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Phytophthora Root and Stem Rot of Soybean

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Figure 1. Phytophthora root and stem rot can cause severe yield loss in soybean fields. (NDSU photo)

Phytophthora root and stem rot has been an economically important disease of soybeans in North Dakota for many years. Generally considered one of the top three yield-reducing diseases of soybeans in the state, *Phytophthora* can weaken and even kill plants throughout the entire growing season, resulting in substantial stand and yield losses. Adding to this, the pathogen may remain present in the soil for many years (Figure 1).

Causal Agent

Phytophthora root and stem rot is primarily caused by a pathogen called *Phytophthora sojae*. This pathogen is often mistaken for a fungus, but it is actually classified as an oomycete, or water mold. Being an oomycete, *P. sojae* is more closely related to plants than true fungi. One of the key distinctions of oomycetes is the use of specialized spores called zoospores, which allows the pathogen to swim in water.

Symptoms

Phytophthora root and stem rot symptoms can appear at any stage of plant development. Early infections may result in seed rot or pre-emergence damping off, where seedlings fail to emerge. In post-emergence stages, infected seedlings may wilt and die, often showing a brown lesion on the lower stem and hypocotyl. Seedlings may also be impacted by this disease without dying, and some of these symptoms can include stunting, rotten roots and yellowing of leaf tissue.

Later in the growing season, symptoms include stem rot, wilting, yellowing of the leaves and plant death. A characteristic of *P. sojae* infections is the dark chocolate brown discoloration extending from the base of the plant up the stem.

Phytophthora root and stem rot can be confused with other diseases, including root rots and stem diseases. Stem canker (caused by *Diaporthe caulivora*) is the disease most commonly confused with Phytophthora root and stem rot. However, stem canker lesions often develop at the base of leaf petioles on the stem nodes and are a lighter brown color with reddish hues. The Soybean Disease Diagnostic Series is an excellent resource for soybean disease identification (PP1867).

Disease Cycle

P. sojae survives in the soil as oospores, which are thick-walled structures that can persist for many years. When conditions are favorable — typically when soil temperatures range between 70-80 degrees Fahrenheit and soils are saturated — the pathogen produces motile zoospores that infect soybean plants. These zoospores will attach themselves to soybean roots, leading to infection. During infection, this pathogen will begin producing new oospores which will serve as new inoculum in the following seasons. Wet conditions, especially after heavy rains, significantly increase the risk of infection.

Figure 2. Symptomatic soybean plant with the dark chocolate brown lesion developing upward from the soil. (NDSU photo)

Management Strategies

Effective management of Phytophthora root and stem rot requires an integrated approach. The following strategies are recommended for North Dakota soybean farmers:

1. **Resistant Varieties:** Planting soybean varieties with resistance to *P. sojae* is the most effective way to manage this disease. Several varieties with major resistance genes (Rps genes) are available. These Rps genes correspond to specific *Phytophthora* populations and will be ineffective if these populations are not compatible. As of 2024, the majority of soybean varieties adapted to North Dakota include either Rps1c or Rps1k, while a minority of varieties include Rps1a, Rps3a, Rps6, or do not have any Rps gene. Due to the overuse of these Rps1c and Rps1k genes, some *Phytophthora* populations in North Dakota have adapted to cause disease even if these resistance genes are present. It is recommended to rotate with soybean varieties that have Rps3a or Rps6 especially in fields with problems of Phytophthora root and stem rot.

   Soybean varieties also have a second type of resistance called partial resistance, or commonly called field tolerance. This type of resistance does not completely prevent Phytophthora root and stem rot from occurring, but it reduces the severity of disease development (Figure 3). This type of resistance is only activated after the V1 growth stage and therefore is not an effective control strategy for early season control.

2. **Seed Treatments:** Seed treatments can protect seedlings from infection during the early stages of development. However, seed treatments do not provide season-long protection and should be combined with other management strategies. At the time of publication, effective seed treatments for Phytophthora root and stem rot in North Dakota include the active ingredients mefenoxam (Apron XL), metalaxyl (Allegiance FL), oxathiapiprolin (Lumisena), ethaboxam (Intego) and Picarbutrazox (Vayantis). It is important to note that oomycete fungicide products do not generally have activity against true fungi (*Rhizoctonia* or *Fusarium*), and other seed treatment products will be needed for coverage of all seedling diseases. Please refer to the latest North Dakota Field Crop Plant Disease Management Guide for up-to-date seed treatment products available. At the time of publication, no *Phytophthora* populations are known to have reduced sensitivity or resistance to any of these active ingredients.

3. **Foliar Fungicides:** There are currently no foliar pesticide products available for the control of Phytophthora root and stem rot.

4. **Moisture Management:** Fields with poor drainage are more likely to experience severe disease outbreaks. Beneficial practices include installing drainage tiles or waiting to plant until field conditions improve. Tillage can improve field conditions at planting; however, this will not reduce the disease pressure in the field and can spread the pathogen inoculum to other parts of the field in the process.

5. **Crop Rotation:** While crop rotation alone may not fully control Phytophthora root and stem rot, rotating with nonhost crops can reduce the inoculum levels in the soil over time. However, because *P. sojae* oospores can persist in the soil for many years, other strategies must also be deployed.

6. **Field Monitoring:** Regular scouting is crucial for identifying Phytophthora root and stem rot. Monitoring fields during wet periods, especially after heavy rainfall, can help detect the disease early. If symptoms are observed, farmers should make note of this for more targeted management plans in future seasons.

Figure 3. Two soybean varieties with varying degrees of partial resistance. In this case, both varieties had Rps1k, which was overcome by evolving pathogen populations. (Courtesy Dr. Martin Chilvers, Michigan State University)

For more information on managing Phytophthora root and stem rot in soybeans, visit the Soybean Disease Diagnostic Series on the North Dakota State University Extension website or contact your local Extension agent.