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Management of Phytophthora Root and Stem Rot of Soybeans

Loren J. Giesler, Extension Plant Pathologist
Amy D. Ziems, Extension Educator—Plant Pathology

Phytophthora root and stem rot affects many Nebraska soybean fields, and once established it cannot be eradicated but can be managed using seed treatment fungicides and resistant soybean varieties.

Phytophthora root and stem rot of soybean is caused by *Phytophthora sojae* and is present in many Nebraska soybean fields *(Figure 1)*. The pathogen survives primarily as "resting" spores in the soil or in association with infested crop debris.

Symptoms caused by *Phytophthora sojae* infections include seed rots, pre- and postemergence damping off of seedlings and stem rot of plants at various growth stages. Disease develops most rapidly when the soil temperature is above 60°F and soil moisture is high.

This disease is most common in low-lying areas of a field, in poorly drained or compacted soil, and in soils with high clay content. It also may occur on well-drained hillsides during very wet growing seasons.

In 2000-2002, *Phytophthora sojae* race surveys for soybean were initiated with funding from the Nebraska Soybean Board. Races 1, 3, 4, 5, 8, 13, 25, 28, 33, 38, 40, 41, 43, and 44 were recovered from soybean fields in Nebraska. Since that time, samples submitted to the University of Nebraska–Lincoln Plant and Pest Diagnostic Clinic have been identified with races 9, 14, 18, and 23, in addition to those identified in the earlier survey. Previous surveys were conducted in eastern Nebraska in 1980 and 1981, resulting in recovery of races 1, 3, 9, 14, 18, and 23. From these isolations and surveys it is apparent that the state's *Phytophthora sojae* population is becoming more diverse and difficult to manage.

Figure 1. Soybean plant with Phytophthora root and stem rot. Note the dark stem discoloration extending from the soil up the stem.

Once *Phytophthora sojae* is established in a field, it cannot be eradicated. The disease must be managed using seed treatment fungicides and resistant varieties. Knowledge of the races present in the state and how varieties with different resistance genes have performed in a grower's field is critical to selecting varieties for maximum profitability.

Table I. Seed treatment fungicides[1] labeled for *Phytophthora sojae* control on soybean.[2]

Product Name	*Active Ingredient*	*Application Rate for Phytophthora Control*	*Manufacturer*
Allegiance 50WP	Metalaxyl	0.2-1.0 oz/100 lbs seed	Bayer
Allegiance Dry	Metalaxyl	1.5-2.0 oz/100 lbs seed	Trace Chem LLC
Allegiance – FL	Metalaxyl	0.75-1.5 fl oz/100 lbs seed	Bayer
Allegiance LS	Metalaxyl	1.2-2.4 fl oz/100 lbs seed	Bayer
Apron Maxx RTA[3]	Mefenoxam + Fludioxonil	5.0 fl oz/100 lbs seed	Syngenta
Apron Maxx RTA + Moly[3]	Mefenoxam + Fludioxonil	5.0 fl oz/100 lbs seed	Syngenta
Apron XL LS	Mefenoxam	0.16-0.64 fl oz/100 lbs seed	Syngenta
Maxim XL[4]	Mefenoxam + Fludioxonil	0.167-0.334 fl oz/100 lbs seed	Syngenta
Warden RTA	Mefenoxam + Fludioxonil	5.0 fl oz/100 lbs seed	Agrisolutions

[1]Product list is intended for information purposes only. No criticism is intended for products not listed nor endorsement for products listed. Always read and follow label directions when applying any pesticide.
[2]Application rates on the high end of the labeled amount are generally necessary for adequate *Phytophthora sojae* control.
[3]In fields with a history of high *Phytophthora* pressure, the label recommends using Apron Maxx RTA or Apron Maxx RTA + Moly at the recommended rate of 5.0 fl oz/100 lbs seed in combination with Apron XL at a rate of 0.16-0.48 fl oz/100 lbs seed.
[4]In fields with a history of high *Phytophthora* pressure, the label recommends the combination of Apron XL LS at a rate of 0.553-0.598 fl oz/100 lbs seeds depending on rates of Maxim XL applied.

Table II. A list of the races of *Phytophthora sojae* identified in Nebraska over the last 25 years and the *Rps* gene reaction to these races (R=Resistant and s=susceptible).

Race	***Rps** Resistance Genes*							
	1-a	*1-b*	*1-c*	*1-d*	*1-k*	*3*	*6*	*7*
1	R	R	R	R	R	R	R	s
3	s	R	R	R	R	R	R	s
4	s	R	s	R	R	R	R	s
5	s	R	s	R	R	R	s	s
8	s	R	R	s	R	R	s	s
9	s	R	R	R	R	R	s	s
13	R	R	R	R	R	R	s	s
14	R	R	s	R	R	R	R	s
18	R	R	s	R	R	R	R	R
23	s	s	R	R	R	R	s	s
25	s	s	s	R	s	R	R	s
28	s	s	R	R	s	R	R	s
33	s	s	s	s	s	R	R	s
38	s	s	s	s	s	s	s	s
40	s	R	s	s	s	R	R	s
41	s	s	R	s	s	R	R	s
43	s	R	s	s	R	R	R	s
44	s	R	R	s	R	R	R	s

Seed Treatment

Seed treatment fungicides can be used to manage early season seed rot and damping off caused by *Phytophthora sojae.* The compounds labeled for control are metalaxyl and mefenoxam. Mefenoxam is one of the chemical compounds that has been isolated from metalaxyl and is the most active part of the metalaxyl products. As a result of isolating the active component, products containing mefenoxam are typically used at half the active ingredient rate of metalaxyl products. A list of products containing these compounds and their recommended rate of application is provided in *Table I.* In general, all varieties of soybean grown in problem fields should be treated since conditions favoring *Phytophthora sojae* also favor *Pythium spp.,* which also commonly causes seedling problems in Nebraska. While all products listed in *Table I* will have activity against *Phytophthora sojae,* the higher rate is needed for good control in most fields.

Genetic Resistance

Using resistant varieties is the most effective way to manage Phytophthora root and stem rot of soybean. Genetic resistance in the host is expressed in terms of *Rps* ("resistant to *Phytophthora sojae")* genes. The race-specific genes are complete resistance to a specific race of *P. sojae* and genes are denoted as *Rps* 1a, 1b, 1c,1d,1k, 3,6,7. The pathogen exists in races or biotypes that interact with these genes. In a resistant reaction, the plant survives infection; susceptible varieties are killed when infection occurs (*Table II*). Race-specific resistance is effective in the early stages of germination.

Soybean varieties are marketed on the basis of their genetic make-up in relation to the predominant *Phytophthora sojae* races in a given area. The predominant races in Nebraska are 3 and 33. The most widely available resistance genes in the Midwest are 1c and 1k, commonly referred to as "c" or "k" in seed company literature. Gene 1c protects against races 1, 3, 8, 9, 13, 23, 28, 41, and 44, where gene 1k protects against races 1, 3, 4, 5, 8, 9, 13, 14, 18, 23, 43, and 44. Gene 3 is the only gene that protects against 99 percent of the races that occur in Nebraska, Currently, 78 percent of the maturity group 2, and 83 percent of the group 3 soybean varieties marketed in Nebraska contain some resistance to *Phytophthora sojae.* Resistance within these maturity groups is listed in *Table III.* Growers should consult local seed company representatives to request varieties with different *Rps* genes than marketed in a specific area.

The other parameter on which soybean varieties are rated for *P. sojae* is partial resistance (also called field resistance or tolerance). Soybean varieties with high levels of partial resistance can become infected with *P. sojae* but the symptoms are not as severe as highly susceptible varieties. In field research trials conducted in Nebraska, good partial resistance performed as well as varieties with resistance genes and partial resistance. In fields where the *P. sojae* biotype is aggressive against the resistance genes available in commercial varieties, this is the only choice for management with genetics. If possible, a combination of good partial resistance and an *Rps* gene are recommended. Partial resistance alone will not be as effective during early growth stages or under high disease pressure.

Table III. Resistant *Phytophthora sojae* genes available in Nebraska for maturity group 2 and 3 soybean varieties in 2008 seed catalogs.

Maturity Group	*Percent Nebraska Marketed Varieties With **Rps** Gene Resistance*										
	1-a	*1-b*	*1-c*	*1-d*	*1-k*	*3*	*6*	*7*	*1c/1k*	*1k/6*	*1k/7*
Group 2	16	0	30	0	52	0	0	0	3	0	0
Group 3	7	0	69	0	22	0	0	0	1	1	0

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