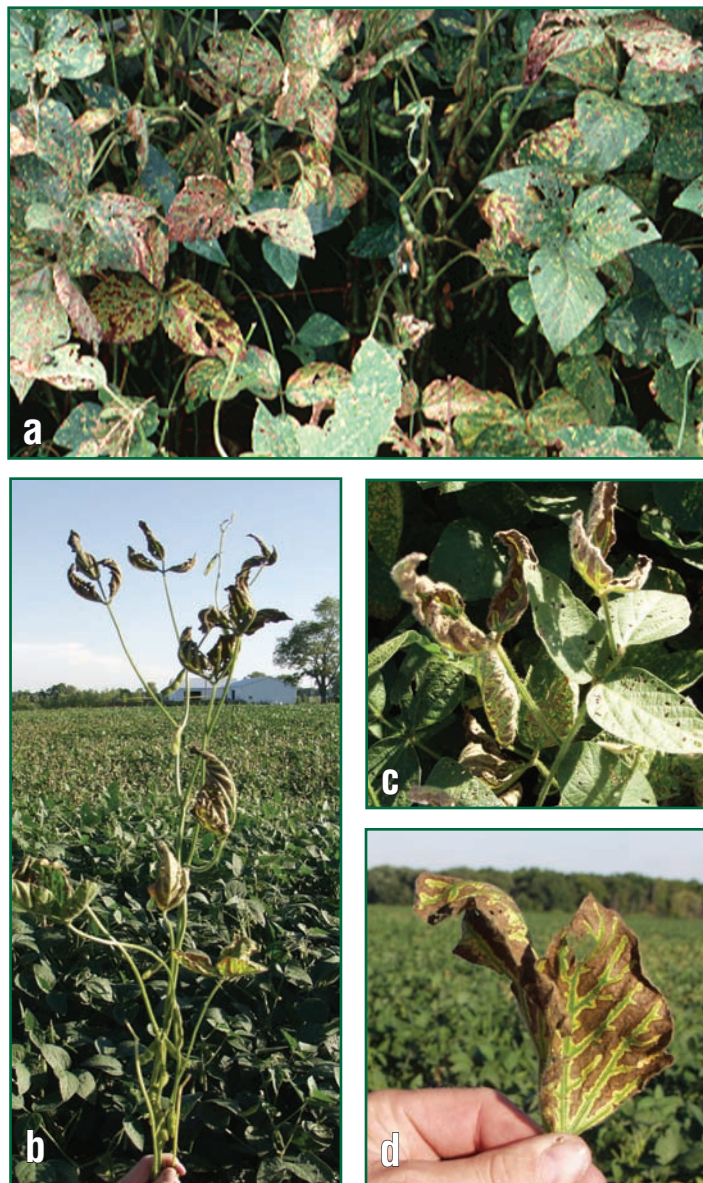


Figure 3. Foliar symptoms of SDS:

- (a) View into a soybean stand with SDS
- (b) Note the loss of leaf blades and that only the leaf stalks remain on this view of the entire plant
- (c) A view into a canopy with SDS-symptomatic leaves
- (d) Note the dead tissue and green leaf veins on this single leaf with SDS symptoms

Although the fungus may produce spores on the taproot's surface during the summer, these spores only spread short distances within a growing season. Over a period of years, flowing water and cultivation practices that move soil can move spores over longer distances, within or between fields.

Management

SDS management options are limited. Although soybean varieties less sensitive to SDS have been developed, there are no highly resistant varieties. Fungicides applied in furrow during planting or as seed treatments have only limited effects, and fungicides applied to foliage have no effect on SDS, presumably because the fungal infection is restricted to root systems and fungicides typically do not move downward in the plant to reach the site of infection. However, there are several management practices that may reduce the risk of SDS damage, although they will not prevent the disease:

Planting Date

Early planting predisposes soybean to infection. Farmers have been planting soybean earlier every spring for the past few years. In cool, wet soils, young soybean plants are vulnerable to infection by *Fusarium solani* f. sp. *glycines*. If early spring conditions are favorable for rapid soybean growth, and if saturating rains do not occur during early reproductive stages of growth, the SDS risk is limited even though the fungus is in the soil. Conversely, if there is no *Fusarium solani* f. sp. *glycines* in a field, the disease will not develop even though other conditions may be favorable. So growers should plant fields with no history of SDS first, then later move into fields where SDS has been a problem.

Tillage

Compacted soils impede water percolation and restrict root growth. A heavy rain when soybean has reached the reproductive stage will saturate compacted areas, which promotes SDS development. Correcting soil compaction and water permeability problems may reduce the risk for SDS. Tile drainage or tillage may improve permeability.

Soils react differently to tillage intensity. In some soils, no-tillage can be beneficial and increase soil water permeability. In other soils, tillage is mandatory for maintaining sufficient vertical water movement. Plowing, chiseling, or similar drastic soil disturbances strongly affect drainage, crop residue position, and the microbial composition of soil.

Reports on the effects of tillage on SDS are contradictory. Some reports suggest the benefit of intensive tillage to improve soil drainage, which should reduce the risk for soil saturation after a rain. Other reports show that the improved soil tilth and drainage capability under continuous no-till reduces SDS risk. Growers should focus on how to create the best drainage in soil — in some instances, that may require intensive tilling, and in other soil types this may be accomplished by adopting a no-till operation.



Figure 4. These leaves show a range of foliar SDS symptoms, from very light yellowing to severe interveinal chlorosis.



Figure 5. Root symptoms of SDS:

- (a) Note the discoloration and lack of secondary roots on the infected root system (left) compared to the healthy root
- (b) The split stem on the right is infected with SDS — note the light tan discoloration
- (c) Note the blue stains on the outside of this freshly dug root system, indicating the presence of sporulation of the SDS fungus

Rotation

There does not appear to be a rotation that significantly reduces SDS. In particular, corn does not reduce the incidence and severity of SDS, and severe outbreaks of the disease have occurred even after several years of continuous corn. However, crop rotation does reduce other soybean pathogens. It appears that shifting to two-year rotations of corn and soybean (compared to longer rotations that involved small grains and perhaps forages) has favored the buildup of populations of *Fusarium solani* f. sp. *glycines* and other soilborne soybean pathogens in Indiana fields.

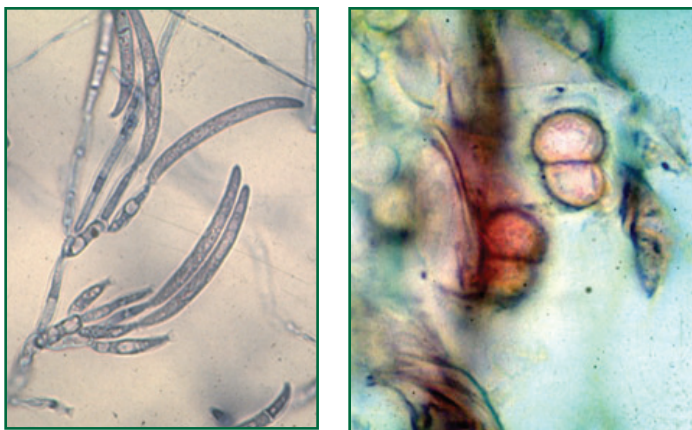


Figure 6. Spores of the SDS-pathogen:

(a) Numerous macrospores like these make the blue stain that's visible on the outside of soybean roots with severe SDS

(b) Chlamydospores are long-lasting and can survive in soil and plant debris

Purdue studies have found that soybean roots were not visually healthier after a rotation with corn compared to continuous soybean. When corn is grown in the field, soil-borne soybean pathogen populations may decline, but not enough to substantially reduce the problem when soybean is grown in the field the following year. Although a two-year rotation may hold soybean cyst nematode populations below threshold levels when its initial population is low, such a rotation appears to be too short to reduce populations of *Fusarium solani* f. sp. *glycines* during the year corn is grown. It is not understood why SDS can be severe even after several years of continuous corn.

Resistant Soybean Varieties

Soybean breeders are developing SDS-resistant varieties, but progress has been slow. While most seed companies have removed highly susceptible varieties from their inventories, no highly resistant varieties are available. Because seed companies continually introduce new varieties, and retire older ones, it is critical that growers seek accurate information about how each variety reacts to SDS. Read variety descriptions carefully, and

when looking at a variety described as resistant, ask seed dealers how extensively it was tested under conditions known to favor SDS.

Interactions with Other Soilborne Organisms

The combined action of *Fusarium solani* f. sp. *glycines* and soybean cyst nematode (SCN) will damage a soybean variety susceptible to both pathogens much more than either pathogen could on its own. Both pathogens are considered present in at least half of Indiana's fields.

Production practices that maintain SCN at low levels may reduce the risk for SDS, but much more work is necessary to better understand the nature of the interaction of the two pathogens. If a field infested with the SDS pathogen has not been evaluated for SCN, it should be, and if SCN is present, a management strategy for both pests should be implemented.

Conclusions

Growers should keep good field records of when and where SDS and other soilborne diseases occur. Growers also should map problem fields or areas within fields. Handheld GPS receivers work well, but even simple sketched maps will help record problem areas. Documenting problem areas will allow growers to determine if management practices are reducing problems, holding them steady, or are failing to provide suppression.

Fields severely affected by SDS should be earmarked for later planting when they are scheduled for soybean planting in the future, and every operation improving water permeability should be considered including compaction-correcting tillage or tile drainage. Finally, varieties with some degree of resistance should be planted in these fields.

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