Recent Studies on Management of Phytophthora Root and Stem Rot

X. B. Yang
Iowa State University, xbyang@iastate.edu

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Phytophthora root rot is an old disease familiar to Iowa soybean growers. The disease caused severe damage in the 60s and 70s in Iowa. Major damage by this disease is through stand reduction as a result of damping-off. The disease has been considered a major disease in soybean production. A major effort in disease management has been to breed resistance to this disease. Not until recently has the wide use of resistant varieties put this disease under control, exemplified by the lack of severe outbreaks. However, this situation could change as Phytophthora races shift and agricultural production practices change, such as the use of conservation tillage. Conservation tillage is often followed by an increase in certain diseases. This article will discuss 1) the possibility of race shifts for Phytophthora populations; 2) the effects of soil types and tillage on disease occurrence; and 3) the management options for this disease.

New races

The Phytophthora root rot fungus has many races. They are generally numbered in the order they were reported over years, although that is not always the case. Over the years, many genes have been used in Phytophthora resistance breeding. These genes are named as Rps-1a, -1b, -1c, and -1k, among others. Different genes impart resistance to one or several Phytophthora races. For instance, the Rps-1k gene (often called the k-gene) conferred resistance to all reported races before race 25 was found in 1984, a reason that this gene is used in most Phytophthora resistant soybeans today. On the other hand, different races can defeat different groups of resistance genes. Some races can defeat less and some more. The genes that a Phytophthora race can defeat form the virulence formula of the race. For instance, race 34 can defeat genes 1a, 1k, and 7 and its virulence formula is expressed as (1a, 1k, 7). Different races have different virulence formulas and currently many races have virulence formula that can defeat the Rps-1k gene (see Table 1). A study from Purdue University reported race numbers as high as race 44 with race 40 first reported in Iowa. A recent study from Arkansas reported race 46. Table below shows that many races reported after the 1990's can defeat the Rps-1k gene.

Because of its effectiveness, the Rps-1k gene has been widely bred into soybeans for growers to manage Phytophthora root rot. According to Soybean Disease Resistant Varieties for Iowa, a publication by ISU Extension, more than half of the varieties resistant to Phytophthora utilize the Rps-1k gene. Wide use of this resistance gene over time would put selection pressure on this fungus, increasing populations of races that can defeat the Rps-1k gene. Recently, we have observed an increased prevalence of Phytophthora that can overcome the 1k-genes. Keep in mind that besides race 25 many other races can defeat the Rps-1k gene (Table1).
In Iowa, there are an increasing number of reports that the 1k-gene is no longer effective in some soybean fields. The first reported case of Phytophthora defeating the 1k-gene in Iowa involved an old public variety, Williams 82, in 1995. An ISU survey from 1992-1994 showed that less than 5% of Phytophthora isolates in Iowa were race 25. A 1998 study of variety trials having Rps-1k resistance at eight separate locations around Iowa showed disease infestation at six locations. At some locations, patches of stand reductions were observed. At the ISU Plant Disease Clinic, the number of samples of Phytophthora infected soybeans that have Rps-1k gene has also increased in recent years with varieties from almost every major seed company. Reports on replanting due to Phytophthora damping-off among these varieties have also increased, especially in regions of heavy soils. Further research is needed to determine the level of prevalence of races that can defeat the Rps-1k gene before the risk of outbreaks of this disease in Iowa can be determined.

### Table. Phytophthora sojae races defeating Rps 1k*

<table>
<thead>
<tr>
<th>Race</th>
<th>Virulence Formula</th>
<th>Year Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>1a, 1b, 1c, 1d, 1k, 3a</td>
<td>1993</td>
</tr>
<tr>
<td>25</td>
<td>1a, 1b, 1c, 1k, 7</td>
<td>1984</td>
</tr>
<tr>
<td>28</td>
<td>1a, 1b, 1k, 7</td>
<td>1993</td>
</tr>
<tr>
<td>29</td>
<td>1a, 1b, 1k, 6, 7</td>
<td>1993</td>
</tr>
<tr>
<td>30</td>
<td>1a, 1b, 1k, 3a, 6, 7</td>
<td>1993</td>
</tr>
<tr>
<td>33</td>
<td>1a, 1b, 1c, 1d, 1k, 7</td>
<td>1997</td>
</tr>
<tr>
<td>34</td>
<td>1a, 1k, 7</td>
<td>1997</td>
</tr>
<tr>
<td>40</td>
<td>1a, 1c, 1d, 1k, 7</td>
<td>1996</td>
</tr>
<tr>
<td>41</td>
<td>1a, 1b, 1d, 1k, 7</td>
<td>1997</td>
</tr>
<tr>
<td>45</td>
<td>1a, 1b, 1c, 1k, 6, 7</td>
<td>1997</td>
</tr>
</tbody>
</table>

* The formula of a race indicates which resistant genes including Rps-1k the race defeats.

**Effects of soil types and tillage**

Because conservation tillage reduces soil erosion and production costs, the acreage under conservation tillage increased in Iowa after 1990. Conservation tillage, especially no tillage, can bank carbon in the soil and thereby reduce atmospheric carbon dioxide. Currently, there are proposals to provide farmers with credits who bank carbon through no-till, which may call more interest to no-till. Use of tillage is also a major tool for disease management and changing tillage practices will likely change the disease picture. Leaving crop residue on the soil surface increases soil moisture. This in turn increases the risk of Phytophthora root rot because this pathogen needs free moisture to attack soybeans. Several ISU studies confirm that no-till increases disease risk, and as a consequence, no-till growers face more challenges in management of Phytophthora. More stand reductions are found in fields of heavy soils. However, the amount of residue left by conservation tillage affects the disease in fields of heavy
A recent study at ISU (Workneh et al.) addressed this question. In the study, samples were taken from over 1,400 soybean fields to determine the soil type and infestation by Phytophthora. Fields were then sorted by tillage (conservation and conventional) and by soil types to determine their effects on the disease.

The study found that *Phytophthora* occurs more frequently in areas of heavy clay soils. Heavy soils have poor drainage and retain high soil moisture longer after rain, which is conducive to Phytophthora infection. The proportion of Phytophthora infested fields increased as the proportion of clay increased (Figure 1). Sorted by tillage system, the risk of Phytophthora also increased for most soil types when conservation tillage was used. However, sandy loam soil had much higher Phytophthora under conventional tillage than other soil types (Figure). Possible explanation for high infestation of *Phytophthora* in sandy loam fields may be the results of higher soil compaction received (Workneh et al., 1999).

![Figure](image-url)

**soil textural class**

**Figure.** Relationship between soil texture types and proportion of Phytophthora infestation under conservation and conventional tillage. Source: Workneh et al., 1999.

**Management options**

In a field, if Phytophthora infection is found in a sizeable proportion of 1k-gene varieties, the 1k-gene no longer provides a sure protection against *Phytophthora*. The occurrence of Phytophthora rot or stem rot in July and August is a warning sign of damping-off in future soybean crops. The level of potential damage depends on the population density of races that can defeat the Rps-1k gene. These virulent races take time to build up. Therefore, the earlier the ineffectiveness of the Rps-1k gene is detected in the field, the easier disease risk is managed.
Scouting. Phytophthora can be misidentified as stem canker, a mistake made by many. Some Phytophthora infested plants have stem rot, but no root rot, and sharply defined lesions at the nodes of plants, which are typical symptoms of stem canker. In this case, check for more diseased plants with typical Phytophthora root rot symptoms. Check for bare spots around diseased plants. These spots are likely the results of damping-off, an indication of Phytophthora occurrence at earlier growth stages. Symptoms of Phytophthora damping-off is similar to Pythium damping-off and sometimes is hard to tell the differences. In such case, use of test kits can identify *Phytophthora*.

Seed treatment. Use of seed treatments can be effective to prevent loss, because major damage by *Phytophthora* is through damping-off. The fungicide Apron is effective for controlling Phytophthora and has been mixed with other compounds for seed treatments. ApronMaxx is a relatively new soybean seed treatment. It is a prepack formulation of Maxim (fludioxonil at 2.5 g/100 kg seed) and Apron XL (at 3.75 g/100 kg seed). It can be used for on-farm seed treatments with simple equipment mounted directly and conveniently on a wagon or a truck box to dispense fungicides onto seeds during planting. This treatment can effectively control a broad spectrum of soybean seedling diseases, including almost all important seedling diseases in Iowa. It reduces fungal damage by contact and systematic control. Field evaluations by scientists at several universities show an increase in yield and stand establishment when using seed treatments.

Variety selection and tillage. If Phytophthora occurs in your 1k-gene soybeans, take note. Check with your seed dealer and ask for varieties with the Rps-6 gene. This gene is a new Phytophthora resistance gene effective against race 25. However, varieties with this gene are rare to find. Those available have been listed within the last several years in ISU extension publications. Use of tillage is the last options if Phytophthora damping-off already occurs.

Reference

