Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Final Report – 2018 – 2023

Activity title:
Late blight: Tracking pathogen strains and their characteristics

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Activity Objectives*:*
The overall objectives of the project are to track the distribution of strains of the late blight pathogen in Canada, determine various important biological characteristics of isolated strains including fungicide sensitivity, with the overall aim of improving disease management and economic returns.

The specific objectives of this project are:
Sub-activity 1.1 Tracking potato strains of *P. infestans* in Canada
To identify strains of *Phytophthora infestans* causing late blight of potato in production areas across Canada and to develop a map showing the distribution of strains in this country.
Sub-activity 1.2 Characterization of novel strains including host/cultivar preference, environmental triggers, fungicide sensitivities, and control options
To assess novel late blight pathogen strains in Canada for their ability to cause disease in above and below-ground tissues of solanaceous plants, and to determine their sensitivity to registered and novel fungicides as well as the optimal environments for infection, spore production and survival (with the aim of understanding the impact of climate change on late blight pathogen population dynamics).

Research Progress & Results:

Sub-activity 1.1 Tracking potato strains of *P. infestans* in Canada
Late blight was of varying incidence in Canada over the course of this project, depending upon local climates, but in each year of the study, disease was recorded yielding pathogen isolates. Fortunately, a network of collaborators across Canada participated in sample submission allowing us to establish collections of pathogen isolates in each year of the study. This project was very successful at establishing strong relationships among researchers working in potato and horticultural crops within the federal government (AAFC), provincial governments (NB, MB, ON, BC, PEI), universities (Dalhousie University and University of Manitoba) and industry partners. One PhD student (Segun Babarinde) from Dalhousie University was supervised by Drs. Al-Mughrabi and Prithiviraj and trained in Dr. Burlakoti's lab at Agassiz RDC for 6 months. Segun should complete his degree requirements within the year.

Our study revealed that strains of *Phytophthora infestans* recovered in Canadian potato- and tomato-growing regions are quite diverse. Strains from eastern Canada also differed from those found in the Pacific west. Outside of British Columbia, the US-23 genotype (A1 mating type, sensitive to intermediate-sensitivity to Ridomil) was predominant in both tomato and potato. In British Columbia, a very diverse pathogen population was found in both tomato and potato crops. Genotypes including US-8, US-11, US-17, and US-23 were identified, a collection which includes both pathogen mating types (A1 and A2) and significant resistance to Ridomil. We also found several new strains/genotypes of *P. infestans* in BC and recent SSR genotyping is comparing the relatedness of these isolates (family trees). However, this strong circumstantial evidence would indicate a sexually reproducing population of the pathogen in BC, which complicates management options and could contribute to the earlier development of disease. Further research to recover oospores in production areas would confirm this suspicion. Home and community gardens seem to be reservoirs of diverse *P. infestans* genotypes, and more outreach to educate the public on diseased plant eradication and the use of late blight-resistant tomato varieties is warranted.

Sub-activity 1.2 Characterization of novel strains including host/cultivar preference, environmental triggers, fungicide sensitivities, and control options

Host/cultivar preference

Eleven NRBK differential potato lines were grown and then detached leaves inoculated with an isolate of the US-24 strain of the late blight pathogen at the greenhouse conservatory, Department of Plant Science, University of Manitoba under the direction of Dr. Daayf. The NRBK 4, 5, 8, 9 lines showed resistance against the tested US-24 isolate. Moderate infection was observed in NRBK 10 and 11. These data will allow further characterization and differentiation of pathogen isolates and also inform breeding efforts for disease resistance.

Greenhouse studies on the susceptibility of host tissues (potato and tomato varieties) to inoculation with isolates of either the US-8 or US-23 strains of the late blight pathogen were completed in multiple years of the project. Results showed that isolates of both strains were able to infect potato, but US-23 was much more aggressive on tomato than US-8. Both US-8 and US-23 genotypes of the pathogen were very virulent on potato tubers and could cause significant disease. Tomato varieties with genes for late blight resistance were significantly less diseased than varieties without resistance and maintained a strong level of disease suppression against isolates of either pathogen strain.

Environmental Triggers

Experiments run in BC and PEI comparing the growth of pathogen genotypes in culture or inoculated onto detached leaves, indicated that some isolates representing novel genotypes were able to grow at temperatures greater than 25°C suggesting that novel strains are adapting to warmer temperatures as a result of climate change. This adaptation may have given these strains a competitive advantage in the environment, contributing to their establishment and spread.

Fungicide Sensitivities

Segun Babarinde, graduate student at Dalhousie University supervised by Drs. B. Prithiviraj and K. Al-Mughrabi, conducted a number studies to determine the effectiveness of a range of fungicides registered for the control of late blight in Canada. All tested fungicides (Ridomil Gold® (metalaxyl-m and –s isomer), Ranman® (cyazofamid), CurzateTM (cymoxanil), Allegro® (fluazinam), Bravo®ZN (chlorothalonil), Reason® (fenamidone), Revus® (mandipropamid) and Orondis®Ultra (mandipropamid and oxathiapiprolin)) were able to reduce the growth of a US-23 isolate of *P. infestans* in culture, at varying concentrations of active ingredient, depending on the product used. Similarly, all tested fungicides were able to significantly inhibit germination of spores of the US-23 strain of the pathogen. Fungicide efficacy studies were also performed on living plants in a growth chamber environment. Fungicides were applied at recommended rates prior to inoculation with an isolate of the US-23 strain of *P. infestans*. Results showed that all fungicide products were able to significantly reduce disease development compared to an untreated control. As well, fungicides were all similar in their ability to control disease.

Control Options

Fortunately, based on the information obtained in this project, growers have a number of options to manage late blight in potato and tomato crops in Canada. In addition to the usual cultural control methods (disease-free seed, kill down of hot spots, etc.), a spectrum of fungicides currently registered in Canada still maintain their efficacy against novel genotypes of *P. infestans*. As well, tomato varieties with at least 2 known genes for late blight resistance provide good control of the US-23 strain, which if taken advantage of, should help to limit the spread of pathogen inoculum to

commercial production areas. Concerns arise if sexually-reproducing populations generate oospores that overwinter to cause early season disease and yield strains with higher virulence and fungicide resistance.

Key Message(s):

Even though late blight was not prevalent in all provinces of Canada during the last few years, samples were obtained in each year of the project, yielding collections of pathogen isolates for further study. In British Columbia, late blight was observed in home and community gardens in all years of the project and samples were obtained in each year. As well, late blight was observed in late June to early July of 2020 in several commercial potato farms in BC. In Ontario, late blight was found in commercial tomato crops in some years. A continued understanding of the prevalence and characteristics of pathogen strains will be critical for successful disease management. Some of the key findings of our project would include:

- Identification of predominant strains US-23 (outside BC) and US-8, US-11, US-17 and US-23 as well as other previously unrecorded novel genotypes (diverse population) in BC
- Identification of tomato varieties with genes for late blight resistance that mitigate disease caused by novel strains
- Defining the virulence and pathogenicity of the US-23 genotype on tomato foliage and potato foliage and tubers
- Identification of strains that grow and reproduce at warmer temperatures than previous strains
- Confirmation that current fungicides still provide efficacy against the current common US-23 strain of the pathogen

The diversity apparent in pathogen populations in BC indicate that there could be a reproducing population of the pathogen in this production area which could lead to the generation of even more new strains and the potential for overwintering structures (oospores) which would start disease earlier in the season. A good news story is that although some strains are resistant to Ridomil, US-23 is still effectively controlled by a variety of currently registered fungicide tools used for disease control. Some of the newer strains have adapted to infect and reproduce at warmer temperatures which may be one reason they are becoming more common. As mentioned previously, there is increased interest among the public to grow food plants, including tomatoes and potatoes in home gardens. We are encouraging home gardeners to grow late blight-resistant tomato varieties, so they are not a risk factor in spreading disease to surrounding commercial crop production areas.

So far, currently available registered fungicides are effective at managing late blight in Canada, but this could change with the loss of older Group M chemistries and the generation of new strains in some production regions. So far, tomato varieties with genes for late blight resistance are effective against the common US-23 strain found in Canada, but with increasing pathogen diversity in some growing regions, this resistance could be breached in future in those areas. Research outcomes from this study would indicate that continuous monitoring of pathogen populations is critical for effective management of this destructive disease.

Overall benefit to industry:

Data generated by this study has had a direct impact on the success of late blight management in Canada. Identification of late bight resistant tomato varieties has allowed the industry and particularly home gardeners to utilize these resources to obtain healthy crops and not be a risk for disease spread to adjacent commercial crops. Fungicide sensitivities of novel strains were identified to highlight those products that can still be successfully used by growers to manage disease. Identifying the characteristics and diversity of prevalent strains in each production region has allowed better tailoring of management strategies in each production area.

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