Managing Phytophthora Root and Stem Rot of Soybeans

CROP BULLETIN

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KEY POINTS

- Phytophthora is a disease of extended wet field conditions. Such conditions may occur in any field but are most common on heavy soils.
- Phytophthora may attack soybeans at any time during the growing season. The disease displays a seed rot phase, a seedling blight phase, and a root and stem rot phase.
- Selecting varieties with specific race resistance or field tolerance is the primary means of combating Phytophthora.
- Varieties with specific race resistance provide a high level of protection but may lose effectiveness if Phytophthora races change. Tolerant varieties provide protection against all races of Phytophthora.
- Other management practices include improving field drainage, remediating compaction and hardpans, planting fields when soils are warm, and using seed treatments.

IMPACT ON SOYBEANS

Phytophthora is a soybean disease associated with wet soil conditions commonly occurring on heavy, poorly drained, or compacted soils. However, if normally well-drained fields are saturated for an extended period due to heavy rainfall or even excessive irrigation, Phytophthora can infect those fields as well. The ideal temperature for infection is 60 to 80°F. Disease severity is highly dependent on environmental conditions, Phytophthora races in the field, and genetic resistance or field tolerance of the soybean variety. Depending on those factors, yield reductions can range from as little as 5% to over 50% when infection occurs in a field. When early infection results in severe seed rot and damping off of seedlings, replanting is a common outcome. This article will describe the stages and symptoms of Phytophthora on soybeans and how to minimize its effects by use of genetically resistant and field tolerant varieties and employing other management practices.

DEVELOPMENT AND SYMPTOMS

Phytophthora may attack soybeans at any time during the growing season. The seed rot phase may affect soybeans as soon as seeds imbibe water and swell. The seedling blight phase may occur prior to emergence or during early seedling growth. The root and stem rot phase may occur any time throughout the summer.

Seed Rot Phase

Soybeans seeds are at risk to Phytophthora as soon as seeds begin the germination process. Infected seeds are dark brown and soft to mushy. Severe infection at this stage may result in complete deterioration of the seed. Seed rot is most common when soils become saturated immediately after planting, conditions remain wet, and temperatures are optimum for disease development.

Seedling Blight Phase

The seedling blight phase of Phytophthora may infect plants during the emergence process or shortly thereafter. Severe infections can result in rapid decay, wilting and death of the just-emerged seedling, commonly referred to as “damping off”. Symptoms include a dark brown to black discoloration of the stem, usually beginning at the soil line. Diseased tissues quickly become soft and water-soaked and wilting and plant death may soon follow. Seedling plants may also succumb to Phytophthora at later stages.

Another soil pathogen, Pythium, can also result in seed rot and damping off. Pythium is the more active of these two pathogens from 50 to 60°F. Above 60°F, Phytophthora is more active.

Root and Stem Rot Phase

Because the Phytophthora fungus is a soil-borne organism, infections begin in the root of the plant and then progress into the lower stem. Infections may eventually kill the soybean plant outright or may just weaken it to varying degrees. Even if plants survive, productivity is often greatly reduced compared to that of healthy soybean plants.

Root symptoms include brown, discolored secondary roots and an overall reduction in root mass that allows the plant to be easily pulled from the ground. The main tap root is also brown on the surface, and splitting the root reveals a tan discoloration of the inner tissues. Nodulation is often minimal on the roots, and this is expressed as light-green plants above ground. Plants may also be stunted, resulting in fields with an uneven appearance. Root damage results in wilting of the plant during periods of stress.

Figure 1. Dark-brown lesion on lower stem is a key symptom of Phytophthora.

If the root infection spreads into the stem, a brown discoloration begins to develop at the soil line. Eventually, a dark brown to red-brown lesion may progress several nodes up the stem from the base of the plant. This girdling lesion is one of the key diagnostic features of the stem rot phase of Phytophthora. However, disease progression may not reach this stage when infection is moderate or begins later in the season.

Above-ground symptoms of Phytophthora may not be evident for several weeks after initial infection. Often, a period of drought stress is required before diseased plants begin to show the effects of reduced root systems and inadequate water transport capability within the stem. Symptoms progressing from the bottom to the top of the plant include leaves wilting followed by petioles drooping. As plants reach the permanent wilt stage, leaves may develop a grayish cast followed by yellow spots.

MANAGEMENT PRACTICES

Variety Selection

Phytophthora is a highly diverse organism – over 70 different races have been identified throughout the US. In a given field, many different races are represented in the Phytophthora population, with one or two of these being the most dominant (most frequently occurring). A field population of Phytophthora is dynamic – it is constantly changing in response to climate and soil conditions, varieties grown, crop rotation and other factors.

Genetic resistance bred into soybean varieties is race specific. This means it is able to defeat certain races but is overcome by others. When the dominant race in a field shifts it may overcome the resistant soybean varieties developed for an area. Soybean breeders must then find a new source of resistance to defeat that race and incorporate it into new varieties. This illustrates the drawback of race-specific resistance – it may eventually lose its effectiveness as Phytophthora populations change. In fact, use of the same resistance gene continually will eventually cause a race shift that reduces the effectiveness of the gene.

Another type of genetic protection against Phytophthora is known as "field tolerance". This term is alternately referred to as "tolerance", "partial resistance", and "rate-reducing resistance" by various researchers and seed companies. Field tolerance is not race-specific – it is effective against all races of Phytophthora. This type of protection is more enduring over time than that offered by specific resistance genes, which may eventually need to be replaced.

Varieties containing both genetic resistance and field tolerance have two mechanisms of protection. In areas where a resistance gene is beginning to lose its effectiveness, the additional protection afforded by the field tolerance trait is very useful. A difference in field tolerance is often the reason that two competing varieties, each with the same resistance gene, may perform very differently in the field.

The effectiveness of several common resistance genes to 25 races of Phytophthora is shown in Table 1. (Phytophthora races differ from area to area, and new races emerge as the most dominant in an area. For that reason, the races indicated here may not be the most important ones for your area.) Researchers evaluate soybean varieties in hundreds of environments throughout North America. These researchers are developing new varieties with the appropriate resistance genes for each area, as well as incorporating higher levels of field tolerance into new varieties. Your local sales professional can help you select the appropriate Phytophthora resistant or tolerant varieties for your fields.

Table 1. Effectiveness of several resistance genes against various races of Phytophthora (green = effective.)

Race of Phytoph.	Resistance Gene (Rps)						
	1a	1b	1c	1k	3	4	6
1	■	■	■	■	■	■	■
2	■		■	■	■	■	■
3		■	■	■	■	■	■
4		■		■	■		
5		■		■			
6		■	■	■			
7		■	■	■	■		
8		■	■	■	■		
9		■	■	■		■	■
10	■		■	■	■		
11	■		■	■		■	■
12						■	■
13	■	■	■	■	■		
14	■	■		■	■		■
15	■	■	■	■			■
16	■				■	■	■
17	■	■	■	■			
18	■	■		■	■	■	■
19						■	■
20						■	■
21		■	■			■	■
22		■		■			
23			■		■		
24	■		■	■			
25					■	■	■

Source: South Dakota State University, 2001. (Note that races shown here may not be the most important ones for your area.)

Field Drainage

Because Phytophthora development requires saturated soils for a prolonged period, improving field drainage is one key to successful management. Other field characteristics that contribute to waterlogged soils include compaction and hardpan layers. Remediating these soil structure issues is another useful management tool to reduce Phytophthora infections.

Planting Date

Early planting may increase the risk of Phytophthora damage if soils are wetter and cool temperatures slow soybean emergence. Planting later when temperatures are more favorable to soybean growth gives soybeans the edge in outpacing disease development. This is more important on heavy soils or in no-till farming systems where seedbeds are intrinsically cooler.

Figure 2. Soybean dying dying under high Phytophthora pressure. Seed treatments help provide early protection.

Seed Treatments

In some fields with a history of Phytophthora damage, seed-applied fungicides should be routinely considered. Three fungicide active ingredients – oxathiapiprolin, metalaxyl, and mefenoxam – have specific activity against Phytophthora. These fungicides may provide protection for up to two to three weeks. This early period of protection often covers the period from planting to emergence and allows soybean seedlings a head start on the diseases. Fungicide seed treatments are especially useful when cool, wet soil conditions develop after planting. These conditions favor diseases and slow soybean growth, creating an ideal scenario for crop damage.

Manure and Fertilizer Application

Application of high levels of potash, manure, or municipal sludge immediately before planting soybeans may result in more severe Phytophthora root rot (Dorrance, et al., 2002) This is because of the chloride, salt or nitrate contained in fertilizer, manure and sludge. Application of these products should be made in the fall to allow time for leaching of soluble salts prior to planting. Growers should also avoid concentrating manure or sludge in specific fields, even if they are closer to the source.

CONCLUSION

Resistant and field tolerant varieties provide the first line of defense against Phytophthora. Resistant soybean varieties are available in most maturity groups, as well as varieties with excellent field tolerance to this disease. In addition, the highest quality seed with high germination and good seedling vigor can improve stand establishment and overall performance in the presence of Phytophthora.

REFERENCE

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