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MANAGEMENT OF PHYTOPHTHORA ROOT AND STEM ROT OF SOYBEANS

Phytophthora root and stem rot (PRR), caused by the soil-borne fungus *Phytophthora megasperma* f. sp. *glycinea*, can be an extremely destructive disease of soybeans throughout Illinois. During wet years that favor disease development, losses in severely diseased fields can exceed 60 percent of a stand and 50 percent of the potential yield. The disease is most severe in low, wet, poorly drained, high clay soils subjected to shallow tillage. Other reported hosts of the *Phytophthora* fungus include three species of lupines (*Lupinus* spp.) native to the United States, alfalfa, garden pea, snap bean, tomato, subterranean clover, and white clover.

Figure 1. Seedling showing decay from infection by Phytophthora megasperma f. sp. glycinia.

Although primarily a root rot problem, this disease may appear at any time during the growing season. Seed decay and damping-off problems associated with the *Phytophthora* fungus, and a closely related fungus *Pythium*, can reduce stands to the point where replanting is necessary. Late-season losses, although not a problem with *Pythium*, can be severe with PRR when the pods are filling; yields may be substantially reduced unless proper management techniques are followed.

PRR is not consistent in appearance and severity from year to year. It is a disease that depends heavily upon favorable weather (cool and wet). If these conditions are not present, disease losses may be very minor. If soil moisture levels are high, plants infected with PRR may not show symptoms aboveground. These "hidden" infections usually do not become apparent until a period of hot, dry weather; thus growers may not be aware of PRR until the plants become water stressed.

Several races of the PRR fungus may be present in a single field. Each race of the fungus has different genes which may allow it to attack the soybean variety in the field. This occurs when the genes in the fungus are not matched by resistance genes in the soybean.

Many soybean varieties carry multiple genes for resistance and cannot be attacked by the more common races of PRR found in Illinois. When a new race appears, however, there is the chance that it can become a major problem if genes for resistance are not quickly incorporated into soybean varieties. This is known as race specific resistance, since the genes provide resistance only against certain specific races of PRR. A second method of genetic control of PRR is through the planting of field resistant or "tolerant" varieties.

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These varieties do not carry genes for specific races, but rather have broad resistance against all races. Field resistance is not expressed until 10 to 14 days after emergence when stands can be heavily damaged by the seed rot and seedling blight phase of PRR.

Figure 2. Mature plants showing symptoms of Phytophthora infection.

Symptoms

The earliest symptoms of PRR and *Pythium* infections are seed decay and seed rot (Figure 1). Such soybean plants do not emerge. Infected seeds are dark brown and soft to mushy. Crop loss can range from a few plants in specific areas to entire fields. Both PRR and *Pythium* commonly occur in early planted beans where soils are wet and temperatures are below 60°F (16°C) at planting.

Seedlings that emerge and become infected exhibit typical symptoms of postemergence damping-off. A dark brown to black discoloration of the stem, usually beginning at the soil line and progressing upward, is the earliest symptom. As infection continues, diseased tissues become soft and water-soaked. Plants usually turn yellow, wilt, fall over, and decay shortly after stem infections become noticeable. Roots of infected seedlings are usually dark brown to black and show signs of decay. The outer root tissues may slough off, leaving a stringy appearance to the roots. Infected roots commonly develop a soft, watery rot.

Although PRR is commonly believed to only infect early in the season, favorable weather and growing conditions may delay the expression of symptoms until the pods are filling. A primary symptom that appears on maturing plants is a dull dark brown discoloration of the lower stem beginning at the soil line and progressing upward, often into the lowermost four or five side branches. Infected stems may shrink slightly and feel hard and dry. A very sharp line divides darkened, diseased tissue from healthy, green tissue.

The lower leaves on affected plants turn a lemon yellow to almost white. As the disease progresses, the upper foliage turns yellow, the plant wilts completely, and the entire plant may resemble a half-opened umbrella (Figure 2). The withered leaves commonly remain attached to the plant for 10 to 14 days after plant death. Affected plants usually occur in groups in a section of row rather than singly.

Roots on mature plants are dark brown and may have extensive rotted portions. If soil moisture is adequate to excessive, most of the root system may decay without visible wilting of portions aboveground. This may mask the extent of the disease until dry soil conditions or moisture stress appears.

Disease Cycle

The PRR fungus belongs to a group of fungi known as "water molds." These fungi are common in low, wet areas of fields and where soil compaction or a hardpan layer inhibits drainage. Although these fungi are most destructive in such areas, they also are found on higher ground where drainage is poor or where subsurface water flow occurs.

The PRR fungus produces three types of spores depending on environmental conditions. Zoospores, the primary infective unit, are produced under cool conditions (optimum 68°F or 20°C) when soil is saturated.

These spores actually swim through soil water and are attracted to soybean roots by exudates given off by the roots. Once they reach a root, they form a cyst, penetrate, and infect the root. Oospores and chlamydospores, the other spore types produced by the PRR fungus, serve primarily as survival structures during adverse periods. These spores are thick-walled, resist drying, and allow the fungus to persist for many years in fields without host plants being present.

Both oospores and chlamydospores may germinate and penetrate a host root directly (optimum temperature is 75°F or 24°C) or may form a spore-bearing structure called a sporangium or zoosporangium containing zoospores. The zoospores are released when wet conditions prevail.

Management of PRR

PRR is a disease that requires yearly management. Soilborne fungi do not depend on wind or insects to carry them into new crop areas each year. Once established in a field, they become "permanent residents." They may not cause extensive damage each year, but the threat of disease loss is always present.

Follow these guidelines when managing PRR:

1. Learn to identify the symptoms of the disease at all stages of crop growth. Several other soybean diseases mimic PRR at various stages throughout the season. Rhizoctonia root and stem rot and Fusarium seedling blight, for example, may attack seedlings and produce symptoms similar to PRR. However, each disease has distinctive characteristics that help identify the causal agent.

2. Plant in a warm (60°F or 16°C or more), fertile, well-drained soil. Avoid deep planting and an excessive seed rate.

3. Select a PRR tolerant or race-specific resistant soybean variety. If there is a known history of PRR problems in the field, avoid susceptible varieties. Even if there are no known problems, PRR is a disease that can appear suddenly if conditions are favorable. There is no "yield penalty" for planting a PRR-tolerant or race-resistant variety in the absence of disease.

   Know the type of resistance in all varieties selected. Be sure that the varieties you plant carry resistance to all races in fields where they will be planted. Most race-specific resistant varieties are resistant to races 1 and 2, but may vary greatly in resistance to other races.

   If tolerant varieties are selected, strongly consider using a seed treatment to protect seedlings until the tolerance mechanisms begin to operate (about 10 to 14 days after emergence). If other fungi are a problem, a combination of two or more fungicides will be needed.

4. Where feasible, improve drainage in problem areas and reduce soil compaction. Tiling and/or ditching will help to remove excess soil water, a major factor contributing to losses from PRR. Reduced soil compaction will also help reduce disease levels. Compaction reduces water percolation through the soil and restricts root growth, two factors that stress the soybean plant and increase susceptibility to PRR.

5. Crop rotation is of very limited value in controlling PRR. *Phytophthora* and other soilborne fungi can remain dormant for many years, even without a host crop. Growing continuous soybeans is not recommended since this practice increases the levels of many disease-causing organisms in the soil and crop debris.