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Biology and Management of Premature Yellowing and Death of Soybean Caused by Phomopsis Idiaporthe Fungi

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In recent years, there is an increasing interest in premature yellowing and death of soybean during a growing season. To some growers, premature yellowing soybean has become a production problem to their efforts to stabilize yield. We have received more and more questions why soybeans turn yellow prematurely. Few years ago, the problem was mainly from eastern Iowa and now soybean samples submitted to ISU Plant Disease Clinic come from every region of Iowa. People have called such a problem top dieback or tip blight. Typical symptoms of diseased plants are yellowing of top leaves, often followed by brown margin on the leaves. The problems are caused by a group of closely related fungi, which can cause Phomopsis seed decay, top-dieback, pod and stem blight, and northern stem canker. This article discusses the biology and management of this disease.

History of the disease

The disease is not new to soybean pathologists and soybean growers in Iowa as well as in the north central regions. The diseases caused by this group of fungi were major production problems in about 20 years ago in the north central region. During that time, there was a major research initiative on the diseases caused by Phomopsis and Diaporthe fungi, which generated great amount literature on this disease complex. At Iowa State University, extensive studies were done on Phomopsis seed decay and seedborne aspect of this disease. For nearly 18 years, the disease was not a production concern. Over the last few years, soybean top die back (also called tip blight) re-emerged as a production concern in eastern and central Iowa and other states of north central regions, such as Illinois, South Dakota, and Wisconsin.

Causal fungi

The majority cases of premature yellowing are caused by Phomopsis/Diaporthe complex, a group of genetically closely related fungi. These fungi are common fungus in soybean production. Diaporthe is the name for the fungi when their sexual/reproductive stage in their life cycle have been found. Phomopsis is the name for fungi that do not have reproductive stag in their life cycle. For Diaporthe, the name Phomopsis also is used to refer to non-reproductive stage of fungi. In the reproductive stage when ascrospores are found, the fungus is called Diaporthe. Several closely related species of Phomopsis/Diaporthe have been found to attack soybeans and cause different diseases. Names of fungi in Phomopsis/Diaporthe complex are:

- Diaporthe phaseolorum var. sojae (DPS)
- Diaporthe phaseolorum var. caulivora (DPC)
- Diaporthe phaseolorum var. meridinalis (DPM)
Phomopsis lonicolla
Phomopsis phaseoli

Because there are still much unknown on the genetics of this group fungi, Phomopsis/Diaporthe complex is used to simplify the communication in literature.

**General Disease cycle**

Disease cycle is a key information on pathogen biology and key information to manage the disease. For diseases caused by Phomopsis/Diaporthe, inoculum can be seedborne and also can survive in infested residues. Spores of this fungal complex are abundantly reproduced from infested residues during a growing season in fields having a disease history. For an uninfested field, infected seeds serve as the introduction of the inoculum. In a regional based, inoculum for epidemics that cause severe yield reduction is most likely from infested residues.

After planting, when conditions are inducive, fungi can infect plants from seedling stage to later reproductive stages. When infected seeds are used, the fungi infect seedlings but the level of transmission from infected seeds to infected seedling varies by fungi. The disease symptom may not be seen after infection, which is called latent infection. Stress can enhance the expression of disease symptoms. Depending on time of infection and type of fungi attacking soybeans, the disease problems are further grouped as pod and stem blight, top die-back, and stem canker.
**Type of diseases**

*Pod and stem blight.*  
Field patterns of this disease can be misidentified as sudden death syndrome. Disease lesions are first found at nodes. Lesions produce spores to cause further infection. When pod and stem blight occurs, dark lesions are found in pod, petioles, and nodes of stem late in the season. Upper portion of an infected plant turns yellow and dead. If pod infection is severe, seed decay after harvest by the fungi may happen. Cool summer and delayed planting are favorable for this disease.

*Phomopsis Seed Decay*  
Phomopsis/Diaporthe is widely present in fields where soybean has been grown. The fungi are also seedborne and can be introduced into production fields when infected seeds are planted. Therefore, there are two possible sources of inoculum, infected seeds and infested debris from previous soybean crops. The potential damage of using severely infected seeds is through risk of seedling damping-off. If inoculum are in the form of spores produced from soybean debris of previous growing seasons, the spores can infect young seedlings and symptoms can be found before the first trifoliate stage (V1). Infected seedlings are first seen to have dark lesions on the cotyledons. In severe cases, more than 90% of the seedlings can have infected cotyledons. If the infected cotyledons drop, no subsequent seedling damping-off occurs. The fungus then remains in the plants without showing symptoms unless plants become stressed in later, reproductive stages. The fungi infect pods and seeds which often are small and shriveled at harvest. Seed decay may occur during storage and such seeds have a reduced germination rate.

*Top dieback*  
Top die-back was first documented by Shmitth henner's lab in 1981 in Ohio (Plant Disease 65:618-620). Shmitthhenner and his colleagues demonstrated that infection by stem canker fungus in top of soybean plants resulted in top die-back while infection in lower stems results in stem canker. In most books, top die-back is described in chapter for stem canker. The symptoms occur after the middle of August.

Top dieback shows up after mid-August in fields of having apparent health growth before disease shows up. Initial symptoms of top dieback are yellowing and death of leaves in the upper portion of the plant canopy followed by discoloration of internodes. Follow the death of new growth, leaves in the upper portion of the plant canopy followed by discoloration of internodes. Plants die prematurely when the disease is severe.

Top dieback has initial symptoms of yellowing in new growth of leaves. Symptom on new growth is similar to K deficiency. Symptomatic plants sometimes are in rows with normal height and low level of K may enhance the disease. Infected seeds often are small and shriveled on these plants. Plants under stress will have more severe symptoms. A preliminary study has indicated that symptoms of this disease may invoke nutrient deficiencies in soybeans.
**Stem canker**

The first symptoms of northern stem canker also become visible in August. The fungus causing this disease is referred to as *Diaporthe*. The same fungus causing top dieback also causes northern stem canker. The disease is different from top dieback in that lower nodes of infected plants have lesions which do not have well defined. On these lesions, the typical *Phomopsis* symptoms are present, such as black pycnidia arranged in conspicuous lines. Infected plants, noticeable because of leaf necrosis at the top of the plant, may be scattered or found in patches within the fields. A patchy distribution of diseased plants suggests that inoculum is from infested residue and that this disease has been in the fields for years.

**Management options**

Because this genetically closely related fungi require similar environmental conditions in growth and survival, management options are similar for all these diseases. First, use pathogen-free seeds. Recent years, seed lots with high level of *Phomopsis* infection have been detected as results of increase prevalence of this disease. In 2001 season, we found fields which had *Phomopsis* infected seeds as high as 50 percent. One should not avoid saving seeds from fields where the disease level was high. Otherwise, check seeds for *Phomopsis* infection.

Scouting disease is important to prevent from saving infected seeds and to get management information for next crops. Scouting may start at seedling stages if excessive rainfall occurs. If you find fields with high levels of infection on the cotyledons, keep an eye on these fields in mid-August for foliar symptoms. Prevention of the introduction of the fungi into a field is not a recommendation as the fungus is everywhere, although one should avoid using infected seeds to reduce the risk of damping-off. Avoid practices which stress soybean plants as stress enhances top dieback. Because the pathogen survives in infested soybean residues, use tillage practices to bury infested soybean residues if the diseases were severe.

In early 80’s, several studies by agronomists reported on the effects of K on the severity of *Phomopsis*. In these studies, different levels of K were applied to soybean fields infested with the *Phomopsis*. Most papers reported that K deficiency enhanced disease severity which was measured as percentage of infected seeds. Studies show that application of K suppressed the disease. One study showed no difference between disease levels after K application, however. Therefore, one can check K level for a field where top die-back is found.

**Yellowing not caused by Phomopsis/Diaporthe**

Some yellow soybean samples we received at ISU Plant Disease Clinic did not fit into diseases caused by *Phomopsis/Diaporthe*. After visited many problematic fields and examined these samples, we found other factors can also caused yellowing and premature death and the problems can be grouped as follow.

The first group of yellowing is from damage of soybean cyst nematodes or by soybean aphids. Often, yellow soybeans are short and aggregated in patches. Great number of cysts of SCN can be found on the roots. Reports for these cases are often from regions where damage by SCN is
relatively new or has not been previously reported. In northeastern Iowa, severe damage by soybean aphids has also been associated with symptoms similar to top die back. For this case, soybean leaves are fully covered with aphids.

The second group of premature yellowing is result of fungal root rot, caused by *Fusarium*, *Rhizoctonia*, or *Phytophthora*. For this group, yellowed soybeans are stunted and aggregated in patches in lower areas of a field. Plants have poor root systems with a discolored tap roots due to fungal infection. Like plants infected by SCN and aphids, plants affected by these fungi remain stunted in the rest of seasons.