Managing Sudden Death Syndrome of Soybeans

Sudden death syndrome (SDS) of soybeans has spread to soybean fields in almost all soybean-growing states and Ontario, Canada. SDS favors poorly drained and/or compacted field areas that remain wet and seasons with high rainfall. SDS continues to spread to new fields and progressively larger areas of infected fields each year. In fact, plant pathologists in many states now rank this disease as second only to soybean cyst nematode (SCN) in economic losses caused to soybeans.

SDS is caused by a virulent strain of the common soil-inhabiting fungus *Fusarium solani* (also called *Fusarium virguliforme*). This root-rotting organism infects soybean plants very early in the growing season, often as early as germination to just after crop emergence. However, above-ground symptoms occur much later when the fungus produces a toxin that damages the leaves. This article will discuss the environmental conditions leading to SDS development, the symptoms it causes in soybeans, and the management strategies growers can use to limit its damage to the crop.

Conditions Favoring SDS Development

Like other soil-borne root rots, SDS often appears first in certain spots in the field, such as low, poorly drained or compacted areas. In some cases, severe SDS outbreaks can also occur on highly productive soils with high moisture-holding capacity. Because disease severity is highly dependent on environmental conditions, time of infection and other stresses on the soybean crop, it varies from year to year and within field areas. Higher incidence of SDS often occurs when soybeans have been exposed to cool, moist soil conditions early in the growing season. Early planting is therefore much more likely to predispose the crop to SDS.

Though SDS infects soybean plants just after germination and emergence, symptoms usually do not appear until reproductive stages (typically mid-summer). The appearance of symptoms is often associated with weather patterns that bring cooler temperatures and significant rainfall to an area during flowering or pod-fill. First symptoms are often noticed about 10-14 days after heavy rains that saturate soils. Wet soils allow toxins to be produced by the fungus in the roots of the plant, which are then translocated to the leaves. These toxins are responsible for the striking foliar symptoms of SDS, even though the fungus itself remains in the roots and base of the stem and does not invade soybean leaves, flowers, pods or seeds.

SDS symptoms are usually more severe if SCN is also problematic in the field. SCN increases the stress on the soybean plant and also provides wounds through which the SDS pathogen can enter the roots.

SDS Life Cycle and Symptoms

The *Fusarium solani* fungus that causes SDS survives in crop debris and as mycelia in the soil. The organism enters soybean roots early in the growing season. Root infection is facilitated by wounds from SCN, insect feeding, and mechanical injury. The fungus colonizes the soybean root system and has been isolated from both the taproots and lateral roots, but is not found above the crown of the plant. A toxin produced by the fungus and translocated throughout the plant is responsible for above-ground symptoms.

Root and Stem Symptoms

SDS begins as a root disease that limits root development and deteriorates roots and nodules, resulting in reduced water and nutrient uptake by the plant. On severely infected plants, a blue coloration may be found on the outer surface of tap roots due to the large number of spores produced. However, these fungal colonies may not appear if the soil is too dry or too wet. Splitting the root reveals that the cortical cells have turned a milky gray-brown color while the inner core, or pith, remains white. The general discoloration of the outer cortex can extend several nodes into the stem, but its pith also remains white.

Figure 1. SDS-infected stem and root. Note blue mold at soil line.

Leaf Symptoms

Leaf symptoms of SDS first appear as yellow spots, usually on the upper leaves, in a mosaic pattern. The yellow spots coalesce to form chlorotic blotches between the leaf veins. As these chlorotic areas begin to die, the leaf symptoms become very distinct, with yellow and brown areas contrasted against a green midvein and green lateral veins. Rapid drying of necrotic areas can cause curling of affected leaves. Leaves drop from the plant prematurely, but leaf petioles remain firmly attached to the stem.

Figure 2. Symptoms of SDS infection on soybean leaves.

Whole-Plant Symptoms

As plants lose leaf area and roots deteriorate, yield components are affected. Flower and pod abortion are common, resulting in fewer pods and seeds produced. Seeds that do develop are usually smaller. Later-developing pods may not fill, or seeds may not mature. Because plants and pods dry down faster, harvest losses may also increase in SDS-infected plants. Severity of yield reduction is highly dependent on the growth stage of the soybean plant when infection and symptoms occurred. In some cases, premature death of the entire plant can occur without the typical defoliation symptoms, as affected plants yellow and die gradually.

Distinguishing SDS from Other Diseases

Leaf symptoms of SDS are similar to both brown stem rot (BSR) and stem canker. However, there are several characteristics that readily differentiate these diseases. To distinguish SDS from the other two diseases, first examine the outside of the stem. If the outside of the stem has large brown-black sunken lesions, then it is likely stem canker. If no lesions are present, split the bottom 8 inches of the soybean stalk. If SDS is the problem, the pith (inner core) of the stem will be white, and the surrounding cortex will appear grayish-brown. In contrast, BSR will cause the pith to be dark brown while the cortex remains green.

Management of SDS

Sudden death syndrome varies in severity from area to area and from field to field. Therefore, growers must clearly understand the extent of SDS infection in each of their fields to effectively manage the disease. This requires scouting fields when disease symptoms are present, ideally using GPS tools to map SDS-prone areas. Such maps could be overlayed with yield maps to reveal the extent of yield losses from SDS.

Once the scope of the problem is documented, a combination of crop management practices can help minimize the damage from SDS. These include selecting SDS-tolerant varieties, planting the most problematic fields last, managing SCN, improving field drainage, reducing compaction, evaluating tillage systems, and reducing other stresses on the crop.

Foliar Fungicides Not Effective

Although foliar symptoms and defoliation are trademarks of SDS, the fungus itself does not spread to the leaves. Rather, the fungus produces toxins that are transported to the leaves, while the fungus only colonizes the roots and base of the stem. For this reason, foliar fungicides are not effective in reducing damage to soybeans from SDS.

Scouting Fields

Scouting for SDS involves identifying suspect plants based on leaf and whole plant symptoms and then looking closer at the stem and roots to distinguish SDS from other soybean diseases (see previous section on symptoms). SDS is evident from a considerable distance when full-blown above-ground symptoms develop. This usually occurs in August in the Midwestern U.S.

Tolerant Soybean Varieties

Soybean varieties can show dramatic differences in tolerance to SDS infection with tolerance exhibited primarily as a reduction in symptom severity. For that reason, variety selection is a key management practice to reduce plant damage and yield loss due to SDS. To assist growers in choosing resistant varieties, Pioneer researchers rate products in multiple test sites with known historical SDS occurrence. These sites (located in three states) are irrigated and/or planted early to encourage SDS development. Tolerance data are collected and analyzed across years to determine the appropriate SDS tolerance score. Due to continued improvements in breeding for this trait, Pioneer now has varieties that score as high as "8" for SDS tolerance on a 1 to 9 scale (9 = most tolerant).

Pioneer research efforts are providing higher levels of tolerance to SDS in elite varieties that also contain other traits critical for top soybean yields, including SCN resistance. See your Pioneer representative for help in selecting varieties with the right combination of traits for each of your fields.

Planting Sequence

Although many growers today are reluctant to delay planting when fields are ready, research has demonstrated later planting to be effective in reducing SDS occurrence. For this reason, growers should at least consider planting high-risk fields last in their planting sequence. If this delays planting for one or two weeks, the impact on SDS occurrence could be significant. To effectively schedule planting in order of lowest to highest SDS risk, growers should have scouted and documented the extent of SDS infection in each of their fields.

Managing Soybean Cyst Nematode (SCN)

SCN is a problem requiring management in many soybean fields that are also at risk to SDS. SCN increases the stress on the soybean plant and also provides wounds through which the SDS pathogen can enter the roots. Scientists have also discovered the SDS pathogen can be carried in SCN bodies. This means that managing SCN and limiting its stress on the soybean plant is critical to also limiting damage due to sudden death syndrome.

Like SDS, SCN cannot be eradicated from an infested field. But planting SCN-resistant varieties, rotating crops and rotating sources of SCN resistance can reduce SCN populations in the field. Keeping SCN numbers below levels that will cause significant yield loss is the primary goal of SCN management. In addition, any practice which promotes good soybean health and growth will also help against SCN.

Improving Field Drainage and Reducing Compaction

Improving field drainage and reducing compaction go hand-in-hand, as wet areas are easily compacted, and compacted areas stay wetter due to restricted soil drainage. In these field areas, soybean roots are inhibited by compaction, saturated soils and the effects of the disease. This often leads to severe yield reductions if dry soil conditions develop in mid to late summer. For that reason, growers should strive to improve field drainage and remediate compacted areas as a high priority to reduce the effects of SDS.

Evaluating Tillage Systems

A study conducted at the University of Missouri showed that no-till systems resulted in much higher percentages of SDS-infected leaves than disking or ridge-till with both May and June planting dates. High crop residue levels are known to result in colder, wetter seedbeds in the spring. In fields with high levels of SDS infection, growers may want to re-evaluate the tillage system they are using.

Reducing Other Stresses

Other plant stresses can render soybeans more vulnerable to SDS attack. These include herbicide stress, nutrient deficiencies, high pH and pest pressure. Maintaining adequate soil fertility, reducing compaction and controlling weeds, diseases and insects all improve soybean growth and plant health and enable the plants to better withstand the effects of sudden death syndrome.