Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Fall 2021

Activity title: Enhancement of Canadian Potato Industry through Smart Agriculture.

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Names of Collaborators and Institutions: Drs. Farooque (PEI University), Zaman (Dalhousie University), Schumann (Florida University), Esau (Dalhousie University), Al-Mughrabi (NBDAAF), Comeau (AAFC), Zebarth (AAFC), Lafond (AAFC), Ziadi (AAFC), Chokmani (INRS-ETE), Adamchuk (McGill), Biswas (Guelph) and Duchemin (AAFC)

Activity Objectives (as per approved workplan):

The overall objective is to develop and evaluate precision agriculture (PA) practices suitable for applications in potato production areas of Canada including delineation of management zones (MZs) and variable rate application (VRA) of fertilizer, pesticides, irrigation, plant density as compared to uniform rate application on the basis of tuber yield and quality, nutrient leaching and economic benefits in the provinces of Québec and Prince-Edward Island (PEI).

Research Progress to Date (use plain language, not to exceed 500 words):

Activity 14A Precision Agriculture in Québec: The 14 ha field selected in 2019 (commercial potato production; cultivar Russet Burbank) was also utilized in 2021 in order to evaluate its potential for the nitrogen (N) fertilization experiment under PA approach. The same three areas with homogeneous characteristics (MZs) was conserved to minimize intra-zone variability and maximize inter-zone variability. Delineation of MZ was based on the soil apparent electrical conductivity (ECa) and pH soil maps. Experimental design was implemented in the field. Four treatments consisted of N rates varied from 162 to 252 kg N/ha were applied in three applications (Fig. 1). Two times during the growing season, soil samples and many plant parameters [i.e., vegetation indices via drone images, petiole nitrate concentration] were measured at 72 georeferenced sampling points (SP) located in all the 16 strip treatments (Fig. 2). On September 20th 2021, total and marketable yield (1-row X 3-m X 2 X 72= 144 yield evaluations) as well as residual soil nitrate were measured on the 72 sampling points. On November 2nd and 4th 2021, soil penetration resistance over a depth of 80 cm was measured all along each of the 4 blocks and over 6 transversal transects crossing some of the 72 georeferenced SP, for a total of 189 measurements. Ground penetrating radar survey will be achieved during winter 2022 over these soil penetration resistance transects. Most laboratory analyses and statistical analysis will be completed later this winter.

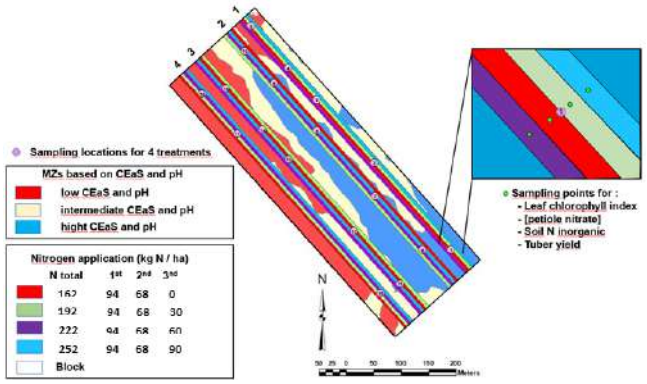

Fig. 1 : Management zones and the N strip treatments implementation.

Fig. 2 : Aerial photo of the field on August 5th.

Activity 14B Precision Agriculture in PEI:

The application phase of variable rate technology was tested in five different potato fields across PEI. All fields were commercial potato fields germinated with Russet Burbank cultivar in mid-May 2021. Initially, soil ECa and topography surveys were conducted to delineate fertility-based soil-water and topography (SWAT) maps (Fig. 3). Twenty-four sampling locations were selected from delineated SWAT-based management zones to quantify the soil chemical and physical properties. The soil samples collected from sampling locations were tested for soil organic matter, soil pH, soil macro, and micronutrients. In addition to soil chemical properties, other soil properties such as soil moisture, soil temperature, and slope data were also collected throughout growing season 2021.

In the year 2021, variable-rate nitrogen application was applied in two fields of Prince Edward Island (Figure 2). Based on soil available nitrogen data, variable-rate nitrogen maps were prescribed for variable rate nitrogen application. To monitor the crop growth, vegetation indices, and soil temperature; a fixed-wing Ebee drone (SensFly, USA) was used to survey the fields throughout the potato growing season. The yield samples, nitrogen uptake, and tuber quality data were collected at the end of the season and will be analyzed in winter 2022 to assess the variable rate application efficacy.

In the year 2021, variable-rate plant spacing trials were also tested in two fields of Prince Edward Island. Three plant spacing (15.3, 17, and 18.7 inches) treatments were tested using a variable-rate planter. Furthermore, the accuracy of plant spacing was also monitored using a fixed-wing Ebee drone (SensFly, USA) using a high-resolution camera. The imagery retrieved from the drone was processed for individual plant counts from each variable-rate plant spacing trial.

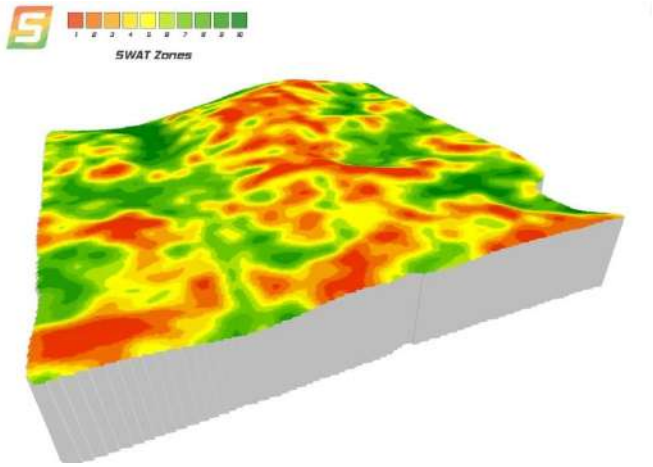

Fig. 3: Soil water and topography (SWAT) based fertility maps of selected fields in Prince Edward Island.

Fig. 24 Variable rate-based nitrogen map for the selected fields in Prince Edward Island.

Extension Activities (presentations to growers, articles, poster presentations, etc.):

Cambouris, A.N. Stratégies d'échantillonnage des sols géoréférencés. Webinar organized by the MAPAQ and CRAAQ presented online, November 16th, 2021 (#224 of participants)

Farooque, A. & **Cambouris, A.** 2021. Learning to Manage Your Soil with Precision Agriculture: Spudsmart Magazine. Available at: https://spudsmart.com/learning-to-manage-your-soil-with-precision-agriculture/

Barrett, R., MacDonald, E., Afzaal, H. and **A. Farooque**. 2021. Remote sensing creates maps of fields to guide P.E.I. farmers. CBC Article. Available at: https://www.cbc.ca/news/canada/prince-edward-island/pei-remote-sensing-maps-manage-fields-1.6212504

Farooque, A. A. 2021. Soil EC based Management Zones for Nutrient Management and Variable Rate Seeding. Invited Talk – Online Webinar at Regional Meetings in PEI (East, West and Centre), organized by the Potato Board PEI. Presented and showcased the project results and demonstrated trials to the Growers, Industry and Government Representatives, Organized by the PEI Potato Board – September 2021.

Peer Reviewer Journal Articles

Khan, H., Esau, T., **Farooque, A. A.,** Abbas, F., Zaman, Q. U., Barrett, R., & Acharya, B. (2021). Identification of Significant Factors Affecting Potato Tuber Yield for Precision Management of Soil Nutrients. *Applied Engineering in Agriculture*, *37*(3), 535-545.

Khan, R., **Farooque, A. A.,** Brown, H. C. P., Zaman, Q. U., Acharya, B., Abbas, F., & McKenzie-Gopsill, A. (2021). The Role of Cover Crop Types and Residue Incorporation in Improving Soil Chemical Properties. Agronomy, 11(10), 2091.

Scientific presentations at national and international conference:

Khan, H., **Farooque, A.,** Esau, T., Abbas, F., Acharya, B., & Zaman, Q. (2021, July 1-14). Development of management zones for site-specific fertilization through proximal sensing of potato fields. American Society of Agricultural and Biological Engineering, virtual.

Khan, H., Acharya, B., Esau, T., **Farooque, A.,** Abbas, F., & Zaman, Q. (2021, June 27-30). Precision management of soil nutrients to identify significant factors influencing potato tuber yield. Proceeding of Canadian Society for Mechanical Engineering International Congress, virtual or on demand.

COVID-19 Related Challenges:

If there is no other shutdown of our laboratories, we will be able to deliver everything we put in the plan.

Key Message(s):

- Develop map/sensor-based precision agriculture systems for Québec and Atlantic Provinces Canada's potato industry based on proper characterization and quantification of variability.
- Identify sensor-based options to perform mapping and tailor management practices to reduce labor and sample analysis cost.
- Apply nutrients based on need to evaluate the productivity benefits.
- Evaluate environmental benefits of the variable rate nutrient management.
- Develop user-friendly protocols for farmers/industry use.
- Train HQP and industry personnel in the emerging area of precision agriculture.

This project is generously funded through the Canadian Agri-Science Cluster for Horticulture 3, in cooperation with Agriculture and Agri-Food Canada's AgriScience Program, a Canadian Agricultural Partnership initiative, the Canadian Horticultural Council, and industry contributors.

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