Canadian Agri-Science Cluster for Horticulture 3

Update to Industry

Semi-Annual – Spring 2021

Activity title: Enhancement of Canadian Potato Industry through Smart Agriculture

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Activity Objectives (as per approved workplan):

The overall objective is to develop and evaluate smart farming (precision agriculture: PA) practices suitable for application in several major potato production areas of Canada. Specifically, this project will: 1) characterize soil spatial variability and evaluate methods for mapping this variability; and 2) develop and evaluate precision agriculture strategies most relevant to each production region.

The main objective for the province of Quebec is to assess the benefits of a precision N management approach based on management zones (MZ) in terms of yield and N-use efficiency as compared to uniform N management. The precision N management approach proposed will be based on soil MZ and in-season N status.

In Prince Edward Island (PEI), the main objective is to assess the benefits of precision agriculture approach based on soil MZ 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. The VRA implementation will be based on spatio-temporal soil and crop property maps.

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

Activity 14A Precision Agriculture in QC: Research Progress to Date:

Following the travel restrictions imposed by the COVID-19, the 2018 field was reused to implement the 2020 nitrogen fertilization experiment. The field presented three MZs : $MZ_{Low\_Elevation}$, $MZ_{intermediate\_Elevion}$ and $MZ_{Hight\_Elevation}$, with mean elevations of 153 m, 154 m and 155 m respectively. Russet Burbank was planted on the field. An experimental design of four strip treatments (six rows X length of the field) were distributed in a RCBD with four replicates and went through all the MZs. The N rate of the four treatments varied from 170, 204, 237, and 270 kg N ha^{-1} (referred as N170, N204, N237, and N270). Many plant parameters [i.e., vegetation indices from images acquisition using drone, petiole nitrate concentration] were measured at 72 sampling points (SP). The soil surface nitrate were determined at the same time and on the same SP. At harvest, 3-m rows were dug to determine the total (TY) and marketable yield (MY) at the 72 SP. Ground penetrating radar measurements were done in fall 2020 and winter 2021 to detect soil heterogeneities and compaction zone in the field in order to fine-tune the MZs.

Preliminary results showed that the main effects of MZs on TY indicated significant difference between $MZ_{High\_Elevation}$ (34.2 t/ha) and MZ_{Low_Elev} (39.6 t/ha) or $MZ_{intermediate\_Elev}$ (42.4 t/ha). The results indicated also significant difference between $MZ_{High\_Elevation}$ (32.1 t/ha) and MZ_{Low_Elev} (38.4 t/ha) or $MZ_{intermediate\_Elev}$ (40.3 t/ha) for MY. The $MZ_{intermediate\_Elev}$ was more productive than the others. The MZ_{High_Elev} was the least productive. The main effects of N rates on TY indicated no significant difference between N170 (38.1 t/ha), N204 (38.8 t/ha), N237 (38.6 t/ha) and N270 (39.4 t/ha). Same

observation for the MY. For TY and MY, the interactions between MZ x N rates were not significant suggesting that the N170 gave the higher yield in MZs. Drone images (hyperspectral and multispectral) are being analyzed and all other soil, plant and petiole laboratory analyses will be completed during the fiscal year 2021-2022 due the long shutdown we had in QRDC due to Covid-19.

Activity 14B Precision Agriculture in PEI; Research Progress to Date

Variable rate application (VRA) was tested in four fields of PEI. Prior to planting, soil apparent electrical conductivity (ECa) was measured to delineate fertility zones in each field. Afterward, zone sampling was conducted from the three productivity zones for sensors (Moisture, NDVI, Slope, ECa, and Temperature) and yield data collection. Furthermore, in addition to ECa mapping, soil water and topography (SWAT) maps were also included in delineating the soil MZs for determining VRA of agrochemicals. The results reflected the efficient applicability of SWAT and ECa mapping in determining optimized application rate of soil inputs. High similarities were observed between soil surface temperature, SWAT, and yield maps for Hamilton and O'Leary fields. Slope parameter addition to ECa maps adds more accuracy to MZs in areas like PEI, where the topography is not very flat with undulated agricultural fields. By adopting SWAT based variable rate technology, there was $36/acre and $35/acre profit for Hamilton and O'Leary fields respectively using the same amount of potash as used for broadcasting application. These profits were only for variable potash application and there is potential of generating more revenue by adopting VRA in other fertilizer applications such as nitrogen, lime, etc. Information about variable plant spacing is an important element to control and optimize the input resources. It was interesting to get the different yield responses by using variable seed spacing. For example, both high plants spacing (18.7 inches) and low plant spacing (15.3 inches) generated more yields e.g., 425 cwt/acre and 454 cwt/acre respectively, in comparison with conventional plant spacing (17 inches) treatment with yield of only 349 cwt/acre. The results suggested the potential of high yields by optimizing the plant spacing, however, more detailed studies are required to optimize plant spacing for individual fields.

Furthermore, field characteristics had direct impacts on tuber productivity. The trend of the slope, soil moisture content, soil surface temperature, and yield of the low, medium, and high productivity zones were meaningful. For example, for the O'Leary field, it was found that the portion of fields with high slope had lower productivity and vice versa probably because of higher soil erosion from steep slopes resulting in the loss of soil nutrients, poor soil health, and reduced tuber yield. As such slope had a direct impact on retention of soil moisture content; the high slope areas ended in retaining the least soil moisture content (15.7%) followed by medium (20.7%) and low slope areas (26.5%).

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

Related to Activity 14A

Published article in peer-reviewed journal:

Clément, C. C., **Cambouris, A.N**., Ziadi, N., Zebarth, B. J., & Karam, A. (2020). Growing season nitrate leaching as affected by nitrogen management in irrigated potato production. Agronomy Journal, 112(5), 3773-3787.

Lajili, A., **Cambouris, A. N.**, Chokmani, K., Duchemin, M., Perron, I., Zebarth, B. J., ... & Adamchuk, V. I. (2021). Analysis of Four Delineation Methods to Identify Potential Management Zones in a Commercial Potato Field in Eastern Canada. Agronomy, 11(3), 432. https://doi.org/10.3390/agronomy11030432

Scientific presentations at national and international conference:

Cambouris, A.N., H. Ajili, K. Chokmani, I. Perron. 2020. In-Season Nitrogen fertilizer Application under Potato Crop in Delineated Soil Management Zones. Virtual presentation done at the Precise Nitrogen Community Webinar October 8th, 2020 part of the Virtual ICPA 2020 Fall Webinar Series (Oral presentation; **Invited Speaker**).

Clément, C.C., **A. N. Cambouris**, N. Ziadi, B. J. Zebarth, A. Karam. 2021. Nitrate Leaching as affected by Nitrogen Fertilization in Irrigated Potato Production on Sandy Soils. Virtual presentation done at the Northeast Technology Potato Forum held on 23-24 March, 2021. (Oral presentation).

Technology transfer to the sector:

Lafond, J., N. Goussard, **A.N. Cambouris**, S. Gumiere, V. Vanlandeghem, A.-D. Baillargeon, M. Duchemin, C. Lambert-Beaudet. 2021 Georadar et compaction. Virtual workshop held on March 18, 2021 with the project partners J-002057. (Oral presentation, 13 people).

Cambouris, A., M. Duchemin, A.-A. Aymot, N. Ziadi, K. Chokmani et Jonathan Lafond 2021. Résultats préliminaires saison 2020 : Ferme Cantin et Fils. Virtual meeting held on March 18, 2021 with the project partners J-002057.

Related to Activity 14B

Published article in peer-reviewed journal:

Khan, H., Acharya, B., **Farooque, A.A.**, Abbas, F., Zaman, Q.U., Esau, T. 2020. Soil and crop variability induced management zones to optimize potato tuber yield. *Appl. Eng. Agric*. 36:499-510.

Khan, H., **Farooque, A.A.**, Esau, T., Abbas, F., Acharya, B., Zaman, Q.U. 2020. Delineation of management zones for site-specific soil fertility characteristics through proximal sensing of potato fields. *Agronomy*, 10: 1854.

Scientific presentations at national and international conference:

Khan, H., Acharya, B., Esau, T., **Farooque, A.A**., Abbas, F., & Zaman, Q. (2020, June 21-24) Identification of significant factors affecting potato tuber yield for precision management of soil nutrients. Proceeding of Canadian Society for Mechanical Engineering International Congress, Charlottetown PEI.

Khan, H., Acharya, B., **Farooque, A.A.,** Abbas, A., Esau, T., & Zaman, Q. (2020, May 10-14). Effect of within field soil variability on potato tuber yield. International Commission of Agriculture and Biosystem Engineering, virtual.

Technology transfer to the sector:

Farooque, A. A. 2021. Soil, Water and Topography based management zones for variable rate seeding and nutrient management. Keynote address at a virtual annul grower meeting, organized by the Prince Edward Island Potato Board. March 19, 2021.

Farooque, A. A. 2021. Variable rate seeding and nutrient management using SWAT based zones: An economic prospective. Invited address at a virtual webinar, organized by the School of Climate Change and Adaptation, University of PEI. March 19, 2021.

COVID-19 Related Challenges:

Considering the constraints resulting from COVID-19, laboratory activities have been significantly reduced for the 2020-2021 season. And the delay in soil, plants analysis will be catch up during the fiscal year 2021-2022.

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.

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