Identifying $NEMO_{potato}$; a tool for strategic N recommendation

LIVING LAB - ATLANTIC

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Introduction

Identifying optimum nitrogen rate (N_{opt}) is essential for increasing production while limiting potential environmental contaminations, especially for high demand N crops such as potato. However, N_{opt} varies by climate and soil. The central questions of N management is then: What should be recommended N for given soil and climate?

What is an optimum N rate?

Economic optimum N rate (N_{opt}) is an N rate at which the economic net return is maximized. At this rate the slope of yield function, known as N use efficiency (NUE), is equal to $N/$Yield.

Ecophysiological N_{opt} is a rate at which the N excess (i.e., the amount not taken up by plants) is minimized with little reduction in maximum achievable yield known as yield potential.

How is N_{opt} affected by soil and climate?

The soil type and interannual climate variations affect the shape of yield function and corresponding N_{opt}.Therefore, a unique optimum NUE (slope) results in different N_{opt} in different years and locations.

Here, we intent to identify the ecophysiological NUE_{opt}, and recommend an environmentally friendly N rate.

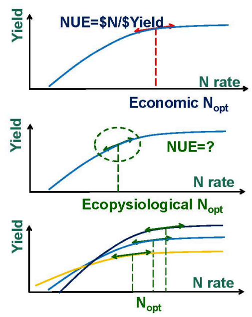

Figure 1. Yield functions

Method (Identifyung NEMO) tool, a package for research community

We developed a model-based approach, Identifying NEMO (nitrogen ecophysiologically modelled optimum) for potato N recommendation. This approach was originally developed for corn (Mesbah et al. 2017, 2018). An interactive R package (Figure 2) was developed to ease the use of this approach by advanced users. The steps are:

- Insert a csv file containing modelled yield responses to N. The color-coded points in Figure 2.a are year-specific modelled yield.
- The tool fits the Mitscherlich Baule-plateau (MB-P) function to the modelled data from each growing season separately (Figure 2.a).
- Select NUE_{opt} from an interactive bar that updates bottom panels representing two criteria:
  1. An environmentally friendliness criterion represented by the R^2 of linear fit to yield and N_{opt} data (Figure 2.c).
  2. The difference between yield and maximum achievable yield (Figure 2.d).
- Once the NUE is selected, the linear fit in bottom left panel is used for N recommendation for given expected yield

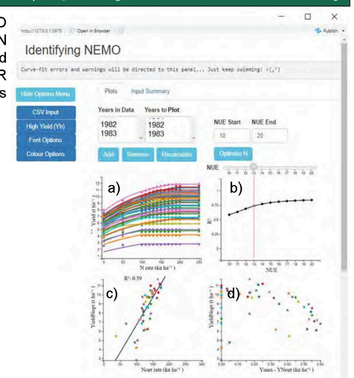

Figure 2. Identifying NEMO R tool

Results

Yield to N rate response curves were constructed using the STICS crop model (Brisson et al. 2003). We used long term climate data (30+ years) in four regions (Summerside, New Glasgow, Charlottetown, and Souris) and 3 dominant soils across PEI (Fig. 3). The dominant soils In each region were identified from CANSIS database in a circle around the weather station with a diameter of 20 km. For the simulations, the climate data were collected form the ECCC weather stations, and the gap filling was performed using nearby weather stations if available, and NASA Power gridded data otherwise. The SCTICS crop model was previously calibrated for Russet Burbank Potato (Morissette et al. 2016) and used for simulation. The initial soil N content was set to 0 for these simulations.

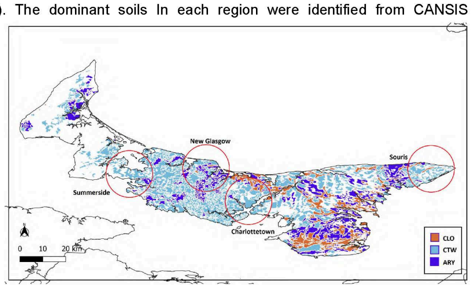

Figure 3. Regions with available long term climate data used for simulations. The dominant soil codes in all regions are CLO (Culloden), CTW (Charlottetown), and ARY (Alberry).

An example of simulated yield response to N rate is presented in Figure 4. Note that each color represents a simulated yield response for given year. Figure 4 demonstrates the impact of soil and climate on yield. The ARY soil has relatively higher yield compared to CTW, and CLO. The climate variations can cause up to 35 t/ha (280 Cwt/ac) variations in yield between high and low yield years.

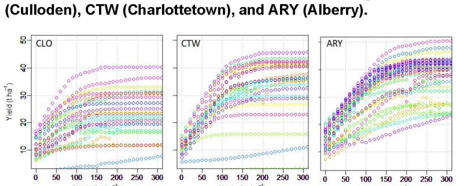

Figure 4. Simulated yield to N response for Charlottetown.

Table 1 is an example of outputs from Identifying NEMO approach. N rate and yield are presented in two different units for both research use and producers. Our model-based results indicates that the probability of achieving a yield of 324 Cwt/ac in Charlottetown region (i.e., up to 10 km away from the Charlottetown weather station) for CWT soil is 22% (once every 5 years). To aim for such yield, 145 lb/ac N rate is recommended. Note that this recommendation is based on 0 soil initial N content, and should be reduced based on farm-level initial soil content. This lower than currently recommended (185 lb/ac) rate reduces the excess N for high yield years to 21 lb/ac on average.

Table 1. Example of Identifying NEMO outputs in Charlottetown region for CWT soil

NUE_{opt} = 20 t N ha-1 t yield ha-1									
Expected yield (Y_{exp})		Probability of (Y_{exp}<Y) %	Recommended N		Fraction of yield potential on average	N deficient (-) or excess (+) on average			
						Y<Y_{exp}		Y_{exp}<Y	
Cwt/ac	t/ha		lb/ac	kg/ha	%	lb/ac	kg/ha	lb/ac	kg/ha
259	32	70	103	115	75	12	14	-21	-24
291	36	35	124	139	80	34	38	0	0
324	40	22	145	163	83	55	62	21	24

To facilitate the use of this tool, we developed a web-interface (Figure 5) under which the users can select the region, soil, and expected yield, and see the outputs.

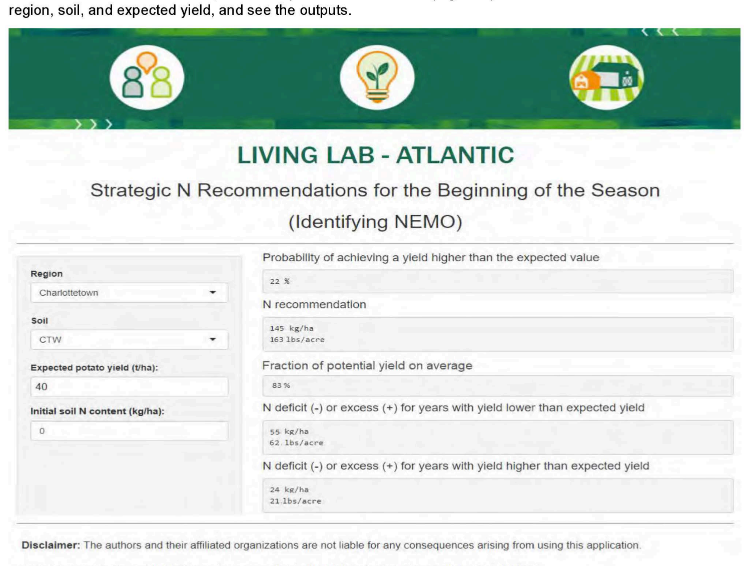

Figure 5. A web tool for strategic N recommendation.

Reference

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Acknowledgment

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