**Overview**

*Phytophthora sojae* is one of the most destructive soybean pathogens in the North Central region, and a major cause of stand establishment problems. Seeds and seedlings can be infected and killed at any time after the seed has absorbed moisture.
The fungus also infects plants later in the season following periods of heavy rain, causing stem rots or chronic root rot.

- Phytophthora Root & Stem Rot develops quickly in warm, saturated soil.
- *Phytophthora sojae* belongs to a group of organisms called oomycetes, also known as “water molds”. This group includes some of the most damaging plant pathogens such as *Pythium*, Aphanomyces of peas, downy mildew and late blight.
- Warm soil and periodic rains at weekly intervals are ideal conditions for Phytophthora diseases. Optimum conditions for infection are warm soils at a temperature greater than 60°F, and soils that are flooded or saturated.

Phytophthora diseases are most common in fields or parts of fields with poor drainage. But they can also occur in well-drained fields when the pathogen is present and the soils are saturated for 7 to 14 days due to heavy rain or irrigation.

**The disease cycle is adapted to saturated soil.**

Phytophthora Root & Stem Rot has a disease cycle unique to fungi that are adapted to saturated soils. It survives in soil as spores called oospores which are produced in infected plants. The oospores can survive for many years in soil after plant residues decompose.

Oospores germinate when there is high soil moisture, forming sporangia. Sporangia germinate directly and infect the root, or they can produce zoospores. Zoospores are tiny, motile spores that are released when soils are flooded or saturated. The motile spores are attracted to seeds and roots by genistein and other isoflavonoid exudates released by soybean roots.

**Scouting**

Scout for Phytophthora infection during the early vegetative growth stages, especially if heavy rains occur shortly after planting and soils are warm. If you spot stand establishment problems or no emergence, dig up the seed and check for seed rot. *Phytophthora sojae* can infect and kill soybean plants at all stages of growth, from seedlings to older stands. Infected stands may survive but are less productive than healthy stands.

**Damping-off phase**

Phytophthora-infected areas of the stem will look water-soaked or bruised and will disintegrate easily. Infected plants are easily pulled from the ground since the root system is damaged. It is difficult to distinguish Phytophthora root rot from Pythium root rot at this stage. Both diseases cause taproot and lateral root rot and root pruning. Generally, *Pythium* is active in cold soils, and *Phytophthora* active in warm soils.
Stem and root rot phase
If damping-off is a problem in the spring, be on the look-out for Phytophthora infection following rainy periods later in the season, too. You’ll recognize it by a distinct chocolate-brown lesion moving up the stem from the soil line. *P. sojae* slowly girdles its host, causing wilting, yellowing and death.

The root rot phase of Phytophthora is not as readily recognized as the stem rot phase. Infected plants can be stunted and less vigorous, although this is hard to spot unless the infected plants are near a healthy comparison.

For disease scouting, you are most likely to find the disease in the following places:

- low and wet spots in a field.
- fields with high clay content.
- fields that have been in no-till for a few years.
- weedy areas that may be the result of stand reduction earlier in the season.

Stem canker, caused by the fungus *Diaporthe* can look similar to stem rot symptoms of Phytophthora. One way to separate stem canker and Phytophthora stem and root rot is to check whether diseased plants have root rot because the stem canker pathogen causes only stem lesions and not root rot.

Damping-off phase
Soybean seeds can be infected before they emerge, causing them to rot.

Phytophthora can kill young seedlings shortly after emergence as well. Plants infected at this stage will show typical “damping-off” disease symptoms.

Several other pathogens can cause damping off at this stage, too, such as *Pythium* and *Rhizoctonia*.

Generally, damping off by *Pythium* occurs when soils are still cold, while Phytophthora fungi are active when soils warm to 60°F or higher. Laboratory tests can distinguish seed and seedling rot caused by *Phytophthora sojae* from *Pythium* or other seed-rotting fungi at this stage.

Stem rot or root rot phase
Symptoms of infection at later growth stages may include yellowing, wilting and death of plants, or stunting and yellowing with no death.

The symptoms will develop 5 to 14 days after soil has been saturated and are often confused with flood damage, or can occur along with flood damage.
Flooding injury to soybeans destroys the cortical cells of the roots but leaves the root stele (center) intact. Phytophthora grows in all parts of the soybean roots and turns the entire root tissue a tan to dark brown color.

**Stem lesions are a diagnostic symptom**
A key diagnostic symptom of Phytophthora stem rot is a brown lesion that develops from the roots and progresses up the stem from the soil line. The key difference between Phytophthora stem rot and other stem cankers is that there will be few or no roots on a plant that was infected by *P. sojae*, and it will be evident that the infection occurs from the base of the plant. Other pathogens that cause stem canker do not cause root rot.

On occasion, the Phytophthora lesion may develop on only one side of the soybean stem. Cut the stems open to determine if the internal tissues are colonized from the soil line to the top of the lesion.

**Root rot phase**
The root rot phase is not as readily recognized as the killing stem rot phase. Plants will be a lighter green, and may be stunted and exhibit uneven growth. Stems of older plants may become watersoaked and eventually the leaves will turn yellow, wilt, and die. These symptoms are the secondary effects of an impaired root system that is less efficient in supplying the plant with water and nutrients.

**Management**
Phytophthora Root & Stem Rot can affect soybeans at any stage of development but is often most damaging when it occurs early in the season.

Factors that increase the risk of losses from Phytophthora Root & Stem Rot are:

- **Field history** of Phytophthora or a history of stand establishment problems.
- **Years in soybean production** – risk increases with more years in soybean production.
- **Heavy rains** following planting; wet and warm weather conditions in the spring. Disease development is most rapid at soil temperatures above 60°F with high soil moisture.
- **Poorly-drained fields** due to flooding, low spots, compacted soils, or a high clay content
- **Susceptible soybean variety planted**
1. Plant resistant varieties
Variety selection is the key for managing Phytophthora Root & Stem Rot. There are two different types of genetic resistance available in soybean varieties.

Single-gene resistance is a complete resistance to a specific pathotype of *P. sojae*, in which the fungus is unable to colonize the plant tissue. Many soybean varieties have resistance genes, called Rps for “resistant to *Phytophthora sojae*”. The most common Rps genes that are available include Rps1a, Rps1c, Rps1k, Rps3a, and Rps6 or a combination of one or more Rps genes. This information is available in seed catalogs and in state variety evaluations.

Varieties with the same resistance genes may perform differently because of different levels of partial resistance (also called quantitative resistance or field resistance) to all pathotypes of *Phytophthora*. Soybean varieties with high levels of partial resistance can become infected with *Phytophthora sojae* but symptoms are not as severe as varieties that are highly susceptible. Partial resistance will not be as effective during the first 7-10 days until seedlings are established, or when disease pressure is high.

In fields with known Phytophthora Root & Stem Rot problems or conditions that would favor disease, the current recommendation is to always choose a cultivar with the best levels of partial resistance available in the desired maturity group. Partial resistance will not eliminate Phytophthora Root & Stem Rot but it may delay disease onset. Select a cultivar based on which specific resistance genes are known to be effective in your region.

2. Monitor the performance of the Rps genes
Growers should monitor the performance of the resistance package of the soybean varieties they choose. If optimum disease conditions for Phytophthora infection occur during the growing season, scout those areas of the fields to look for stem rot development. If a large number of plants with Phytophthora stem rot are found, make a note to choose varieties with a different Rps gene and higher levels of partial resistance for the next season.

Phytophthora Root & Stem Rot is known to adapt to the Rps genes of soybean varieties, but it’s a slow process. Careful monitoring of plant performance is all that is needed. If a large number of plants with Phytophthora Root & Stem Rot are found when optimum disease conditions occur, this may indicate that a new pathotype has become dominant in your field.

University soybean researchers in the north-central region are actively monitoring Phytophthora pathotypes in order to advise soybean seed companies of changes in Phytophthora populations. Switching or stacking Rps genes in new soybean varieties may be recommended.
3. Treat seeds
Partial resistance to *Phytophthora sojae* is not effective in the seed or early growth stages until the seedling is established. Seed treatments with fungicides can provide some effective early protection for those fields where *Phytophthora sojae* has been a continuous hurdle.

4. Improve soil aeration, drainage and structure
Wet and waterlogged soils provide a favorable environment for many soilborne pathogens including *Phytophthora sojae*.

Use good soil management practices. Improve soil drainage through tiling or tillage, except when tillage will compact the soil. Compact soil and poor soil structure leads to poor aeration and increased disease levels.

5. Rotate crops
Crop rotation prevents the rapid build-up of inoculum but will not eliminate the disease or eradicate *Phytophthora* because the oospores can survive in the soil for long periods of time.

However, planting soybeans year after year can increase the *Phytophthora* population in the soil and promote the development of new pathotypes. Under high levels of inoculum, the effectiveness of partial resistance declines.

Resources

**Oomycete Diseases of Soybean and Current Management**
*Jim Kurle, University of Minnesota. Plant Management Network, 2013*
http://www.plantmanagementnetwork.org/edcenter/seminars/soybean/Oomycete/

**Phytophthora root and stem rot of soybean**
*American Phytopathological Society/Plant Health Instructor, 2012*
https://www.apsnet.org/edcenter/intropp/lessons/fungi/Oomycetes/Pages/PhytophthoraSojae.aspx

**Integrated Management Strategies for Phytophthora sojae Combining Host Resistance and Seed Treatments**
*Plant Disease 93:893-882, 2009*

**Population Structure Among and Within Iowa, Missouri, Ohio, and South Dakota Populations of Phytophthora sojae**
*Plant Disease, 2016*
Scouting for Phytophthora Root and Stem Rot in Soybean
Crop Protection Network CPN1002, 2015

Scouting for Soybean Stem Diseases
Crop Protection Network CPN 1002, 2015