2022 Northeast Potato Technology Forum (Virtual)

March 16-17, 2022

Hosted by the Prince Edward Island NEPTF Committee

Meeting Facilitator: Ryan Barrett, Prince Edward Island Potato Board (ryan@peipotato.org)

* denotes presenting author

Wednesday, March 16

12:45-1:00 **Welcome: Lorraine MacKinnon, PEI Department of Agriculture & Land**

Session 1: **Plant Breeding and Host Responses to Pathogens.**
Moderator: Yefang Jiang, AAFC Charlottetown

1:00-1:15 **Assessment of cultivar sensitivity to potato mop-top virus induced tuber necrosis**. Xianzhou Nie*, Mathuresh Singh, Jacques Lavoie, Vikram Bisht, Manisha Shukla, Alexa Creelman, Tyler Mackenzie, and Marco Lai

1:15-1:30 **The functional decline of tomato plants infected by *Candidatus* Liberibacter *solanacearum*: an RNA-Seq transcriptomic analysis.** (Eric) Jiacheng Chuan*, Jingbai Nie, William Rodney Cooper, Lawrence Hale, and Sean (Xiang) Li

1:30-1:45 **Validation of marker-assisted selection for resistance to potato cyst nematode '*Globodera rostochiensis*' in Canadian potato germplasm.** Benoît Bizimungu*, Mélissa Antoun, and Benjamin Mimee

1:45-2:00 **Genome sequencing of adapted diploid potato clones**. Sai Reddy Achakkagari, Maria Kyriakidou, Kyle M. Gardner, David De Koeyer, Hielke De Jong, Martina V. Strömvik, and Helen H. Tai*

2:00-2:15 **Phellem morphology, polyphenols, and inheritance analyses of tuber skin defects on Dark Red Norland.** Manlin Jiang*, Tracy Shinners-Carnelley, Darin Gibson, Debbie Jones, Jyoti Joshi, and Gefu Wang-Pruski

2:15-2:30 **Genetic characterization of the complete Agriculture and Agri-Food Canada potato breeding germplasm collection.** Kyle M. Gardner*, Katheryn Douglass, Lana Nolan, Erica Fava, Robyn Morgan, David De Koeyer, and Helen Tai

2:30-2:45 **Break**

Session 2: **Pests and Pathogens**
Moderator: Christine Noronha, AAFC Charlottetown

2:45-3:00 **Application of the Next Generation Sequencing technology for supporting various CFIA potato regulatory programs.** Huimin Xu* and Desmond L. Hammill

3:00-3:15 **Identification and characterization of *Fusarium* spp. associated with root rots of field pea in New Brunswick and Prince Edward Island.** Kamrun Nahar, Louis-Pierre Comeau, Claudia Goyer, Tandra Fraser, Aaron Mills, and Dahu Chen*

3:15-3:30 **Insecticide resistance varies regionally in the Colorado Potato beetle, *Leptinotarsa decemlineata*.** Jess Vickruck*, Ian Scott, Cam Donly, Sheldon Hann, Pier J. Morin, Emine Kaplanoglu, Sophie Krolikowski, Pamela MacKinley and Chandra Moffat

3:30-3:45 **Drone trial to target site-specific post-emergence herbicide application in a potato field In Grand Falls, NB.** Breno Rachid*, Erika Naruzawa, Leandro Passarini, and Keenan Kavanaugh

3:45-4:00 **Epidemiology of PVY in the NB seed potato industry: An update on PVY trends and factors driving its spread.** Tyler MacKenzie*, Suzanne Young, Mitchell Smith, Angela Gallagher, and Mathuresh Singh

4:00-4:15 **2022: Revisit Bacterial Ring Rot caused by *Clavibacter sepedonicus*: Current progress and future prospects.** Xiang (Sean) Li*

Thursday, March 17

12:45-1:00 **Welcome: Lorraine MacKinnon, PEI Department of Agriculture & Land**

Session 3: **Cropping Systems**
Moderator: Andrew McKenzie-Gopsill, AAFC Charlottetown

1:00-1:15 **Chronicles of a long-term potato cropping systems management study: 2004-2021.** Robert Larkin*

1:15-1:30 **McCain's Farm of the Future.** Manphool Fageria* and Yves Leclerc

1:30-1:45 **Preliminary results of controlled traffic farming on commercial potato fields in McCain's Farm of the Future.** Rachel Lewis, Claudia Goyer, Dahu Chen, Ikechukwu Agomoh, Yulia Kupriyanovich, and Sheng Li*

1:45-2:00 **Soil nitrate, soil properties and potato yield responses to different preceding forage crops.** Jennifer Whittaker, Judith Nyiraneza*, Bernie J. Zebarth, David L. Burton, and Yefang Jiang

2:00-2:15 **Evaluating the use of fall-seeded cover crops in the year before potato production on yield, quality, and soil health.** Morgan McNeil* and Ryan Barrett

2:15-2:30 **Evaluating the effect of legumes on potato early dying complex and marketable yield of processing potatoes.** Ryan Barrett* and Morgan McNeil

2:30-2:45 **Break**

Session 4: Soil-Plant Dynamics and Environment Interactions
Moderator: Judith Nyiraneza, AAFC Charlottetown

2:45-3:00 **The effect of chemical fumigation and substrate carbon availability on soil respiration, apparent plant residue decomposition, and microbial diversity.** Louise Sennett*, Claudia Goyer, David L. Burton, and Bernie J. Zebarth

3:00-3:15 **The free-living nematodes of New Brunswick, Canada.** Erika H Young*, Claudia Goyer, Louis-Pierre Comeau, Linda Jewell, Sheldon Hann, Jeremiah Vallotton, and Adrian Unc

3:15-3:30 **Identifying the irrigation critical point In potato crop fields using UAV remote sensing to Smart Farming Proposes – A Case Study.** Sarah Martins*, Rachid Lhissou, Karem Chokmani, and Athyna Cambouris

3:30-3:45 **CO_2 – stimulation of photosynthetic performance and potato yield is cultivar dependent.** Matthew Milne, Taylor Gervais, Benoit Bizimungu, and Keshav Dahal*

3:45-4:00 **Climate change and potato production in NB: A crop modeling perspective.** Mohammad Islam, Yulia Kupriyanovich, and Sheng Li*

4:00-4:15 **Potential economic and environmental effects of supplemental irrigation: Insights from historical potato yield and weather data in Prince Edward Island.** Yefang Jiang*, Matt Ramsay, Tobin Stetson, Ana Kostic, Fanrui Meng, and Scott Anderson

Members of the 2022 NETPF Committee:

- Scott Anderson, AAFC Charlottetown
- Ryan Barrett, Prince Edward Island Potato Board
- Yefang Jiang, AAFC Charlottetown
- Lorraine MacKinnon, PEI Department of Agriculture & Land
- Andrew McKenzie-Gopsill, AAFC Charlottetown
- Christine Noronha, AAFC Charlottetown
- Judith Nyiraneza, AAFC Charlottetown
- Rick Peters, AAFC Charlottetown

Northeast Potato Technology Forum 2022 : Abstracts of Presented Talks

Assessment of cultivar sensitivity to potato mop-top virus induced tuber necrosis

Xianzhou Nie[1*], Mathuresh Singh[2], Jacques Lavoie[3], Vikram Bisht[4], Manisha Shukla[1], Alexa Creelman[1], Tyler Mackenzie[2], and Marco Lai[1]

[1] Fredericton Research and Development Centre, Agriculture and Agri-Food Canada, Fredericton, New Brunswick, Canada E3B 4Z7; [2] Agricultural Certification Services, Fredericton, New Brunswick, Canada E3B 8B7; [3] New Brunswick Department of Agriculture, Aquaculture and Fisheries, Potato Development Centre, Wicklow, NB, Canada E7L 3S4; [4] Manitoba Agriculture, Box 1149, #65 - 3rd Avenue NE, Carman, Manitoba, Canada R0G 0J0

Potato mop-top virus (PMTV, genus *Pomovirus*, family *Virgaviridae*) is a soil-borne virus that causes a severe tuber disease called spraing, which is characterized by internal necrotic arcs or rings in infected potato tubers. The disease can result in significant economic losses to the potato industry when disease incidence becomes sufficiently high. Since its first discovery in North America in 2003, the virus has been reported in many potato production areas in USA and Canada. PMTV is transmitted by *Spongospora subterranea* f.sp. *subterranea* (Sss, the causal agent of powdery scab disease in potato), and infested soil is the major source leading PMTV infection in potato. Previously, we reported the development of high resolution DNA melting (HRM) for simultaneous detection of PMTV and Sss in soil and the identification of PMTV- and/or Sss-infested fields by HRM. Here we report the preliminary assessment of potato cultivar sensitivity to PMTV-infection and the infection-induced spraing disease by trials in a PMTV-infested field identified by HRM. Of 15 cultivars/clones tested in 2019, the red-skinned cultivars Dark Red Norland and Chieftain showed the highest susceptibility to PMTV-associated tuber necrosis with an occurrence of ca. 7.8% and 6.5%, respectively, followed by Kennebec (5.3%), Snowden (3.4%), Yukon Gold (2.5%), Atlantic (1.6%), Shepody (1.3%), Russet Norkotah (1.3%), Goldrush (0.9%), Lamoka (0.9%), and Russet Burbank (0%). Among the four advanced clones, F13014 showed the most susceptibilities to PMTV-associated tuber necrosis with an occurrence of 2.2%, followed by F13007 (1.3%), F13015 (0.9%) and F13049 (0.6%). A similar trend was observed preliminarily from tubers of different cultivars in a trial carried out in the 2021 cropping year.

The Functional Decline of Tomato Plants Infected by *Candidatus Liberibacter solanacearum*: An RNA-Seq transcriptomic analysis

Jiacheng Chuan (Eric)[1,2], Jingbai Nie[1], William Rodney Cooper[3], Larry Hale[2], and Xiang Li (Sean)[1]*

[1] Canadian Food Inspection Agency, Charlottetown Laboratory, PE; [2] Department of Biology, UPEI, Charlottetown, PE; [3] United States Department of Agriculture, Agricultural Research Service, Wapato, WA 98951

Presenter: Jiacheng (Eric) Chuan, PhD Student.
Corresponding author: Xiang (Sean) Li, Canadian Food Inspection Agency, Charlottetown Laboratory, PE. sean.li@inspection.gc.ca

Candidatus Liberibacter solanacearum (CLso) is a regulated plant pathogen in European and some Asian countries, associated with severe disease in economically important Apiaceous and Solanaceous crops, including potato, tomato, and carrot. Twelve haplotypes of CLso have been identified based on the difference in rRNA and conserved genes, and, most importantly, host specificity. Although CLso haplotypes are pathologic to different host plants at different geographic regions, haplotype A and B are pathogenic to potato and tomato, causing potato zebra chip disease in USA. To date, the virulence mechanisms of the pathogen to the host plants are not clearly illustrated, nor are the plant's response or functional decline of the host plants. This study provides insights into plant defense and functional decline of tomato plants to phytopathogenic CLso, using whole transcriptome sequencing with qPCR validation. Results demonstrated how tomato plants react in metabolic pathways during the deterioration caused by pathogenic CLso. The interactions between host plant and pathogenic CLso provide references for other plants, such as potato plants that face invasion of the same bacteria. Understanding the underlying mechanisms can enhance disease control and create opportunities for breading resistant or tolerant varieties of tomato and potato.

Validation of Marker-Assisted Selection for Resistance to Potato Cyst Nematode '*Globodera rostochiensis*' in Canadian Potato Germplasm

Benoît Bizimungu[1]*, Mélissa Antoun[2] and Benjamin Mimee[3]

[1]Agriculture and Agri-Food Canada, Fredericton Research and Development Centre; [2]Charlottetown Laboratory, Canadian Food Inspection Agency; [3]Agriculture and Agri-Food Canada, Saint-Jean-sur-Richelieu Research and Development Centre

The golden potato cyst nematode (*Globodera rostochiensis*) is an important quarantine pest and a significant threat to potato production in many areas of the world. Besides stringent quarantine and seed certification measures, the use of resistant potato varieties is an important management strategy because it can reduce nematode population levels in infested soil and limit the spread to other production areas. The Agriculture and Agri-Food Canada's breeding program has included among its objectives the development of resistant cultivars compatible with end-users' requirements in order to provide growers an effective management tool. Because of its quarantine nature, screening of advanced selections was carried out in the absence of the pest, using marker-assisted selection with the 'TG689' molecular marker associated with the H_1 gene that confers resistance to pathotype Ro1. In collaboration with the Canadian Food Inspection Agency, we then conducted a greenhouse evaluation of resistance for varieties and breeding clones previously selected. The internationally accepted standard method (EPPO PM 3/68) was used, with amendments made to represent Canadian climatic conditions and Canadian pathotypes. Preliminary test results indicated the absence of cyst nematode on AAC Mimosa, AAC Alta Crisp, AAC Confederation and AAC Intrepid Russet, confirming the utility of marker-assisted selection. However, cysts were extracted from a number of other breeding clones and varieties previously found to carry the marker. This study provides useful information for growers regarding potato cyst nematode resistant varieties, and some guidance in the use of marker-assisted selection in Canadian potato germplasm.

Genome sequencing of adapted diploid potato clones

Sai Reddy Achakkagari[1], Maria Kyriakidou[1], Kyle M. Gardner[2], David De Koeyer[2], Hielke De Jong[2], Martina V. Strömvik[1] and Helen H. Tai[2*]

[1] Department of Plant Science, McGill University, Sainte-Anne-de-Bellevue, Québec, H9X 3V9, Canada
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Cultivated potato is a vegetatively-propagated crop, and most varieties are autotetraploid with high levels of heterozygosity and genetic complexity. Reducing the ploidy and breeding potato at the diploid level can increase efficiency for genetic improvement including greater ease of introgression of diploid wild relatives and more efficient use of genomics and markers in selection. More recently, development of F_1 hybrid breeding opens another facet of diploid potato breeding with the potential for hybrid vigor. Diploid F1 hybrid breeding requires self-compatible diploid clones for development inbred lines. Severe inbreeding depression was documented for diploid potato and presents challenges for F1 hybrid breeding. The current study provides genome sequence resources for nine legacy non-inbred adapted diploid potato clones developed at Agriculture and Agri-Food Canada by retired breeder Hielke (Henry) De Jong. *De novo* genome sequence assembly using 10x Genomics and Illumina sequencing technologies show the genome sizes ranged from 714 Mbp to 952 Mbp. The genomes were analyzed for dysfunctional genes that can contribute to inbreeding depression. Genotyping of loci controlling early tuberization (*StCDF1*) and self-incompatibility (*Sli*) was also done. These resources will be useful in advancing genome design for diploid potato breeding.

Phellem Morphology, Polyphenols, and Inheritance Analyses of Tuber Skin Defects on Dark Red Norland

Manlin Jiang[1*], Tracy Shinners-Carnelley[2], Darin Gibson[3], Debbie Jones[3], Jyoti Joshi[1], Gefu Wang-Pruski[1]

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[3]Gaia Consulting Ltd., Newton, MB, Canada

Dark Red Norland is an important potato cultivar in the fresh market mainly due to its attractive bright, red color and good yield. However, some serious skin defects on the skin of Dark Red Norland tubers badly influence the tuber skin quality and marketability of this cultivar. Three typical skin defects are studied in this project, including silver patch, surface cracking, and russeting. A three-year field trial was conducted by Peak of the Market in Manitoba from 2019 to 2021 to find out the causes of these skin defects. Heat stress was applied in different tuber growing stages under both irrigation and rainfed applications. Results showed that irrigation did help in reducing the soil temperature. It also played an important role in Dark Red Norland's total yield and skin quality. Soil data were also collected and analyzed for comparing the nutrients among treatments. For both 2019 and 2020, significant higher concentration of sodium (Na) was found in the irrigated plots. Based on skin microscopy imaging analyses, tubers that grew without irrigation tended to form larger number of suberized cell layers than that of irrigated ones. Skin area defected by surface cracking had more suberized cell layers than the normal skin. In addition, higher amount of total polyphenols was found in silver patched skins with a mean of 76.55 mg gallic acid equivalents (GAE)/100 g fresh weight (fw) than that of normal skins, which had a mean of 69.81 mg GAE/100 g fw. Total anthocyanins were tested for more detailed comparison between silver patched skins and normal skins. Silver patched skins had a lower amount of total anthocyanins with an average of 0.053 mg C3GE/100 mg fw than that of normal skins with a mean of 0.073 mg C3GE/100 mg fw. Tubers with and without defects were selected and grown under greenhouse conditions to investigate if the defects would be passed on to the next generation. Silver patched skins were found on most of the offspring tubers more than any other skin defects. Also, silver patch was found to be more serious on the tuber side down-facing to the deeper soil with a coverage occurrence of 85%. The gene expression analysis was also performed using quantitative real-time qPCR to better understand the molecular processes associated with tuber periderm formation and defects, including two candidate genes (FHT and CYPA86) associated with suberin biosynthesis and two candidate genes (JAF13 and WD40) related with anthocyanin biosynthesis. The result revealed that the relative expression levels of FHT and CYPA86 genes were significantly up-regulated in russeting samples (p-value <0.05); while CYPA86 was significantly down-regulated in silver patch samples as compared to that of the normal skin group. The outcome of this study may provide key information and potential strategies to improve tuber skin quality and minimize the market loss.

Genetic characterization of the complete Agriculture and Agri-Food Canada potato breeding germplasm collection

Kyle M. Gardner*, Katheryn Douglass, Lana Nolan, Erica Fava, Robyn Morgan, David De Koeyer, and Helen Tai

Agriculture and Agri-Food Canada, Fredericton Research and Development Centre, Fredericton NB, Canada

Here we describe the application of high throughput genotyping technology to characterize the complete Agriculture and Agri-Food Canada (AAFC) potato breeding germplasm collection. This collection of 935 unique potato clones was composed of breeding germplasm, heritage varieties, and commercial varieties released over the last 40+ years in North America and abroad. The clones were each genotyped at ~ 45000 single nucleotide polymorphism markers through genotyping by sequencing, and the genotype data was used to quantify population structure and genetic relatedness among all pairs of clones. Across the population, we observed population structuring associated with clone market class (eg. processing vs. fresh market), and complex patterns of relatedness, with over 80% of clones having one or more close relatives also in the population. Using two years of partially replicated trait data we used genome-wide association analysis (GWAS) to identify individual genetic markers linked to tuber characteristics (colour, shape), agronomic traits (maturity), and select processing traits such as chip colour. Lastly, we present preliminary analysis of the use of genomic prediction to estimate breeding values for more complex traits such as total tuber yield, tuber number, specific gravity, and average tuber weight, and discuss the practical application of these breeding values for clone improvement.

Application of the Next Generation Sequencing Technology for Supporting Various CFIA Potato Regulatory Programs

Huimin Xu* and Desmond L Hammill

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Over 50 viruses and viroids can infect potatoes naturally and many of these viruses are often the restriction factors for interrupting Canadian seed potato trade. The viruses of concern to the Canadian potato industry include a dozen common viruses that are known to infect potatoes in Canada while the rest are considered exotic potato viruses. PCR-based tests have been implemented in Canada for detecting the common viruses and to date no validated tests are available for the detection of all the other potato viruses. It will take a long time and a great deal of efforts to develop and validate PCR-based procedures for all these known potato viruses and viroids.

However, the next generation sequencing (NGS) technology, since first published in 2009, has led to a revolution in virus discovery and exciting new possibilities for the diagnosis of viruses and almost all other organisms and carries the promise of routine, generic detection of viruses, viroids and other pathogens alike. NGS technology can provide rapid and sensitive methodology to reveal all pathogens present in one test sample and this feature makes NGS a perfect and powerful screening tool for conducting various regulatory testing.

To explore the potential applications of NGS technology as a sensitive, specific and cost-effective tool to reveal a wide range of viral and viroid pathogens in diagnostic samples for supporting CFIA regulatory testing, four research projects were conducted in the Charlottetown Laboratory (CL) from 2014 to 2021. Upon the completion of these projects, procedures were developed and validated for extracting nucleic acids of high quality, constructing cDNA libraries, processing the raw NGS data and assembling contigs.

The NGS technology is now routinely used in CL for detecting virus and viroid pathogens in potato tubers, *in vitro* microplants and seedlings from true (botanical) potato seeds (TPS) for supporting various CFIA potato regulatory programs, such as the Potato Post Entry Quarantine (PPEQ) program, and import surveillance and export certification testing. Positive NGS detection is always validated using one or two other diagnostic methods, such as PCR-based assays, before a final testing report is issued and released.

NGS followed by validation testing provides a new strategy that can significantly reduce time and cost for conducting a wide range of regulatory testing. One nucleic acid extraction and one NGS run can reveal all viruses and viroids in a test sample without any previous knowledge of the presence of the pathogens. The validated diagnostic procedures for all viruses and viroids that test samples may harbor are no longer the restriction factors for conducting regulatory testing. In this report, the application of NGS technology in recent years in CFIA Charlottetown Laboratory for detecting viruses and viroids will be described and the perspectives of the future development and applications will be discussed.

Identification and Characterization of *Fusarium* spp. associated with Root Rots of Field Pea in New Brunswick and Prince Edward Island

Kamrun Nahar[1], Louis-Pierre Comeau[1], Claudia Goyer[1], Tandra Fraser[2], Aaron Mills[2] and Dahu Chen[1]

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Leguminous crops are widely used as rotation crops to improve soil fertility and reduce pathogen populations of some diseases, however, they may also pose pathological risks for subsequent crops through shared pathogens, especially those of the genus *Fusarium*. Field peas were recently re-introduced as rotation crops into the potato production system in New Brunswick (NB) and Prince Edward Island (PEI). Root rot is an economically important disease of field pea in most areas of the world where the crop is grown. However, little is known about the causal organisms of the root rot complex of the field peas and their potential impact on potato production in the Maritimes.
A disease survey across NB and PEI was undertaken from July to August in 2018 to assess the distribution and severity of pea root rot, to identify the causal organisms and their potential impact on potato dry rot (FDR) in Maritimes. Symptomatic pea plants were collected for pathogen isolation from 14 and four commercial fields in NB and PEI, respectively. Pure isolates were obtained either using single spore isolation. Morphological characteristics in potato dextrose agar and Carnation leaf agar and the DNA sequences of the species-specific markers, including the internal transcribed spacer (ITS) region, the translational elongation factor 1-α and β-tubulin genes were used for *Fusarium* species identification.

Root rot disease was present in all surveyed fields and disease severity ranged from low to medium. 247 and 46 fungal isolates were recovered from NB and PEI samples, respectively. Five *Fusarium* species were identified in NB, and four species in PEI. *F. solani* was the most frequent (46% of total NB isolates and 60% of PEI isolates), followed by *F. oxysporum* (43% in NB and 24% in PEI), *F. avenaceum* (8% in NB and 12% in PEI), *F. equiseti* (2 % in NB) and *F. commune* (1% in NB and 4% in PEI). The pathogenicity of representative isolates for *F. oxysporum, F. avenaceum, F. equiseti* and *F. commune* were tested in a greenhouse on soybean, field pea and faba bean and five potato cultivars (Atlantic, Chieftain, Russet Burbank, Shepody, and Yukon Gold) in an incubator. All tested species caused root rot in soybean, field pea and faba bean. *F. oxysporum*, *F. avenaceum*, and *F. commune* were highly aggressive in soybean, field pea and faba bean while *F. equiseti* isolates were moderately aggressive in the tested crops. *F. avenaceum* isolates were the most aggressive compared to other species causing FDR in all five potato cultivars, with the average disease severity scale ranging from 3.9 to 4.7 among cultivars, followed by *F. commune* (2.0 to 3.7), *F. equiseti* (0.3 to 3.0) and *F. oxysporum* (0.6 to 2.6). This study indicated that the root rot pathogen complex of field peas may have a potential impact on potato FDR in Maritimes Canada.

Insecticide resistance varies regionally in the Colorado Potato beetle, *Leptinotarsa decemlineata*

Jess Vickruck[1], Ian Scott[2], Cam Donly[2], Sheldon Hann[1], Pier J. Morin[3], Emine Kaplanoglu[2], Sophie Krolikowski[2], Pamela MacKinley[1] & Chandra Moffat[4]

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The Colorado potato beetle (CPB) *Leptinotarsa decemlineata* is an economically important insect pest of Canadian potato crops. In commercial settings, control of CPB typically occurs through the use of chemical insecticides. Management of CPB damage is often challenged by their ability to develop rapid resistance to registered products. Across Canada there are different combinations of chemistries used depending on the province or region. This leads us to consider the possibility that resistance to certain products is regionally specific, and could cause different rates of resistance development when new products are introduced. To understand patterns of insect resistance in CPB populations in Canada we collected beetles from 5 provinces (AB, MB, ON, QC and PEI) over 4 years (2018-2021) in order to assess susceptibility with 3 insecticide classes: spinosyns (Entrust and Delegate), neonicotinoids (Titan and Actara), and diamides (Coragen, Verimark, Exirel, Harvanta and Vayego). Our results indicate that regional patterns of resistance, with some annual variation, are present. Relative differences in susceptibility to newly introduced products was also evident in certain provinces. Stakeholders will be made aware of these trends in order to best manage CPB in their regions, in part through the development of an interactive map that provides a visual representation of our results.

Drone Trial to Target Site-Specific Post-Emergence Herbicide Application in A Potato Field in Grand Falls, NB

Breno Rachid[1*], Erika Naruzawa[2], Leandro Passarini[2], Keenan Kavanaugh[3]

[1]Alvaz R&D [2]CCNB-INNOV, 160, Réservoir street, Grand Falls (NB), E3Y 3W3, CANADA
[3]Thomas Kavanaugh & Sons Ltd.

Unmanned aerial vehicles such as drones can image ground data with corresponding geographic locations, providing crop health conditions. In this way, drone technology can be used for fast and early decision-making on the farm, which improves agricultural productivity. This technology can reduce pesticide application and improve overall profitability. It may reduce the average operation cost by 21% and 53% in soy and sugarcane, respectively. Validation of this technology in NB potatoes fields needs to be performed. This project aimed to use a drone technology already validated on other countries and several crops in a pilot study in New Brunswick potato field. This project took place on the farm owned by Thomas Kavanaugh & Sons Ltd., a well-established potato producer located in Grand Falls, NB. The results showed that the area covered by weeds corresponded to 9.25% of the total area. The Alvaz Research and Development Inc. recommendation allowed a 91% reduction of herbicide utilization in a post-emergence pass, which represents a reduction of 40 $ to 868 $ of herbicide (Prism SG and Sencor 75 DF, respectively) per acre only for this pass. The targeted application on weeds in three acres had 84% assertiveness, representing an excellent potential to be employed in New Brunswick potatoes fields. A higher assertiveness might be reached by increasing the nozzle's size and the grid area. Information gathered in this work might be extrapolated later to other NB commodities such as grains, blueberries, and forest operations. NB producers will be able to apply this sophisticated but economically attiring tool to their crops, increasing their competitiveness and cash receipts. Commercial application and market potential are immense as this technology is already commercialized in other countries and is a proven solution used by the agricultural industry abroad.

Epidemiology of PVY in the NB seed potato industry: An update on PVY trends and factors driving its spread

Tyler MacKenzie[1]*, Suzanne Young[2], Mitchell Smith[2], Angela Gallagher[1], Mathuresh Singh[1]

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Potato is the most important agricultural crop in New Brunswick (NB), and includes a valuable seed potato industry used domestically and for export to other potato producing regions. *Potato virus Y* (PVY) is an important disease agent which has been a major focus of research and management in this industry. Through close cooperation of researchers, regulators and growers, significant advances in managing PVY in the NB seed potato crop have been realized in the past decade. Since 2009, average post-harvest PVY in NB seed lots dropped from 11.8% to less than 1%, with a record low of 0.43% in 2016. A resurgence in 2017-18 doubled mean PVY level across NB, which has only slowly dropped to 0.55% by 2020; for the first time since that recovery, average PVY has begun growing again to 0.59% in the 2021 harvest. While changes in average PVY appear small, these shifts were indicative of large changes in PVY near the regulatory threshold for maximum allowed PVY in seed lots (currently capped at 4% PVY incidence). For example, the 2017-18 resurgence peaked with an increase of only ~0.7% but resulted in more than three times as many seed lots failing the PVY cap than in the previous four years of relatively low PVY – representing millions in lost revenue.

Our research group has amassed a large and growing data set of seed lot PVY outcomes, including potato variety, seed class, PVY in seed planted, local aphid and climate data and grower identity and management practices – amounting to nearly 7000 seed lots since 2009. Major trends over this time have impacted PVY spread and management, including a major consolidation in the seed production industry of varieties grown and number of commercial-scale growers. On average, ~103 potato varieties are tested annually for seed certification in NB; a decade ago, eight varieties made up over 50% of seed production acreage, dropping to only four varieties currently. Three of these four tested higher than average for PVY level. The largest, Russet Burbank, grew from 15% to 35% of acreage since 2009, with consistently higher PVY than average for other varieties in the past 6 years, with a trend that continues to diverge higher. At the same time, the number of commercial growers participating in the NB seed certification program dropped in half since 2009, while their individual production has increased. More of these growers produce both seed, requiring low PVY levels, and processing or fresh market potatoes, without constraints on PVY. Such growers have shown significantly higher PVY in their seed crops, compared to growers focused on seed production alone. Many growers express concern that several factors driving PVY spread are outside their control, such as climate variables, abundance of aphids which are vectors for PVY in their fields or recent shifts in PVY populations to more transmissible strains, or factors they have only limited influence on, such as PVY levels in the available seed supply to plant their fields. Our epidemiological modeling does indeed show the strong effects of these factors on PVY outcome industry-wide, however, equally important is the variation in PVY outcomes between growers after statistically accounting for all these other factors. Our analysis shows that management choices by each grower are sufficient to greatly reduce PVY in their fields, despite the effects from factors outside their control, and several specific management practices identified by our modeling will be discussed in this presentation. With these data and modeling efforts, factors associated with PVY spread, both at the industry-scale and by individual growers, can explain much of the great shift in PVY levels in potato seed crops in recent years, predict PVY outcome under specific growing conditions, and identify strategies growers can adopt to maintain low PVY in their crops.

2022: Revisit Bacterial Ring Rot caused by Clavibacter sepedonicus: Current progress and future prospects.

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Bacterial ring rot (Brr) disease caused by *Clavibacter sepedonicus* (Spieckermann and Kotthoff 1914) Li et al. 2018 was one of the earliest descripted plant pathogenic bacteria, dated back in 1905 (Appel, 1906). *Clavibacter sepedonicus* is a monophyletic taxon comprised only of potato strains of the genus, and is under strict quarantine regulation in Europe and North America with zero tolerance imposed. Historically, potato is the only economically-important host for *C. sepedonicus* whereas the bacterium is capable of infecting tomato, eggplant and buffalo bur (*Solanum rostratum*) under lab conditions. As for the non-solanaceous plant species, *C. sepedonicus* can induce disease symptoms on rape (Brassica napus), stinging nettle (Urtica dioica), and sugar beet (Beta vulgaris) plants. On sugar beet, the pathogen causes severe wilt, infected young petioles are curled, and whole leaves are distorted. Vascular tissues in the longitudinal root cut are brown to deep brown. Only eight out of 40 sugar beet cultivars of Russian and German origin were found susceptible to the ring rot pathogen. Recently, natural occurrence and pathogenicity of *C. sepedonicus* on tomato was reported by Van Vaerenbergh et al. (2016) in Belgium. *C. sepedonicus* remains as a regulated plant pathogen in seed potato production in North America. In Canada, the disease was suppressed and functional eradication achieved in some regions largely due to the regulations enforced through the Canadian Seed Certification Program introduced in 1997. In the United States, seed certification is regulated at the state level with coordination of standard protocols as recommended by the Potato Association of America. As the result of continuous efforts toward functional eradication, discovery of ring rot disease in the field is rare. In Canada for instance, there has not been any report of observing the disease in the field during last twenty years despite routine scouting by the regulatory agency. In addition to the current methodology based on molecular and serological techniques, we have designed and evaluated a novel qPCR assay to enhance the toolbox of the detection and identification of *C. sepedonicus* causing Brr in potato tuber and stems.

Chronicles of a long-term potato cropping systems management study: 2004-2021

Robert Larkin, USDA-ARS, University of Maine, Orono, ME

Beneficial soil and crop management practices, such as longer crop rotations, cover crops and green manures, organic amendments, and reduced tillage, may help improve soil and crop health when incorporated into cropping systems. In 2004, ARS scientists established a long-term potato cropping systems study in Presque Isle, ME with the purpose of establishing the potential and extent in which improved cropping systems could be used to reduce or remove the constraints and limitations holding back potato production in the northeastern US. Three different 3-yr potato cropping systems focused on management goals of soil conservation (SC), soil improvement (SI), and disease suppression (DS) were developed, evaluated and compared to a standard 2-yr rotation (SQ) and a non-rotation control (PP). The SI system included a history of compost amendments and the DS system included biofumigant green manures and cover crops. Although some modifications have been made to the systems over the years, the core principles have remained, and the trials have now been in place for more than 18 years.

Over the course of the study, yearly fluctuations in potato yields and disease development have varied considerably due to changing environmental conditions, but relative cropping system effects have been consistent. Throughout the study, the SI system has increased potato yields by an average of 32% and 25% over the non-rotation (PP) and standard rotation (SQ) controls, respectively, as well as improved soil organic matter content and other soil physical and chemical properties. The DS system also has maintained improved potato yields (by 10-15%) and reduced the soilborne diseases black scurf and common scab (by 10-30%) relative to the SQ and PP controls. Several noted trends could only be observed after several years, indicating the need for such long-term trials. Increasing soil organic matter through compost amendments resulted in increased yields for many years after ending compost applications, and disease reduction was only observed in SI system after several years. These results show that improved cropping systems incorporating management practices such as organic amendments and disease-suppressive rotations can effectively improve soil and crop health and enhance agricultural sustainability and viability.

McCain's Farm of the Future

Manphool Fageria and Yves Leclerc, McCain Foods Ltd., Florenceville, NB

Against a backdrop of an ever-growing population, climate change, soil degradation, biodiversity loss and food waste, the future of global food systems is at risk. McCain Foods has recently established a Farm of the Future in Florenceville, NB to increase the resilience of our cropping system and bring back some of the principles that helped our soil and land thrive in the past. It is where we are marrying modern technology and equipment with Regenerative Agriculture practices and using current scientific knowledge of ecological and agricultural principles to farm holistically. The Farm of the Future prioritizes the crop and its interaction with soil to reduce impacts on the environment. It embraces biology to improve soil health including introducing more biodiversity to farmlands to reduce the need for chemical applications, and aims at lowering water use. The Farm of the Future aims to reduce the carbon footprint of farming while increasing the quantity and quality of potatoes grown per acre. By 2025, McCain Foods will have three Farms of the Future operating in different growing regions around the world. The first Farm of the Future is located just outside McCain's hometown of Florenceville, New Brunswick, in Canada, had its first fully operational season in 2021. McCain Food's Farm of the Future has developed partnerships with AAFC, University of Guelph, Dalhousie University, NB Department of Agriculture, Resson and other organizations, bringing together people with different experiences, knowledge and skills to quantify the impact of regenerative practices being implemented at the Farm of the Future because '*If you cannot measure it, you cannot improve it.*

Preliminary results of controlled traffic farming on commercial potato fields in McCain's Farm of the Future

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Agricultural machinery is essential to modern agriculture. Over the past century, the size and weight of agricultural machinery and traffic intensity have increased substantially, leading to widespread soil compaction. One solution to this traffic-induced soil compaction is Controlled Traffic Farming (CTF). CTF limits in-field traffic to fixed permanent tracks so that the areas between these tracks can be traffic-free and, therefore, are not compacted. Despite the obvious benefits of CTF, its adoption in commercial fields is limited in North America, especially on fields under potato productions. Potato is the major cash crop in Atlantic Canada. Traditional potato production system is featured by intensive Random Traffic Farming (RTF) which has led to severe soil compaction in this region. CTF could be a good solution to cope with this problem. However, no research has been carried out in this region for using CTF in commercial potato fields. McCain Foods established the Farm of the Future (FoF) in 2020 in the potato belt in New Brunswick and included CTF as one of the fundamental regenerative practices in the farm.

To examine the effects of CTF in the FoF, a paired site design was used. A total of three fields were selected. Two fields (BR1 and BR2) were managed under RTF while a third field (BR3) was managed under CTF. A three-year crop rotation system consisting of potato, barley and forage was used. In 2021, BR1, BR2 and BR3 were all cropped with potato. In the short term, the effects of CTF were examined by paired comparison between the CTF field and the RTF fields via monitoring of soil properties and rainfall simulation plot experiments on water erosion. Preliminary results from 2021 showed that there were large variations with time and space in the soil moisture and temperature measurements. Effects of slope position and soil layers were not significant. However, there was a consistent pattern of higher temperature and lower moisture for the surface soil on the CTF field than on the RTF fields. For biomass and yield parameters, there were no significant differences between CTF and RTF in shoot dry weight, root dry weight, tuber dry weight and yield or marketable yield. However, CTF had significantly higher specific gravity ($P < 0.01$) and higher dry matter content ($P < 0.10$) than RTF. Soil hydraulic conductivity for CTF was found to be significantly greater than that for RTF ($P < 0.001$) whereas the rainfall simulation plot experiment showed that CTF reduced runoff and sediment outputs by about 20 – 60%. Overall, these results indicate that CTF can enhance water hydrological properties thus reduce water erosion. Although it did not show significant effects on yield but potato tuber quality has been enhanced.

Soil nitrate, soil properties and potato yield responses to different preceding forage crops

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Understanding the effects of different forage crops on soil nitrate leaching potential, soil properties and on potato yield is important to achieve the environmental sustainability and to sustain soil and potato productivities. Two cycles of a 3yr (barley underseeded with forage-forage-potato) rotation were implemented between 2013 and 2018. The tested forages included a legume (red clover), a grass (timothy) and a red clover-timothy mixture. Soil fertilization (N, P, K inputs) was performed so satisfy barley requirements but no nutrient inputs was supplied in the second year of the forage growth. Measured parameters included C and N contents, aggregate stability, active carbon, protein index, soil respiration, soil water content and potato yields. In addition, suction lysimeters were installed at 30 cm and 50 cm and stainless steel lysimeter installed at 85 cm to measure mineral nitrate concentrations in leachate during the growing season and in fall. Monthly soil sampling was also performed during potato growth to measure soil nitrate at 2 depths (0-15 cm; 15-30 cm).

Dry matter biomass, C and N returned to the soils were higher with RC and M than with timothy and timothy returned around half of N in comparison to RC and M. Trends toward lower values of soil nitrate were observed with timothy than red clover or red-clover-timothy mixture. All treatments were associated with comparable potato yields. After 6 years, timothy was associated with lower aggregate stability and protein index in comparison to red clover treatment. In addition, timothy treatment had 13 and 18% lower active carbon than red clover or red clover-timothy mixture. The study suggests that there may be a trade-off between selecting cover crops to reduce nitrate leaching and enhance soil quality.

Evaluating the use of fall-seeded cover crops in the year before potato production on yield, quality, and soil health.

Morgan McNeil* and Ryan Barrett, PEI Potato Board, Charlottetown, PEI

As part of the Living Labs Atlantic program, the Prince Edward Island has undertaken multiple years of on-farm research evaluating the use of fall-seeded cover crops in the year before potato production for a variety of soil health characteristics as well as the resultant potato yield and quality in the following year. Potato growers in Prince Edward Island are rapidly adopting the use of cover crops, as they are associated with reducing soil erosion and improving soil health metrics.

In 2019 and 2020, fourteen field trials were established across three areas of Prince Edward Island where one or more fall-seeded cover crops were planted and compared with a no-cover crop control treatment. There were a total of 19 cover crop species or mixtures to evaluate over two years. Cover crops were established between late August and early October through a combination of direct seeding or broadcast seeding. Species evaluated included barley, oats, brown mustard, oilseed radish, and daikon radish. These species were selected as they have a history of establishing quickly and being somewhat frost-tolerant; however, these species will generally winter kill, not requiring herbicide application prior to potato planting the following year. Data collected included soil chemical and nutrients, soil health metrics (active carbon, soil respiration, aggregate stability, and biological N availability), root lesion nematodes, *Verticillium dahliae*, percentage green cover, soil nitrate concentrations, and potato yield & quality. Results and trends from this testing will be discussed further in the presentation.

In both years, there was no distinctive trend indicating a change in soil chemistry or soil health between cover crop and control treatments; however, the short time frame and limited replication may limit the ability to identify these trends. In fields harvested in 2020, there was a limited trend showing an improvement in soil active carbon favouring the cover crops, but this was not seen in 2021 harvested fields. Root lesion nematode number were quite variable by location and by year. There were no clear trends that indicated that the choice of cover crop had an impact on nematode populations. For *Verticillium dahliae*, there was also no obvious trend that indicated that the choice of cover crop had an effect on populations; however, *V. dahliae* populations generally decreased in the spring following cover crop establishment for both cover crops and control treatments.

A wide range of percent green cover was seen, ranging from as little as 5% to as high as 80%. The most important factor was planting date, with earlier planted covers having much higher percentage of green cover. Periods of dry weather also delayed emergence for cover seeded by broadcast.
In both years, a similar trend was observed related to an increase in potato yield and crop value following a cover crop as compared with the no cover control. In 2020 harvested fields, the average increase in marketable yield across 8 treatment/control comparisons was 24.2 cwt/acre and $425/acre increase in crop value. In 2021, these average increases were 28.8 cwt/acre and $386. Six out of 15 comparisons were found to be statistically significant (all positive), and for 10 out of 15 fields, there was a numerical increase in marketable yield and crop value favouring cover crops. Preliminary analysis indicates that improvements in yield may be more associated with barley and oats than brassica crops, but additional site-years and statistical analysis is required. The ranges of increase in marketable yield (~25 cwt/acre) are similar to what has been found in related studies in Ontario and the United Kingdom. Work in this project will be completed following the 2022 crop year.

Evaluating the effect of legumes on potato early dying complex and marketable yield of processing potatoes.

Ryan Barrett* and Morgan McNeil, PEI Potato Board, Charlottetown, PEI

There have been many questions from potato producers regarding how different species of forage legumes may differentially host *Verticillium dahliae* and root lesion nematodes, causal agents of potato early dying (PED) complex. Past research in PEI has indicated that red clover is a preferred host for both of these pathogens. However, there is little research on other forage legumes like alfalfa and white clover in comparison with grass species.

In the spring of 2019, two fields in western Prince Edward Island were planted with strips of the following forage species: double cut red clover (RC), alfalfa and timothy (ALF), white clover and festolium grass (WC), birdsfoot trefoil (TR), and grass as a non-legume check. Festolium grass was planted at both sites, but did not establish well at one site, so the comparison was done using Italian ryegrass which was planted in the same field directly next to the festolium strip. Birdsfoot trefoil did not establish well at either site; therefore, this strip was excluded from analysis in this report for both fields. Both fields were planted May 2019 using the same seeding rates. Soil chemical, *Verticillium* and nematode testing was completed at planting in the spring of 2019. It was then completed again in the fall of 2019, spring of 2020, fall of 2020, and spring of 2021. Both fields had been planted to potatoes in 2018, and both fields were again planted to potatoes in 2021. Mountain Gem Russets were planted at the Alma field, while Prospect was planted at the Huntley field.

There was no identifiable trend for an increase or decrease in pH, soil organic matter, or soil nutrient concentration between the different forage treatments. Following two years of forages, pH and soil organic matter levels were mostly unchanged, regardless of treatment. In the Alma field, there is evidence of reduced soil compaction in the alfalfa/timothy treatment. Levels of *Verticillium dahliae* were lower across all treatments in the spring of 2021 compared to samples in the spring of 2019 immediately following potatoes in 2018. It is difficult to say whether there was a difference in *V. dahliae* population between the different forage treatments. Root lesion nematode (RLN) populations were more inconsistent across years and treatments, as well as from field to field. In the Huntley field with a higher starting population of nematodes, populations fluctuated substantially, with populations prior to potato planting considered high across all treatments. In the Alma field, with a lower starting population, RLN counts were a bit more consistent from year to year, with three of the four treatments having counts less than 5000 per kg of soil (considered a threshold for damage in Russet Burbank by Dr. Kimpinski, AAFC). In the Alma field, the alfalfa/timothy treatment has consistently lower RLN counts than other treatments.

In both fields, the alfalfa/timothy treatment had the highest total yield and marketable yields. In the Alma field, this was significantly greater ($p < 0.10$) than the three other treatments. For the Huntley field, alfalfa/timothy yields were significantly greater than only the white clover/festolium and festolium treatments. Differences in tuber size and quality variables was largely insignificant across treatments. It is difficult to isolate the reason for the improved yields in the alfalfa/timothy treatments in both fields. While suppression of potato early dying could be one factor, additional factors that may have come into play include additional nitrogen supply) or reduced soil compaction. Nonetheless, the alfalfa/timothy treatment did show a marked improvement in yield and crop value in both fields.

The Effect of Chemical Fumigation and Substrate Carbon Availability on Soil Respiration, Apparent Plant Residue Decomposition, and Microbial Diversity

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Chemical fumigation is an agronomic practice used to manage soil-borne diseases and pathogens in high-value cropping systems, including potato (*Solanum tuberosum* L.) production systems. However, chemical fumigation may also impact non-targeted microorganisms, consequently altering soil microbial diversity and essential soil processes controlled by soil microorganisms. This experiment investigated the impacts of chemical fumigation and substrate carbon (C) availability on soil respiration, apparent plant residue decomposition, and soil bacterial and fungal diversity under controlled conditions over 128 days. The microcosm experiment consisted of a 3 x 3 factorial arrangement in a randomized complete block design. Factors included three fumigation treatments [chloropicrin (CP), metam sodium (MS), or non-fumigated soil (CT)] and three soil amendment treatments [young barley residue (Y), mature barley residue (M), or unamended soil (U)].

The addition of young and mature barley residues to non-fumigated soil increased cumulative soil respiration compared to the non-fumigated unamended soil. In contrast, chemical fumigation decreased cumulative respiration in soils amended with young and mature barley residues compared to non-fumigated amended soils. Additionally, in soils amended with young barley residues, chemical fumigation delayed the maximum soil respiration rate by five days compared to the non-fumigated soil. From 0 to 16 days of incubation, CP- and MS-fumigated soils had a significantly lower percentage of apparent plant residue decomposition compared to non-fumigated soils; however, from 0 to 128 days of incubation, only CP-fumigated soils had a significantly lower percentage of apparent plant residue decomposition compared to the MS and non-fumigated soils.

The addition of young barley residues to non-fumigated soil decreased bacterial and fungal species evenness. In contrast, adding mature barley residues to non-fumigated soil only decreased fungal species richness. Chemical fumigation with MS only decreased bacterial species richness or evenness when combined with young barley residues; however, MS fumigation did not affect fungal species richness or evenness. In contrast, chemical fumigation with CP decreased bacterial richness and evenness, regardless of soil amendment or C availability. However, CP fumigation only decreased fungal species evenness and richness when combined with young or mature barley residues. Although all treatments altered the soil bacterial and fungal community composition over time compared to the non-fumigated unamended soil, CP fumigation gave rise to the most dissimilar bacterial and fungal community compared to all other treatments.

This study demonstrated that chemical fumigation, particularly with CP, altered soil respiration, plant residue decomposition, and soil microbial diversity. Interestingly, although amendment with young or mature barley residues to non-fumigated soil decreased microbial diversity indices and altered microbial community composition, soil respiration was increased, indicating that microbial activity and soil function were preserved in these treatments. Conversely, decreased soil respiration and apparent plant residue decomposition in chemically fumigated soil suggests that decreased microbial diversity and altered community composition were concomitant with a loss of soil function. These findings indicate that chemical fumigation may have long-term implications for soil productivity.

The Free-Living Nematodes of New Brunswick, Canada

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The Atlantic Canada Soil Biogeography and Soil Carbon Project maps and assesses structural and functional relationships among soil properties and biotic parameters across land uses. Free-living nematode communities occupy nodes across trophic levels of the soil food-web, their community composition indicators respond reliably to agricultural management and can thus inform on functional soil quality status. Nonetheless they have not yet been thoroughly surveyed in Atlantic Canada.

Approximately 200 samples were collected between 2020 and 2021 in New Brunswick, Canada (NB); 44 of the samples were collected from the potato belt region. In this a priori assessment, we evaluated the relationship between nematode community trophic composition, trophic group ratios, diversity indices and ecoregion, land use, soil type, and soil properties. More complex nematode communities in terms of greater omnivore and predator abundances may indicate a more stable food-web with greater relative soil quality. Trophic ratios (e.g., fungivore abundance/bacterivore abundance) can inform of the dominant carbon decomposition pathways (i.e., rapid bacterial decomposition vs slower fungal decomposition); higher diversity generally indicates more efficient and resilient food-web functioning.

While nematode communities were distinct between ecoregions of NB, land use had a stronger impact on the community composition. Natural lands (forests and wetlands) were more associated with predator nematodes compared to managed lands, while managed lands (crops and pastures) had proportionally greater bacterivore, fungivore, herbivore, and omnivore abundance. Agricultural lands in the northwest of NB are under intensive potato crop production systems. Soils from the potato belt region had distinct nematode communities compared to those in agricultural soils from elsewhere in NB, these differences were soil type dependent. For example, there were statistically more bacterivorous nematodes in the Podzolic agricultural soils in the potato belt than elsewhere; this was not the case for the Luvisols.

This study suggested that changes in nematode community composition could be related to variability in soil properties as driven by land use and soil type. Thus, it is sensible to further assess nematode community potential as indicators of soil quality in Atlantic Canada.

Identifying The Irrigation Critical Point In Potato Crop Fields Using UAV Remote Sensing To Smart Farming Proposes – A Case Study

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Potato is a tuber plant having a shallow root system. Specifically, in Québec's agricultural region, this crop is cultivated in sand soils, which contributes to the water vulnerability of this culture. Another important characteristic of this region is the low amount of liquid precipitations during the tuberization period, leading to a high need for water suppling by irrigation. Water vulnerability is critical to crop development. Water stress may impact crop yield. Hence, an approach based on plant physiology may allow farmers to meet the crop field water demand precisely over the field. Also, the delay of delivering this kind of information is critical to keep or increase crop yields, because water stress impacts plants healthy. Remote sensing is a fast and precise method to obtain altimetry information over the surface via DEM (Digital Elevation Model) or DTM (Digital Terrain Model) using photogrammetry models. The range of benefits of using remote sensing includes georeferenced data, resolution choices (spatial, temporal, radiometric, and spectral), fast data analysis, and non-invasive data collection. Potato crop plants stop growing when the root deep is stabilized. This is the reference of tuberization period beginning and so the irrigation need. This research is based on field data (root deep – RD) and remote sensed data (plant height – H) acquired at a potato crop field placed in Pont-Rouge/Ste Catherine region (Québec) during 2020 growth season (June to September). Data collection was made weekly in both cases. RD data was taken by direct measurement in fourteen sample points over the field. H data was obtained by drone imagery using the field weekly MDE at every RD sample point. Empirical observations indicate that when plants roots depth is maximal, they stop growing. In shot, the growth curve stabilization can be used as a proxy of maximal root deep, which means the beginning of tuberization period. At this moment, water stress vulnerability becomes a farmer's concern. In this context, this research's aim is to develop a dynamic method based on remote sensing images and photogrammetric approach to precisely determine the moment when the tuberization period begins, named the critical point of irrigation. The 2020 growth season results indicate a high correlation between RD and H, up to 85% for point-to-point analysis. The correlation is independent from infield soil and relief variations, having values up to 95% for management zones analysis. Also, growth rate corroborates correlation results, having a decreasing pattern in time with $R^2 > 0.80$ independent from spatial variations. This lest one was obtained by the gradient of the H over time. In conclusion, the critical point of irrigation can be determined by remote sensing. This innovative approach is flexible over agricultural seasons and independent from climate variations because it is exclusively based on the crop growth dynamic. Regarding the results, this approach may be useful to other crop types having the same pattern as the potato crop and for other agricultural regions in the world. Also, this approach may be merged with others to improve smart farming techniques.

CO_2 – stimulation of photosynthetic performance and potato yield is cultivar dependent

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The effects of long-term elevated CO_2 on photosynthetic performance and tuber yield of five potato cultivars (AC Novachip, Atlantic, Kennebec, Russet Burbank, and Shepody) grown at either ambient (400 μmol C mol^{-1}) or elevated (750 μmol C mol^{-1}) CO_2 were studied. Compared to ambient CO_2-grown counterparts, elevated CO_2-grown plants exhibited a 1.06 – 2.2-fold increase in tuber yield, and a 1.1 - 1.4-fold increase in the rates of photosynthesis across the cultivars. Concomitantly, the stomatal conductance and transpiration rates were decreased by 15- 25% and 5-20 %, respectively, and water use efficiency increased by 10-90 % upon growth at elevated CO_2. The CO_2-stimulation of tuber yield varied with cultivars such that the commercial cultivar Russet Burbank and Shepody exhibited a 120% and 58% increase respectively, whereas, AC Novachip, Atlantic and Kennebec exhibited only 6%, 10% and 44% increase in tuber yield respectively at elevated CO_2. This differential stimulation of tuber yield by elevated CO_2 was consistent with variations in CO_2-stimulation of rates of photosynthesis, tuber number and size across the cultivars. Elevated CO_2 increased the tuber number by up to 80% across the cultivars as compared to at ambient CO_2. Although elevated CO_2 increased the tuber size by 6%, 29%, and 89% for AC Novachip, Kennebec, and Russet Burbank respectively, it decreased the size by 12-20% for Shepody and Atlantic. Surprisingly, we did not observe any significant differences in plant growth and morphology in elevated versus ambient CO_2-grown plants. We conclude that the potential for enhancement of photosynthetic performance, water use efficiency and tuber yield of potatoes grown at elevated CO_2 is cultivar dependent.

Climate Change and Potato Production in NB: A crop modeling perspective

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Climate change has the potential to impact potato yield and yield stability, and thus, threatens the sustainability of New Brunswick (NB) agriculture. Climate change projections in NB anticipate an uncertain precipitation pattern and an overall rise in air temperature and atmospheric CO_2 concentration in the future. Variability of these climatic variables in space and time will further complicate the potato crop management. Potato crop models can be a robust means to assess the impacts of future climate change and potential adaptation strategies. We reviewed crop growth models currently available in literature and assessed a total of 33 potato models for their potential application in climate change impact assessments for potato production in NB. On the basis of a principal component analysis, we selected the SUBSTOR-potato model to assess the impact of climate change on potato yield. Next, the growth and development of Russet Burbank variety was analyzed across numerous climatic scenarios and planting dates, e.g. under a baseline weather scenario (1980-2021) and four future climatic scenarios for up to 2080, varying by precipitation, temperature and CO_2 concentration levels in the atmosphere. In addition, assessment of yield stability under relatively stable and highly variable weather conditions was conducted.

Our results showed that DSSAT-SUBSTOR model needed several necessary adjustments, model calibration and evaluation to adequately simulate under various management and growing conditions in NB. Simulation uncertainty and year-to-year variability became larger by the end of the century. Nevertheless, a general pattern is that potato biomass and yield is predicted to increase with climate change, since the increase of CO2 concentrations can mitigate the effect of rising temperature. Tuber quality could not be adequately evaluated within this time frame. Subsequent simulations revealed that planting time is a key factor to consider with climate change, because early planted crop may be more vulnerable, particularly with the increased precipitation variability. In future simulations, adapting different potato cultivars and cropping systems to climate change needs to be explored to ensure future food security, particularly for this high cash generating crop.

Potential economic and environmental effects of supplemental irrigation: Insights from historical potato yield and weather data in Prince Edward Island

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There has been a growing interest in supplemental potato irrigation (SI) as a result of increasing drought events in this traditionally rain-fed production region. Knowledge about the productivity and profitability of SI and their annual variations is important for making decisions about SI adoption. However, long-term experiments are required to produce this knowledge but usually are not conducted yet. This study was conducted to characterize yield responses of Russet Burbank (RB), Shepody, Kennebec and Goldrush cultivars to water supply by conceptualizing the 2000–2020 (excluding 2018) marketable yields for the four cultivars in Prince Edward Island (PEI) as the results of a long-term un-replicated irrigation experiment with growing season (Jun.–Sept.) precipitation as irrigation water supply. The resulted yield-determining equations were utilized to predict yield gains by SI for beneficial analysis. Yield responses followed second-order polynomial regressions with 69%, 65%, 29% and 50% of yield variation being explained by growing season (GS) precipitation for the four cultivars, respectively. Three of the 20 seasons received insufficient precipitation when SI would be required for optimum potato production; five seasons received excessive precipitation when soil dewatering would be beneficial; 12 seasons received precipitation in the range of 280–400 mm, in which potato yields responded insensitively to varying water supply or SI would create little yield response. These historical data imply that reducing annual variation in potato yield in this region requires not only SI but also a soil dewatering system as GS rainfall can be either insufficient or excessive, depending on the year.

Assuming the costs of SI using a center-pivot system in Maine, US, being comparable to those in PEI, SI could potentially generate net revenue in an extremely dry year under both 20- and 40-ha field sizes, and in a very dry year under 40-ha field sizes but not under 20-ha field sizes; SI would not generate net revenue in a slightly dry or normal year regardless of field size because yields responded insensitively to varying water supply on top of these GS rainfall rates. The annual variation in SI requirements and profitability presents a great financial challenge for widely implementing SI in this region. Assuming equal water access for all potato land, SI could use anywhere from 2.6% in a relatively wet season to as much as 23% in an extremely dry season of annual average groundwater recharge in an intensive potato production watershed. A innovative management strategy is required to address the potential conflict of competing water use between environment and humans in an intensively-farmed watershed in a very dry season when high groundwater pumping coincides with low recharge.