BC FoodWeb

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**RESEARCH SUMMARY**

# Economic and environmental benefits of reducing nitrogen fertilization in potato fields

**Researchers: C. J. Chizen, M. Krzic, T. A. Black, R. S. Jassal, and S. M. Smukler**

**Production Type**
- Vegetables (potatoes)

**Practice Benefit(s)**
- Reduced costs
- Improved nutrient management
- Reduced greenhouse gas emissions

**Research Location**
- Delta, BC

## KEY TAKEAWAYS

- We found that increasing nitrogen fertilization in potato fields (from 90 to 120 kg N per hectare) was **not worth the cost.**
- Yield and revenue did not increase enough to warrant applying the higher fertilizer rate (120 kg N per hectare), especially when considering the negative environmental impacts **(higher nitrous oxide emissions).**
- Excess nitrogen in the soil leads to the production of nitrous oxide, a greenhouse gas that is **265x more harmful** than carbon dioxide.

**Figure 1.** Sieglinde potatoes. Photo by the Centre for Sustainable Food Systems.

## HOW CAN THIS RESEARCH BE USED?

- Potato producers can re-evaluate how much nitrogen they're adding to the soil and **adjust application rate** based on **crop needs** and **soil quality**.
- Producers can work with their local agronomist to conduct a **soil test** and determine how much nitrogen is already in the soil, and how much nitrogen the crop needs.

## WHY WAS THIS RESEARCH DONE?

Decades of intensive cultivation, along with challenges caused by inherent soil properties (poor drainage, fine soil textures), in the Fraser Valley delta of British Columbia (BC) have led to reduced soil quality. However, due to shortages of arable land in this region, producers are often restricted to farming in these degraded fields. During this study, we found that, to compensate for the poor soil quality, producers were generally applying higher nitrogen application rates (120 kg N per hectare) than the provincial recommendation (70 kg N per hectare).

## RESEARCH SUMMARY

Increased nitrogen fertilization can be costly to both producers and the environment. Higher application rates require more input costs and application time. Excess nitrogen in the soil also leads to pollution through nitrogen leaching into the groundwater and nitrous oxide emitted into the air. Nitrous oxide is one of the main greenhouse gases and is 265 times more harmful than carbon dioxide.

**Figure 2.** Potato field in Ladner, BC. Photo by the research team.

Typically, the increase in input cost is worth it if the increase in yield, and thus revenue, is greater. **Therefore, in this study, we evaluated the economic and environmental tradeoffs of three nitrogen application rates (0, 90, and 120 kg N per hectare) for potato production**. Yield and nitrous oxide emissions were evaluated in productive and degraded fields. A degraded field is defined in this study by having high salinity and known issues with growing crops, based on observations from the growers.

## WHAT WAS THE OUTCOME?

Overall, we found that increasing nitrogen fertilization (from 90 to 120 kg N per hectare) was **not worth the cost.**

We calculated the agronomic efficiency and cost efficiency of adding more fertilizer. Agronomic efficiency is the yield produced per kg of nitrogen applied. Cost efficiency is how much revenue, from potatoes, is produced per dollar spent on fertilizer. In the productive field, we found that the two values were similar whether 120 or 90 kg N per hectare was applied (Table 1). Yield in the productive field was 12% higher when 120 kg N per hectare was applied compared to 90 kg N per hectare. However, this difference was not statistically significant, meaning that it was likely a result of chance and other factors rather than the application rates. Overall, nitrous oxide emissions were higher when 120 kg N per hectare was applied (Figure 4). **These findings indicate that yield and revenue did not increase enough to warrant applying the higher fertilizer rate, especially when taking into consideration the higher nitrous oxide emissions.**

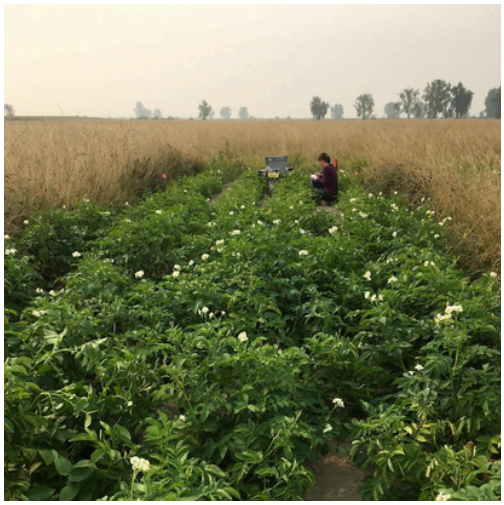

**Figure 3.** Greenhouse gas sampling in the potato field. Photo by the research team.

**Table 1.** Average potato yield, agronomic efficiency, and cost efficiency for the productive and degraded fields after the growing season (May to October 2018).

| Field | Nitrogen fertilizer rate (kg N/ha) | Yield (Mg/ha) | Agronomic efficiency (kg yield/kg N fertilizer) | Cost efficiency ($ revenue/$ N fertilizer) |
|---|---|---|---|---|
| Productive | 0 | 19.5 | – | – |
| | 90 | 31.9 | 137.6 | 51.3 |
| | 120 | 36.1 | 138.8 | 51.7 |
| Degraded | 0 | 20.2 | – | – |
| | 90 | 23.7 | 38.8 | 14.5 |
| | 120 | 24.6 | 36.6 | 13.6 |

In the degraded field, potato yield was similar for all fertilizer rates, even when no fertilizer was applied (Table 1). No matter how much nitrogen was added, the plants were unable to grow more because they were already struggling with the poor soil quality and high salinity. Unlike the productive field where values slightly increased, agronomic efficiency and cost efficiency decreased in the degraded field when fertilization increased to 120 kg N per hectare, meaning that yield and revenue decreased.

Nitrous oxide emissions spiked in the productive field after a heavy rainfall event in November (Figure 4). This was a result of two conditions:

- There was a substantial amount of nitrogen left in the soil, post-harvest, from the excess fertilizer.
- The rain increased soil moisture, creating ideal conditions for the release of nitrous oxide.

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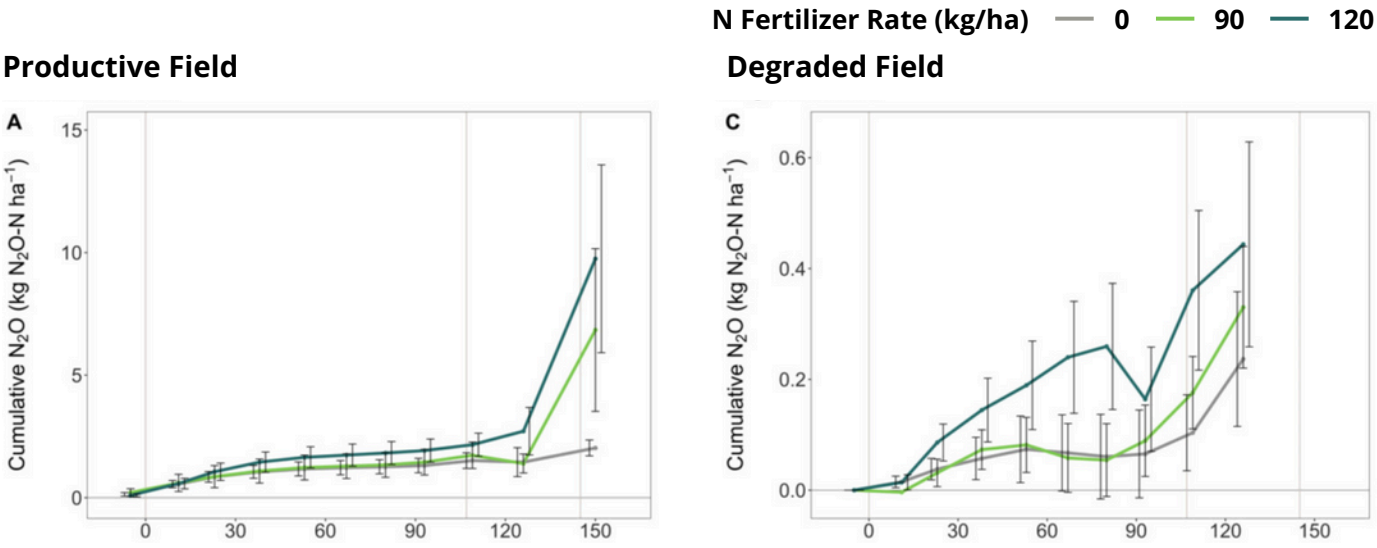


**Figure 4.** Cumulative nitrous oxide emissions for 0, 90, and 120 kg N per hectare fertilizer rates in the productive and degraded fields. Values on the horizontal axis are the number of days since planting.

## WHAT'S NEXT?

Overall, our findings support lowering nitrogen fertilizer rates to reduce fertilizer costs and nitrous oxide emissions, with minimal impact to yield. It is important to note that although nitrous oxide emissions were higher with the 120 kg N per hectare rate overall, the emission differences between the rates were not statistically significant. This was possibly due to the limited number of measurements taken and the inherently high variability in the movement of nitrous oxide. Given the sudden increase in nitrous oxide emissions after heavy rainfall in November, future research should account for emissions in the post-harvest shoulder season (October-November) when evaluating the environmental impact of fertilizer rates.

## HOW WAS THE RESEARCH DONE?

The study was conducted on two farms in Delta, BC from May to November 2018. We identified one field as "productive" and the other as "degraded" (based on its high salinity level). We applied nitrogen, in the form of granular urea, at a rate of 0, 90, and 120 kg N per hectare in different sections of the fields. We planted Kennebec potatoes on May 31 and on June 18. The potatoes were harvested 107 days after planting, and yield was recorded.

From late May to October, we measured nitrous oxide emissions every two weeks. We took soil samples seven times throughout the season to analyze the concentration of available nitrogen. Agronomic efficiency and cost efficiency were calculated for each fertilizer rate in both the productive and degraded fields.

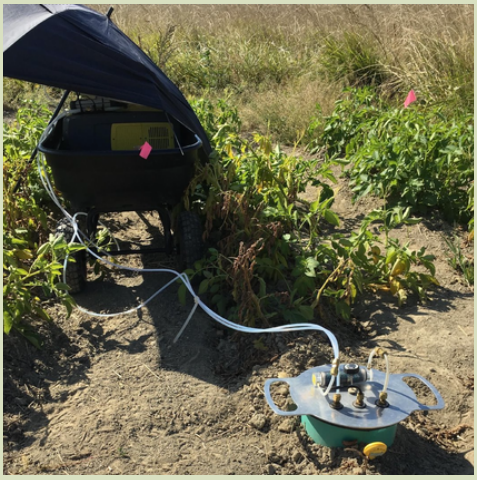

**Figure 4.** Using a gas analyzer to measure greenhouse gas emissions. Photo by the research team.

## ABOUT THIS BRIEF

**This brief is based on the following scientific journal article:**

Chizen, C. J., Krzic, M., Black, T. A., Jassal, R. S., & Smukler, S. M. (2022). Nitrous oxide emissions from productive and degraded potato fields in the Fraser Valley delta of British Columbia. *Canadian Journal of Soil Science, 102*(4), 1000-1004. https://doi.org/10.1139/cjss-2022-0032

**Want to learn more?**

- For questions regarding this research, contact Chantel Chizen at chantel.chizen@usask.ca

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