LIVING LAB - ATLANTIC

Evaluating greenhouse gas emissions under precise nitrogen management

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Introduction

Potatoes are the primary cash crop in Prince Edward Island, the industry is estimated to be worth over a billion dollars each year to the local economy. Significant amounts of fertilizer are used for the successful production of this crop. Globally, agriculture is responsible for a significant amount of anthropogenic sources of greenhouse gases (GHGs). In 2020, 10% of the total GHG emissions reported in Canada resulted from agricultural activities. Agricultural soils represent an increasingly large global source of nitrous oxide (N_2O) emissions, and the potential impact of precise nitrogen (N) management on GHG emissions still needs to be understood. A precise application management practice, or variable rate application determines the variability in a field and matches crop requirements and N input applications. Knowing the variability in a field as it relates to N allows for the development of prescription maps, which outline the amount of an input needed for each measured area. Producers use these maps to then adjust N application rates accordingly.

This research has examined the effects of improved N management strategies on GHG emissions from potato production systems. Best management practices (BMPs) which address the spatial and temporal variability of soil N are necessary to reduce emission levels. The use of technology to increase the precision of practices such as fertilizer application save producers money, protect the environment, and increase on-farm efficiency.

Objectives

The objectives of this research were to:

- evaluate the effectiveness of using precision agriculture practices on mitigating GHG emissions from Atlantic Canadian potato production systems.
- provide scientific evidence for the development of improved precision agriculture strategies.
- contribute to regional and national GHG inventories.

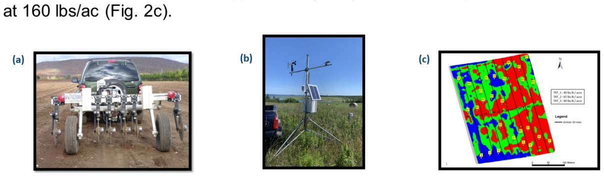
Methodology

Field trials were conducted in 8-15 ha potato fields across Prince Edward Island (Table 1). Intensive soil sampling occurred prior to trials being conducted to measure field nutrient content. Campbell Scientific weather stations were established at each site to monitor weather and climatic parameters (Fig. 2b).

Table 1: Potato cropping system during a 3 yr rotation.

Parameter/Activity	2020	2021
potato variety	Prospect	Russet Burbank
field size	8 ha	15 ha
pre-plant fertilizer blend/rate	46-0-0 + Agrotain Uniform 40, VRA 20, 40 & 60lbs/ac	46-0-0 + Agrotain Uniform 40, VRA 20, 40 & 60lbs/ac
planting date	May 18, 2020	May 30, 2021
seeding rate	34 cwt/ac	20 cwt/ac
fertilizer blend/rate at planting	DAP (18-46-0) and CAN (27-0-0) @ 100lbs N/ac	DAP (18-46-0) and CAN (27-0-0) @ 100lbs N/ac
harvest date	Oct. 7, 2020	Oct. 20, 2021

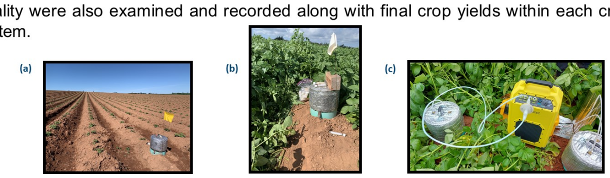
Electrical conductivity (0-1 m) was also measured at numerous sample locations using the VERIS, so that each field could be mapped accordingly (Fig. 2a) based on current field conditions. Nitrogen management zones were divided across all fields and a complete randomized block design was carried out accounting for various management zones; uniform application, variable rate application (VRA) at 120 lbs/ac, VRA at 140 lbs/ac, and VRA at 160 lbs/ac (Fig. 2c).



Figs. 2a: VERIS technology; **2b:** On-farm weather station; and **2c:** Nitrogen management zone map example.

Methodology (cont'd)

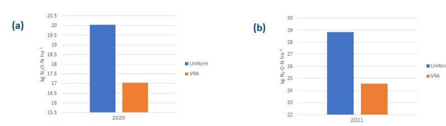
Greenhouse gas sampling locations were then randomly selected within each zone. Soil samples were also obtained before fertilizer application, as well as at each GHG sampling location on a regular basis and were analyzed for N. Nitrous oxide samples were obtained throughout the cropping season from May-Oct. in yr 1 (2020) and yr 2 (2021), and yr 3 was the rotation year. Gas samples were obtained over a 1 hr period during each sampling event and more intensely following any field activities. Nitrous oxide fluxes were collected using static chambers (Figs. 3a and b). Gas samples were placed in glass vials and analyzed using gas chromatography and portable field analyzers (Fig. 3c). Crop health and quality were also examined and recorded along with final crop yields within each cropping system.



Figs. 3a and b: Static chamber placement following planting; **3c:** Portable gas analyzer.

Results & Discussion

Nitrous oxide emissions were variable throughout the growing season and were impacted by fertilizer application, weather and soil moisture. The first two years monitored had very different climatic conditions. For instance, 2020 overall was very dry with a 30-50% reduction in precipitation compared to the 30 yr normal; and 2021 had an increase in precipitation of 7-14% over the 30 yr normal depending on field location. Precipitation events greater than 10 mm impacted overall fluxes when a N source was present. Fluxes were however variable throughout the growing season with peak fluxes occurring after application, top dress, and following heavy rainfall events. Results indicate that VRA can reduce overall total N_2O emissions when compared to uniform rate application (Figs. 4a and b). Using precise N management with potato production systems with specified management zones has the potential to reduce losses throughout the growing season. Total N losses were reduced by 15 and 16% in 2020 and 2021 respectively, when compared to uniform applications. Overall yields were not found to be significantly different with an average of 3 and 7% increase in 2020 and 2021 respectively, when compared to uniform application.



Figs. 4a and b: Total N_2O-N losses in VRA vs. uniform application.

Summary

This collaboration has enabled research to be co-developed and implemented on-farm. During this project, producers, partners and scientists have worked together to develop management practices and evaluate their feasibility and benefits. This research has demonstrated that the use of precise N management in 3 yr potato production systems has the potential to reduce GHG emissions without impacting overall crop health or yield. Overall, N losses in the form of N_2O-N were reduced by 15 and 16% in 2020 and 2021, respectively. This reduction represents a potential savings to the producer through the amount of applied N. Precise N management should be considered a BMP. Technology access and cost will be the main barriers for this adoption; however potential savings allow this cost to be recovered.

Acknowledgements

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