Phytophthora Damping-off and Root Rot of Soybean

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Phytophthora damping off, root, and stem rot have been the most destructive diseases of soybeans in Ohio for more than 60 years. When rainfall saturates fields soon after planting, high incidence of seedling damping-off can result in yield losses greater than 50% in individual fields and require replanting. Statewide yield losses average 11% in years with wet springs and 8% in years with more normal planting seasons. The disease is most severe in poorly drained soils with high clay content. Traditionally, the northwest section of the state has had severe problems with Phytophthora damping off and root rot. With the increased use of no-tillage and reduced tillage residue management systems, however, Phytophthora damping off and root rot has become a serious problem in other areas of Ohio as well.

Causal Agent

The pathogen that causes Phytophthora damping off, root, and stem rot of soybean is *Phytophthora sojae.* This is a watermold and produces oospores in infected plants. When soils are saturated, sporangia are produced which hold and release swimming spores called zoospores.

Rps genes and Pathotypes

This disease has been managed effectively by planting cultivars with *Rps* genes, single dominant resistance genes. Unfortunately, this pathogen does adapt to these genes. To complicate matters further, *P. sojae* exists in soils as populations of different pathotypes. A pathotype is defined by the *Rps* genes that are not effective in controlling that isolate. Over 200 different pathotypes of *P. sojae* have been detected in Ohio soils, with as many as 50 from a single field. The tremendous variability in the *P. sojae* populations from these fields indicate that many *Rps* genes are no longer effective. The final outcome is that *P. sojae* populations in Ohio have adapted to many of the commercial *Rps* genes that are currently available in soybean cultivars (Figure 1).

Phytophthora sojae populations are in the midst of a race shift in Ohio. This means that not every individual can cause disease on a plant with an *Rps* gene. Figure 2 illustrates a *P. sojae* population in one field in Ohio where 100 soil cores were collected, spaced 100 feet apart. *P. sojae* could be recovered from 82 of the 100 cores indicating a very high population. Next, we analyzed this field for race type or pathotype. The squares indicate those locations where the *P. sojae* killed plants with the *Rps1k* gene; circles, *Rps1c*; and stars, *Rps3a*. From this field map we can see that any single gene would provide protection in 50% of the locations in the field, but not all.

Symptoms and Signs

Phytophthora can attack soybean plants at any stage of development. Symptoms in young plants include rapid yellowing and wilting accompanied by a soft rot and collapse of the root. More mature plants generally show reduced vigor and may be gradually killed as the growing season progresses. Foliar symptoms on older plants occur as general yellowing of the lower leaves that progresses upward on the plant, followed by wilting and death.

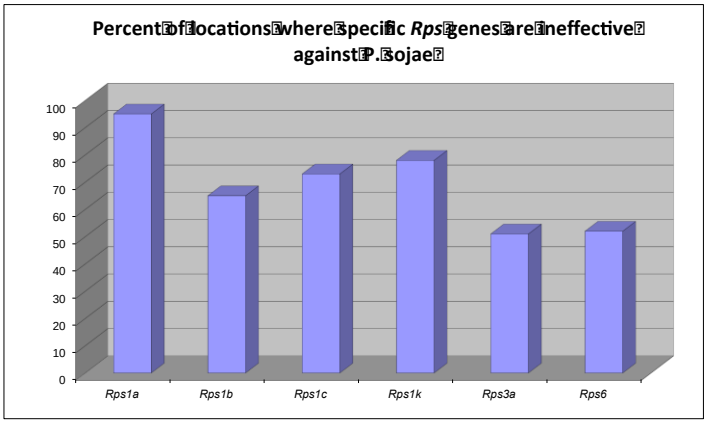

Figure 1. *Trials from several locations around Ohio tested various Rps genes against* P. sojae *infection. Almost 100% of locations had* P. sojae *populations that were able to infect when Rps1a was deployed.*

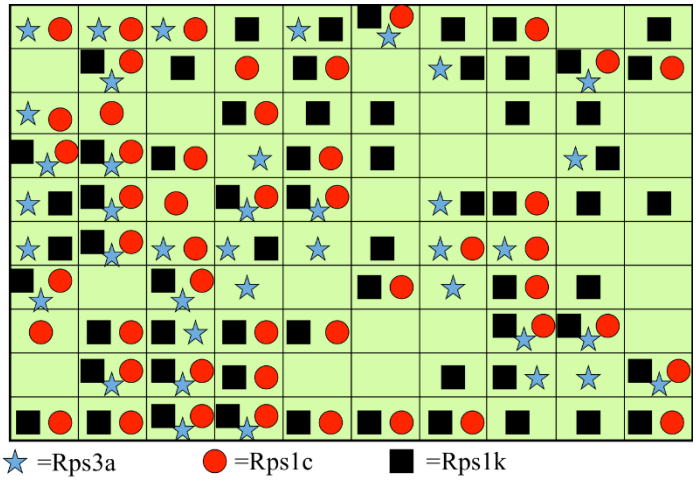

Figure 2. P. sojae *population in one field sampled 100 times. The different shapes represent where* P. sojae *killed plants with the respective Rps genes.*

The root system is usually severely affected such that lateral and branch roots are almost completely discolored. Tap roots show a brown discoloration on the surface and, if split, the inner tissues show a tan to brown discoloration. Perhaps the best diagnostic symptom of the disease on susceptible varieties is a lower stem discoloration that may extend several nodes up the stem.

Symptoms on varieties with partial resistance are not as evident as on highly susceptible varieties. When the soil becomes saturated soon after planting, varieties with partial resistance may be subject to damping-off and root rot. However, when infections occur later in the season, the extent of the root damage will be restricted, and there will be no development of the girdling stem lesions as in susceptible varieties.

Disease Cycle

Phytophthora root and stem rot is caused by *Phytophthora sojae*. This pathogen survives as thick-walled resting spores, called oospores, which can persist for years in the soil. During periods of adequate soil moisture and temperature, oospores germinate to form structures called sporangia. When the soil becomes saturated, sporangia release small swimming spores called zoospores that are attracted to the soybean roots, to which they attach and germinate. Phytophthora then invades the root and grows within the soybean root cells. Conditions favorable for infection occur most often on heavy clay soils with poor drainage. Phytophthora can attack plants at soil temperatures above 50˚F, but severe disease generally occurs when soil temperatures are 60˚ F or above.

Disease Management

Host resistance: Choosing the right variety is extremely important when attempting to manage Phytophthora root rot. There are two different types of genetic resistance available in soybean varieties. Race-specific resistance is effective against certain pathotypes of the pathogen. The genes for resistance are designated as *Rps* genes. The second type is partial resistance. Partial resistance is effective against all pathotypes of *P. sojae*, but the level of resistance is not complete, so some level of disease does occur. In problem fields, it is best to choose varieties with Rps genes combined with partial resistance to achieve better levels of control. Varieties are available with resistance genes *Rps1a*, *Rps1c*, *Rps1k*, *Rps3a*, or *Rps 1k+ 3a*.

Figure 3. *Phytophthora root rot can kill plants quickly in areas with poor drainage and susceptible plants. On the left is a variety with Rps1a and no partial resistance that was planted in a field with very high inoculum. On the right, the characteristic symptom of a discolored lower stem is shown.*

Figure 4. *Phytophthora sojae can cause post-emergence damping-off of seedlings, which can severely impact stand counts and may require re-planting.*

Soil Drainage: An essential step to manage Phytophthora root rot is to improve soil drainage so that flooding is eliminated or minimized. Use cultural practices that reduce soil compaction and improve drainage. Improving drainage is particularly important in no-till soils that retain moisture and require less precipitation to saturate the soil. Phytophthora zoospores are produced only when the soil is saturated; if soils are not saturated early in the season, varieties with partial resistance will escape disease and remain disease-free throughout the season.

Seed Treatments: In areas where Phytophthora root rot is a consistent problem, fungicide seed treatments can be used to reduce the early season damping-off. To achieve the maximum performance out of soybean varieties with partial resistance, it is important to treat the seeds of these varieties with a fungicide that is effective towards *P. sojae* prior to planting. These fungicides are highly specific for control of Phytophthora damping-off of seedlings. These seed treatments in combination with genetic resistance provides one of the best options for limiting losses from this disease.

Figure 5. *Left, a healthy soybean plant next to a plant infected with* Phytophthora *showing symptoms of wilting, chlorosis and necrosis. Right, damping-off of a soybean seedling.*

Figure 6. *Saturation of soybean fields can significantly increase chances of* Phytophthora *incidence.*

Figure 7 & 8. *Symptoms of Phytophthora root rot include stunting, post-emergence damping-off and premature death of soybean plants.*

Useful References

Crop Protection Network – Scouting for Phytophthora Root and Stem Rot in Soybean http://cropprotectionnetwork.org/soybean/scouting-phytophthora-root-stem-rot-soybean-cpn-1014/

C.O.R.N. Newsletter – OSU Agronomic Crops Network
https://agcrops.osu.edu/newsletter/corn-newsletter/