Brown stem rot and sudden death syndrome: Can you tell them apart?

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Brown stem rot (BSR) and sudden death syndrome (SDS) are among the most important yield-reducing diseases of soybeans throughout Iowa. These diseases are easily confused because foliar symptoms are very similar (Figure 1). It is important to diagnose BSR and SDS correctly so that appropriate disease management practices can be applied. This article presents a review of each disease, provides guidelines on how to distinguish them, and describes available management options.

Figure 1. Foliar symptoms of BSR (left) and SDS (right) can be very similar, and splitting of stems is essential to properly diagnose the two diseases.

Importance

BSR is prevalent in most soybean fields in the north- central United States, and yield losses of 5 to 30 percent can be common. In Iowa, BSR is prevalent in most counties. SDS is present in all soybean-producing areas of the United States, and yield losses can range from negligible to severe, depending on disease onset and severity. SDS first appeared in Iowa in 1993 and since then has continuously increased in severity and spread to most counties in the state, although it is most prevalent in the eastern and southeastern counties.

Disease Cycle

BSR is caused by the soilborne fungus *Phialophora gregata*. The fungus enters the plant through the roots and grows inside the vascular tissue of the soybean plant to colonize stems and leaves of soybeans. The fungus survives in infected soybean debris and does not produce any long-term survival structure. BSR is more severe when temperatures are cool and adequate soil moisture is present early in the growing season. Foliar symptoms are particularly sensitive to environmental conditions during reproductive growth stages, and they are suppressed when temperatures are high during these stages.

SDS is caused by the fungus *Fusarium virguliforme* (previously known as *F. solani* f.sp. *glycines*). The fungus infects the roots and base of the stem but has never been found in aboveground plant parts. Foliar symptoms are caused by one or more toxins that are produced by the fungus in the roots and moved up the plant to the foliage. The pathogen can survive in soybean debris and soil for many years, even in the absence of soybean plants. Cool soil temperature and high moisture are critical for disease development, and soil compaction has been associated with increased disease severity.

Symptoms and Signs

BSR causes both stem and, depending on the genotype (genetic type) of the pathogen, foliar symptoms. There are two genotypes of the pathogen.

Genotype A causes internal stem browning and severe foliar symptoms on susceptible soybeans, whereas genotype B causes only internal stem browning and mild or no foliar symptoms on most soybeans.

Figure 2. Internal stem discoloration is the characteristic symptom of BSR.

Browning of the vascular tissue and pith (Figure 2) are diagnostic symptoms of BSR and are caused by both genotypes of the fungus. Browning starts in the root and progresses up the stem as the disease progresses. In the early stages of symptom development, browning may be discontinuous and appear only at nodes throughout the stem. Foliar symptoms are characterized by interveinal yellowing and browning of the leaf (Figure 1a). Similar to most soilborne diseases, BSR usually occurs as small patches of yellow stunted plants within a field. More importantly, soybeans can be colonized by both genotypes of the BSR fungus without showing stem or foliar symptoms. Consequently, yield loss due to BSR can occur without being attributed to this disease.


Figure 3. Soybean root with blue masses of the SDS fungus.

SDS causes both foliar and root symptoms. Symptoms can appear during vegetative stages but are most commonly seen during the early reproductive growth stages through pod fill. Foliar symptoms (Figure 1b) start as scattered, interveinal chlorotic spots that enlarge into chlorotic and necrotic streaks. Severely affected leaflets drop off, leaving the petiole attached to the stem. Infected roots show a tan to light brown discoloration of external (cortex) and internal (vascular) tissues, and blue masses of spores may be seen on the taproot under moist soil conditions (Figure 3). Similar to BSR, roots may be infected with the SDS pathogen without showing foliar symptoms. This may be because root colonization is limited to the cortex of the root, and therefore, the toxin cannot be transported up the plant to cause foliar symptoms.

How to distinguish BSR from SDS. Foliar symptoms of both diseases are very similar (Figure 1) and also can be easily mistaken for early crop maturity or drought stress. The best way to distinguish the two diseases is to split the stems and look for the presence of internal stem browning. Only BSR will cause browning of the pith (Figure 2), while the pith of plants affected by SDS will remain white. In addition, only SDS will cause root rot, and under moist soil conditions, blue masses of spores produced by the fungus can be seen on the root surface (Figure 3).

Interaction with Soybean Cyst Nematode (SCN)

The widespread distribution of the causal agents of BSR, SDS, and SCN can result in co-occurrence and interactions among these pathogens. The incidence and/or severity of both BSR and SDS increases in the presence of SCN. Increasing BSR severity is most pronounced in SCN-susceptible cultivars, but cultivars with resistance to both SCN and the BSR pathogen also can be affected. The interaction between SDS and SCN is not fully understood, but research has indicated that SDS occurs earlier and severity is higher in the presence of SCN than with the fungus alone.

Management

The use of resistant cultivars is the most effective approach to manage both BSR and SDS. In addition, SCN management should be seriously considered due to the important interaction of this nematode with both diseases. Other measures like tillage, crop rotation, and delayed planting will reduce BSR, while tillage and delayed planting may help reduce SDS.

Resistant cultivars

Resistant cultivars with dual resistance to BSR and SCN are available. Soybean cultivars with PI 88788-derived SCN and BSR resistance have been shown to be resistant to genotype A of the BSR fungus and can be used for managing both BSR and SCN. Cultivars with Peking- and Hartwig-derived SCN resistance may be susceptible to BSR and growers are advised to ask seed suppliers which cultivars derived from these sources also have BSR resistance. Growers also are strongly advised to get their fields tested for level of SCN infestation.

Many commercial cultivars with resistance/tolerance to SDS are available particularly in later maturity groups (III-V). Options are still limited for the earlier maturity groups, but promising new advances have been made to obtain resistance for Iowa growers. Iowa State University will be releasing a resistant cultivar of maturity group II (AR03-263051) that will be available to growers in 2008. In addition, two germplasm lines will be available in 2007 for breeders to incorporate resistance into lines and cultivars for Iowa. When available, growers should select cultivars that have resistance to both SDS and SCN.

Tillage

Both BSR and SDS are more prevalent in no-till fields. No-till fields contain more crop residue, which allows increased fungus survival, and have lower soil temperatures and higher soil moisture levels, which favor infection by both BSR and SDS. Thus, tillage can reduce the risk of both BSR and SDS by increasing soil temperatures and reducing moisture and aiding decomposition of crop residue.

Crop rotation

Soybeans are the only known host of *P. gregata*, so rotation with other crops such as corn, alfalfa, or small grains effectively decreases pathogen levels and reduces BSR severity. A longer rotation, two to three years out of soybean, may be necessary in fields where the disease has been particularly severe. In contrast, SDS does not appear to be reduced by crop rotation. Although limited information is available, field observations suggest that the SDS pathogen can survive in soil for many years in the absence of soybeans, and risk of disease remains high even after several years of corn.

Planting date

Infections by both the SDS and BSR pathogen are favored by cool and moist soil conditions. Delaying planting will therefore reduce disease risk by reducing the period in which roots are exposed to favorable conditions for infection.

However, since growers need to consider the effect of late planting on soybean yield, it is recommended that fields with a history of SDS or BSR are planted last.

Current Research at Iowa State University

Current BSR research focuses on generating information that will lead to more effective BSR management and includes determining the impact of genotype B of the BSR fungus in reducing soybean production in Iowa and learning how this strain of the fungus interacts with SCN and SCN-resistant soybean cultivars in reducing soybean yields. Research is also being conducted to determine how widespread the two genetic types of the BSR fungus are in Iowa. Also, BSR-resistant soybeans are being developed from new sources of resistance.

Several areas of SDS research are currently being pursued at ISU. Soybean lines of maturity groups I, II, and III are being developed with resistance to SDS. Epidemiological studies are aimed at understanding the factors responsible for the highly variable nature of SDS symptom expression. These factors include pathogen levels in soil needed for symptom expression, susceptibility of roots to infection at different plant growth stages, interactions of SDS with SCN and other root rot pathogens, effect of post-infection environmental conditions, and genetic variation within pathogen populations. Research is underway to determine the importance of fungal colonization of cortical and vascular root tissues for disease development; the toxin produced by the SDS pathogen is also being characterized. BSR and SDS research is supported by Iowa Soybean Association.

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