Phytophthora Root and Stem Rot of Soybean

Phytophthora root rot of soybean was first identified in Indiana in 1948 and has spread throughout soybean-growing regions of the United States and Canada. The disease is a widespread problem in Iowa, occurring in most areas where soybeans are grown.

Cause

The fungus *Phytophthora sojae* survives from season to season as a resting structure called an oospore or as threadlike structures called mycelia. The fungus survives in the soil or on plant debris associated with the previous crop. The oospores can survive in soil almost indefinitely. Oospores will germinate and produce hundreds of small, mobile spores called zoospores that travel through the water-filled soil pores and infect soybean roots. Spores contained in soil particles deposited on leaf surfaces by the splashing of raindrops also can infect plants.

Symptoms

The disease can affect soybeans from the seedling stage to near maturity. Stand reduction occurs when the disease infects the plants at the seedling stage and causes seed rot (fig.1) and damping off (fig. 2). Infection of older plants causes interveinal yellowing of leaves and eventual wilting and death. The leaves turn gray or brown and remain attached to the plant. Infected roots become discolored, rotten, and eventually die. Plants also become stunted. Large, brown lesions, advancing from the soil line up the stem of the plant, may develop (fig. 3). The lesions will eventually girdle the stem and kill the plant.

Phytophthora root rot can strike early in the season and cause damping-off. Stand reductions will

Figure 1. Soybean seed rot caused by *Phytophthora sojae*.

Figure 2. Damping off caused by *Phytophthora sojae* and *Pythium* spp.

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occur, but may be mistakenly attributed to environmental conditions or herbicide damage. Herbicide damage will be uniformly distributed in the field or follow planting and spray patterns, whereas *Phytophthora*-infected plants often occur in circular patches in low spots or scattered throughout the field (Fig. 4).

Environmental Conditions

Phytophthora root rot is prevalent in heavy clay soils or in soils with poor drainage during wet weather. In seasons where heavy rainfall occurs early and in poorly drained soils, the disease can become severe. Clay contains small soil pores that quickly become filled with water and do not drain well. Periodic rainfall patterns, such as a week of wet weather followed by dry weather, are ideal for a severe disease outbreak. Warm soil temperatures of 70 to 77° F are optimum for infection.

Resistance

Resistance is the most effective tool for disease control. *P sojae* has different races that can be controlled by soybean with specific resistance genes. Over 70 races of *Phytophthora* have been identified in Ohio soils. Studies have shown that races of *P. sojae* vary geographically. It is very important to select cultivars with resistance genes that are effective for the races present in your fields. The predominant races in a field also can shift after a resistance gene is used for a number of years. Although many races exist, only a few races are of major economic importance in Iowa.

Race 1 was first found in a disease survey in Iowa in 1966. Researchers at Iowa State University surveyed Phytophthora root rot races in Iowa from 1991-1994 and 2001-2002 by isolating *Phytophthora* from either soil samples or infected soybean plants. The results of both surveys are given in Table 1. In the 1991-1994 surveys, races 1 (26 percent), 3 (39 percent), and 4 (17 percent) predominated the population. Other races detected included 2, 8, 13, 15, and 25. A population shift of *P. sojae* in Iowa was detected in the 2001-2002 survey. Three new races were identified – races 20, 28, and 35. In addition, the frequency increased when race 25 was detected. Races 2, 3, 4, 8, and 13 were not detected in infected soybean plants, although, with the exception of races 8 and 15, all were detected in soil samples.

Figure 3. A soybean plan infected by *Phytophthora sojae*. A dark brown lesion forms on the stem from the soil line upward. Courtesy of APS Press.

Figure 4. Circle pattern of diseased soybean plants in a field infested with *Phytophthora sojae*.

The races found in Iowa can attack several commonly used resistant genes. The gene Rps1k is very widely used because it is resistant to most races found in Iowa (Table 2). However, the 2001-2002 survey revealed that races that are virulent on Rps1k, namely races 20, 25, 28, and 35, are becoming increasingly important. This may be due to selection pressure by race-specific resistant varieties. *Phytophthora* races that are able to overcome Rps1k resistance were found in Buchanan, Dickinson, Fremont, Greene, Jasper, Johnson, Lee, Lucas, Madison, Marion, Marshall, Sioux, Ringgold and Wayne counties (fig. 5).

Many soybean varieties grown in Iowa use resistance genes Rps1a, Rps1b, Rps1c, or Rps1k. A few varieties include Rps6, which is resistant to races 1, 3, 4, 25, 28, and 35. Growers should use varieties that include Rps1k if the races in a particular field are unknown.

Table 1. *Phytophthora sojae* races found in Iowa from 1991-1994 and 2001-2002

Race	1991-1994	2001-2002
1	26	15.4
2	<2	3.8[s]
3	39	11.5[s]
4	17	3.8[s]
8	<2	0
13	<2[p]	5.8[s]
15	<2[p]	0
20	-	3.8[p]
25	2	11.5
28	-	7.7
35	-	9.6
Unknown	14	17.3

[p] Only detected in infected soybean plants; [s] only detected in soil samples

Table 2. Resistance gene reaction to races of *Phytophthora sojae*

	Resistance gene							
Race	Rps1a	Rps1b	Rps1c	Rps1d	Rps1k	Rps3a	Rps6	Rps7
1	R	R	R	R	R	R	R	s
2	R	s	R	R	R	R	R	s
3	s	R	R	R	R	R	R	s
4	s	R	s	R	R	R	R	s
8	s	R	R	s	R	R	s	s
13	R	R	R	R	R	R	s	s
15	R	R	R	R	R	s	R	s
20	s	s	s	R	s	s	R	s
25	s	s	s	R	s	R	R	s
28	s	s	R	R	s	R	R	s
35	s	s	s	s	s	R	R	s

s=susceptible, R=resistant

An alternative method of disease control by soybean cultivars is tolerance. Major resistance genes,such as Rpslk, can be overcome by mutations in the fungus. Varieties that are said to be tolerant to *Phytophthora* contain factors that limit but do not halt infection and disease progress. Tolerant varieties will allow root rot to progress to the branch roots but the taproot will be unaffected. Highly tolerant varieties will yield comparably to resistant varieties despite infection by *Phytophthora.* Tolerance scores for many varieties grown in Iowa are listed in the *Iowa Crop Performance Test-Soybeans* (AG 18.) published by Iowa State University Extension and the Iowa Crop Improvement Association.

Tillage

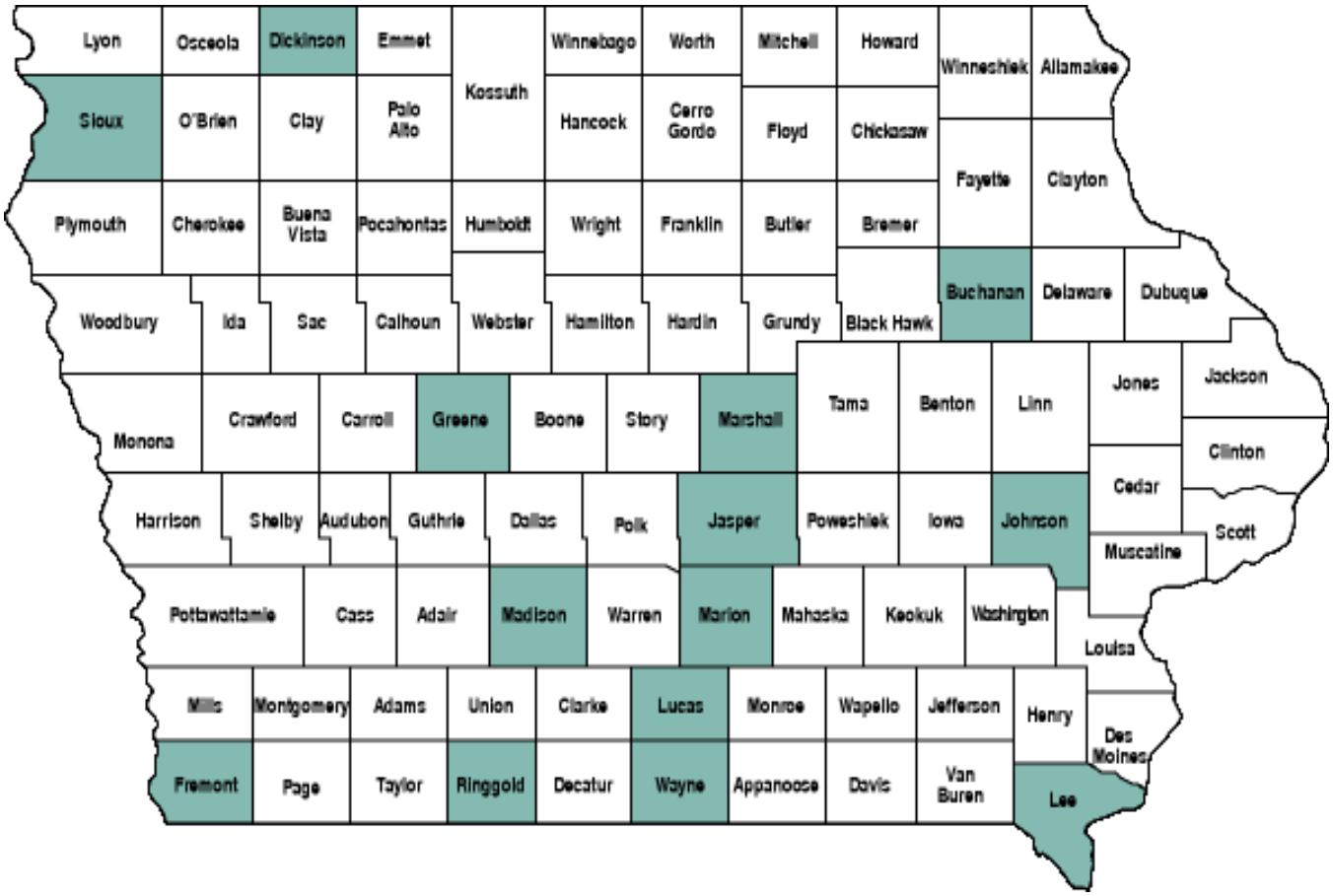
Research shows that no-till practices increase the risk of *Phytophthora,* especially disease, for two reasons. First, the pathogen survives better in no-till than in conventionally tilled ground. In conventional tillage, the fungi are buried in deep soil. In no-till systems, plant residues are left on the soil surface; as a result, the fungus is distributed primarily near the soil surface and has a greater chance of contact with seedlings. Second, soil compaction in no-till results in poor drainage, which is favorable to disease development.

To reduce disease in no-till, it is helpful to reduce compaction and improve drainage.

Chemical control

Chemical seed treatments are recommended in fields with a high risk of *Phytophthora*. The fungicides chloroneb, fludioxonil, mefenoxam, and metalaxyl are very effective for the control of *Phytophthora*. Chloroneb, fludioxonil, and metalaxyl can be used as a seed treatment (trade names: Apron XL LS, Apron MAXX RTA, Apron MAXX RTA + Moly, Maxim XL, and Warden RTA) to control damping-off. Metalaxyl can also be used as a furrow treatment (trade name: Ridomil Gold EC) to reduce root rot.

Figure 5. Iowa counties (in green) where resistance gene reaction to races of *Phytophthora sojae* has been discovered.



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