Limiting Losses to Phytophthora sojae in Ontario and the North Central U.S. Soybean Region

Purpose:

Phytophthora sojae is a soil borne disease that causes significant losses to Ontario soybean production every year. This project was undertaken to:

1) Develop materials on Phytophthora sojae for the Plant Health Initiative, OSG and OMAF websites including fact sheets, disease management guidelines and PowerPoint presentations.
2) Identify the *Rps* genes that may exist in soybean Plant Introductions that are currently being incorporated into northern soybean germplasm.
3) Determine the pathotypes (races) of *Phytophthora sojae* that exist in Ontario and each state and compare them across the North Central region.
4) Determine which cultural practices limit losses to *Phytophthora sojae* on varieties with different levels of partial resistance (tolerance). In addition, test isolates for tolerance to Apron.

Methods:

(1) Materials have been developed on Phytophthora sojae for the Plant Health Initiative Website at www.planthealth.info *and the Ontario Soybean Growers. These materials* include information on i) screening results of *Rps* genes in commercial varieties for Ontario and the specific states; ii) information on the biology, identification, and management of *P. sojae*; and iii) factsheets which explain management tools across the region for different pathotypes as well as soil types. Phytophthora root rot is caused by the soil-borne fungus, *Phytophthora sojae* and the disease continues to be a major threat not only in Ontario but also in the entire north central U.S. Participation in this joint proposal allows Ontario researchers and producers full access to the research results, materials and products that are derived from this study.

(2) Each state and Ontario are responsible for a specific set of Plant Introductions appropriate to its region. PI's will be screened with a number of isolates to determine if there are any *Rps* genes present and, if so, to possibly narrow down the beneficial (candidate) genes. This complexity of *Rps* gene deployment makes screening and resistance characterization much more difficult. The ultimate goal would be to identify Plant Introductions that have not only Phytophthora resistance but multiple disease resistance which would speed-up variety development.

(3) A uniform set of soybean differentials were used to characterize the isolates within the region. Each participant (Ontario/states) inoculated these differentials from their collection of isolates. A database will be established, which outlines the races or pathotypes that exist within Ontario and each state. This information will be used by public and private breeders to assist in soybean variety development.

(4) Isolates of *P. sojae* collected from multiple locations in Ontario, Illinois and Ohio were tested in the laboratory for sensitivity to metalaxyl and mefenoxam.

Results:

Soil samples (120) were collected from central and southwestern Ontario during the summer of 2003 and are being processed. Results from eastern Ontario and Quebec survey of Phytophthora isolates can be found in Table 1. The effectiveness of the various genes for resistance are expressed as a percent. The higher the percentage the less effective the Phytophtora gene is. For instance, Rps 1a provides little protection to producers since 100% or all of the isolates isolated were able to bypass this gene (cause infection).

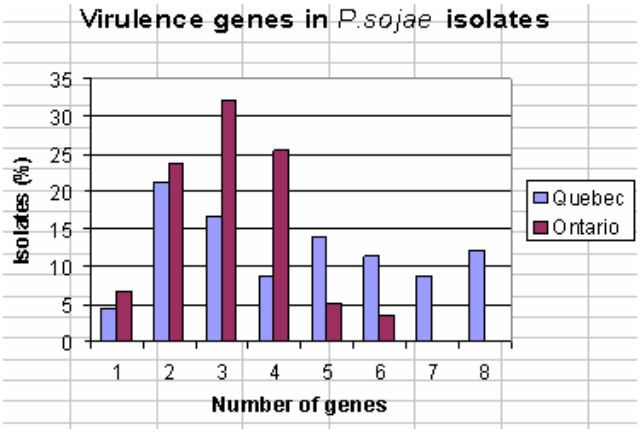
It appears that the populations of *P. sojae* are shifting or have adapted many of the *Rps* genes that have been deployed in the last 10 years. For a soil-borne pathogen, what we are seeing is the beginning of some stand failures, more in season Phytophthora stem rot and more complex pathotypes (isolates that cause disease on soybeans with a greater number of *Rps* genes as shown in Figure 1).

Table 1: Frequency and distribution of *Phytophthora sojae* isolates from eastern Ontario with virulence on selected genes for resistance and putative new genes in Harrow isolines.

Resistance gene/isoline	Genes for virulence				
	Distribution (% of farms)			Frequency (% of isolates)	
	2001*	2002**		2001*	2002**
Rps1a	100	100		100	97
Rps1c	25	29		8	20
Rps1k	75	79		46	47
Rps6	100	86		100	41
Rps8	-	21		-	5
OX744	-	36		-	17
OX939	-	21		-	5
OX940	-	79		-	53

In Illinois, 34 isolates from 20 different counties were tested and all were sensitive to 1 ug/ml metalaxyl and mefenoxam. In Ohio, 33 isolates from different locations were tested, and all were sensitive to 5 µg/ml of metalaxyl. In Ontario, 40 isolates of *P . sojae* from 6 counties in eastern Ontario have been evaluated on 5ug/ml of mefenoxam and all were sensitive at that concentration.

Figure 1 – Phytophthora isolates from Eastern Ontario and Quebec with 1 to 8 virulence



Summary:

Some of the Phytophthora isolates obtained from this study have been able to bypass the newest source of resistance (Rps 8) developed in Ohio. This ability comes naturally in these isolates since the Rps 8 gene has not been used in Ontario soybean varieties but Ontario Phytophthora isolates are able to bypass the Rps 8 gene. This is one of the difficult challenges when dealing with this disease. It has many inherent disease causing genes that are present in the fungus genome even when it has never come into contact with a new resistance gene. The potential to stack multiple resistance genes (Rps) into Ontario soybean varieties may overcome this problem.

Considerable progress has been made in collecting and screening of Ontario Phytophthora isolates. *Phytophthora sojae* populations are in the process of shifting towards more complex pathotypes (isolates that can kill plants with 4 or more *Rps* genes)**.** Partial resistance or tolerance will become more important in the long-term management of this pathogen. The development of new races that can by-pass Rps 1k resistance has been occurring in Ontario and recent work at Harrow has found that for example in Essex county, 44% of the Phytophthora races present in producer fields could cause disease in soybean varieties with Rps 1k. During this study we have found that a similar situation exists in Eastern Ontario where 47% of the isolates are able to damage Rps 1k.

Concern has arisen recently that the increased damage from Phytophthora in Ontario and the North Central region of the US could be the result of the development of tolerance to chemical seed treatments (Metalaxyl or Metalaxyl-M, also known as mefexonam). Isolates obtained in Ontario were found to have no tolerance and are still susceptible to these seed treatments. Therefore, these seed treatments remain effective management tools for Ontario producers. Similar results were found in Ohio and Illinois.

Next Steps:

This project is now completed and the information obtained is being extended to producers and agribusiness across Ontario.

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