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DISEASES OF SOYBEAN

Charcoal Rot

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Charcoal rot is a widely distributed disease of soybean (Figure 1). It is also called summer wilt or dry weather wilt because it often occurs when plants are under heat and drought stresses. These stresses can also occur in irrigated soybeans if water is withheld during critical plant growth stages after the beginning of flowering. Despite its wide distribution, charcoal rot is less of a concern for soybean of the Midwest than in some other regions because drought is less common here. But the disease can develop if August and September are hot and dry.



Figure 1. This image shows a soybean field affected by charcoal rot.

Photo provided by John Rupe, University of Arkansas

Symptoms

Symptom expression depends on the soybean plant's growth stage at the time of infection. An early symptom is the appearance of a reddish streak along the hypocotyl. The disease also may kill the growing point at the tip of the stem, resulting in "twin stems," or two stems instead of one. Seedlings can be infected early in the season, but symptoms do not develop until plants reach reproductive stages, and then only if heat and drought stress the plants.

Later in the season, infected plants will lose vigor and may die prematurely. Leaflets turn yellow, then die and shrivel, but remain attached to the plant (Figure 2). A high proportion of plants in some areas of the field may be affected, while plants in other areas appear healthy.

The most diagnostic feature of charcoal rot is a gray speckling within the lower stem (Figure 3). These speckles are microsclerotia — tiny black masses of fungal tissue — that can be seen best with a good hand lens. Positive identification of the microsclerotia distinguishes charcoal rot from similar diseases that also cause rapid soybean death with retention of dead leaves, for example, brown stem rot, *Sclerotinia* stem rot, and *Diaporthe* stem canker.

Microsclerotia are the primary means by which the fungus survives in soil, but the fungus also can invade and survive in seed. Infected seed may crack and



Figure 2. A single soybean plant with charcoal rot symptoms.

Photo provided by John Rupe, University of Arkansas

shriveled, and microsclerotia may form in fissures. Microsclerotia can last for several years in dry soil.

Causal Agent

Charcoal rot is caused by *Macrophomina phaseolina*. This fungus has a very wide host range, including corn, various broadleaf and grass weeds, and some vegetable crops.

Disease Cycle

Macrophomina phaseolina may already be in a field when soybean is planted, or may be introduced with contaminated seed. Microsclerotia can survive for up to two years in dry soil, but are short-lived in wet soil, which may be an important reason why charcoal rot is a minor problem in the eastern Corn Belt. Experience in Kansas with fumigation suggests that there is no threshold for this pathogen. If conditions are highly favorable, it takes little inoculum to cause charcoal rot. The fungus can sustain itself in the soil by growing on available nutrients in soil or by infecting weed hosts.

When it is introduced into production fields with seeds, the fungus breaks dormancy as the seedling starts to germinate and infects the tender seedling. Whether the fungus is already in a field, or is introduced on seed, it infects the roots and ultimately invades the conductive tissue where it produces microsclerotia. The microsclerotia eventually interfere with water transport in the plant.

In severe cases, the seedling may die before it reaches the soil surface. If the seedling survives this early infection, it may be weakened, and if there is drought during reproductive stages (R1-R7), the plant will develop typical top symptoms. After a plant dies, the microsclerotia rest in plant debris until another susceptible host crop is planted.

Management

Management strategies are aimed at reducing the numbers of microsclerotia in soil. Although there are few



Figure 3. This image shows a soybean stem with microsclerotia of *Macrophomina phaseolina*, the fungus that causes charcoal rot.

Photo provided by Jack Walters, University of Arkansas

soybean lines with resistance, development of resistant germplasm is under way in the South. When possible, use cultivars less sensitive to charcoal rot in fields with a history of charcoal rot and use clean seed.

Planting

Excessively dense plantings will increase drought stress when water becomes limiting.

Tillage

Tillage system apparently has no effect on charcoal rot.

Rotation

Several years of grass crops (either corn or small grains) are necessary to reduce the charcoal rot risk in severely infested fields. Although corn is a host, the microsclerotia numbers will still be

reduced under this crop. It will require at least three years without a soybean crop before microsclerotia levels are low enough to plant soybean again. Once the numbers of microsclerotia are low, a rotation of one year of soybean with one year of corn may keep microsclerotia numbers at low, sustainable levels.

Resistant Soybean Varieties

Some resistance sources have been identified and probably are incorporated into soybean varieties. In the Midwest, few seed dealers will have full information on charcoal rot ratings. However, if particular fields have a considerable problem, seek more information when choosing a variety.

Chemical and Biological Control

Some studies have addressed the usefulness of chemical seed treatments. Although reduced numbers of microsclerotia have been found after fungicide treatments under artificial greenhouse conditions, no positive disease-reducing effects have been reported under field conditions.

