Research update from the University of Lethbridge

The Potato Research Lab at the University of Lethbridge conducts research in potato biology with a specific focus on the interests of Alberta potato industry. Current personnel include principal investigator, two postdoctoral researchers, four M.Sc. students, and one undergraduate student. Major research projects and activities include:

1. **Canadian network for control of potato early dying complex (CanPEDNet).**

The U of L potato lab represents the Province of Alberta in this network. The overall objective is to reduce the severity of potato early dying (PED) and increase potato productivity and profitability in Canada. This will be achieved by improved understanding of the causal agents of PED, development of commercial soil tests for *Verticillium* species, improved management for control of PED, improved soil health to enhance resilience to PED, and dissemination and technology transfer of results. Currently, our lab works on understanding the causal agents of PED: distribution and levels of *Verticillium* species and root lesion nematodes in commercial potato fields of Alberta, relation of PED disease severity to yield loss, interaction of the root lesion nematode species with *V. dahliae*, and the role of other soil-borne pathogens in the PED disease complex.

A minimum of 30 fields (32 fields in 2019 and 31 fields in 2020), planned for planting Russet Burbank next year, were sampled each fall and analysed for *Verticillium* and nematodes species. Eight fields (four with highest and four with lowest pathogen/pest populations) were sampled again in the spring 2020 prior to a potato crop to quantify pathogen/pest levels at the beginning of the growing season. Prior to harvest, each location was assessed for disease severity based on visual symptom development. At harvest, each area was hand-sampled for tuber yield, and tubers are graded according to processing contract specifications. An important outcome of this research is to compare fall and spring pest and pathogen populations to disease and yield so as to provide recommendation to sample timing for potato growers.

2. **Management strategies of potato early dying (PED) complex in Southern Alberta.**

This M.Sc. project was conducted by Colby Robertson, in collaboration with industry partners (McCain Foods Canada) and field owners, and resulted in successful M.Sc. thesis defense in March 2020.

The research focused on identification of the causal agents of PED in potato plants and fields of Alberta, and evaluation of new commercial products – Elatus, Velum Prime and Pic Plus – to control PED under local environmental conditions, as well as the impact of the fumigant on the soil microbiome and potato yields. The study of soil microbiome, or metagenome – the collective genome of microorganisms from the same soil samples – was performed to provide information on changes in the microbial diversity and ecology in potato fields in response to the treatments. Project findings were shared at annual provincial and international conferences (e.g., the Alberta Potato Conference and Tradeshow, the Potato Association of America conference), and in research article titled "Impact of fumigation on soil microbial communities under potato cultivation in Southern Alberta" and published in *American Journal of Potato Research* in 2020. Evaluation of the efficacy of new commercial products to control PED under local environment, and the impact of fumigation on soil microbiome and potato yields will help the industry to mitigate wilt severity and improve potato production in Alberta. The PED research will be continued by new M.Sc. student.

3. **The Potato Pest Monitoring Program.**

The U of L potato lab performs diagnostics of potato pathogens and pests for Promax Agronomy Services Ltd. and the Potato Growers of Alberta to provide early warning of major epidemics. The program focuses on improvement of disease management decisions through monitoring the

occurrence of major potato pathogens – the late blight pathogen *Phytophthora infestans*, the early blight pathogen *Alternaria solani*, *Fusarium* species, and the zebra chip pathogen *Candidatus* Liberbacter solanacearum – in potato fields of Alberta. The program runs each year from May to the first week of September, and employs four U of L undergraduate students. Pathogen diagnostics includes identification and counting fungal spores collected from active spore traps in commercial potato fields, using both traditional and molecular methods. Pest diagnostics involves identification and quantification of potato psyllids *(Bactericera cockerelli*), as well as other pests (green peach aphids) and pest predators, caught on sticky traps at field edges. The potato psyllids were further analyzed for the presence of the zebra chip pathogen *Candidatus Liberbacter solanacearum,* using polymerase chain reaction (PCR) and pathogen-specific DNA primers. The results were reported to Promax company daily to assess the risks for disease developments. The program resulted in several technology transfer protocols for molecular diagnostics of potato pathogens and pests. It also led to spin-off project on isolation of *P. infestans*-like spores, their germination *in vitro,* and morphological and molecular identification. In addition, *Fusarium* conidia were shared with researchers from Agriculture and Agri-Food Canada to assist in other plant pathology studies.

4. **High density micropropagation of potato plants *in vitro.***

Production of high quality, disease-free seed potatoes is the first and most expensive of inputs, as it takes several growing seasons to multiply seed tubers to quantities sufficient for the end users. All nuclear stock seed potatoes originate from certified virus-free potato plants that are grown *in vitro* in the lab. The U of L potato lab continues the development and improvement of media compositions for high density micropropagation of potato plants *in vitro.* The research is conducted by U of L undergraduate student Andrea Abenoja in a series of Research Internship and Independent Study projects. The overall objective is to develop new, low-cost culture media to improve potato growth and multiplication under commercial tissue culture lab conditions. It extends our previous findings on Russet Burbank to other cultivars, such as Ranger Russet and Shepody. It also incorporated more detailed morphological and biochemical analyses, including measuring chlorophyll content, plant biomass, root development, etc. Project findings were shared at annual provincial conferences (e.g., the Alberta Potato Conference and Tradeshow, the Annual Undergraduate Research in Science Conference of Alberta).

5. **Nematode diversity and population levels in Southern Alberta.**

The U of L potato lab has started a comprehensive survey for plant parasitic and other nematodes in agricultural fields of Alberta. The study originates from our PED research and the need for better understanding of soil nematodes contributing to PED and, possibly, to other potato diseases. The research is conducted by plant pathologist/nematologist Dr. Maria Munawar and focused on morphological and molecular characterization of nematode species in potato fields, found both in soil and in plants. All soil samples collected in the CanPEDNet project and analysed for nematodes (to a genus level) in a designated lab, are also processed in our lab to identify the presence of not only the root-lesion nematode *Pratylenchus penetrans,* which is the known contributor to PED, but also other plant parasitic nematodes, such as *P. neglectus,* pin nematodes, stunt nematodes, etc. Special attention is paid to those nematode groups that are found in potato fields in relatively high numbers. The findings have resulted in discovery of new nematode species and two submitted manuscripts on stunt and pin nematodes in Alberta.

6. **Plant host defense peptides.**

This is NSERC Discovery grant project that represents fundamental academic research on plant host defense peptides (HDPs) and their role in the plant innate immunity. The overarching goal of this research includes the elucidation of the molecular mechanism(s) of HDP-mediated disease resistance in plants. Namely, exploration of the mode of action of HDPs and their structural motifs essential for antimicrobial activity, their intracellular localization and transport within the host plant, and the role of HDPs in modulating the plant innate defense. The research is

conducted by two M.Sc. students. This study will fill a critical gap in our understanding of the mechanisms involved in plant innate immune system, and the findings may be used in the conventional potato breeding programs to improve disease resistance in the established cultivars.

Diverse research projects and teaching upper level courses at the University of Lethbridge have generated genuine interest in potato research among undergraduate students. As a result, a growing number of promising students are interested in Research Internships, Independent Studies, and graduate studies hosted by the Potato Research Lab.