BC FoodWeb

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RESEARCH SUMMARY

Improving highbush blueberry nitrogen management with nitrification inhibitors

Researchers: A. J. Messiga, S. Nyamaizi, S. Yu, and M. Dorais

Production Type
- Berries

Practice Benefit(s)
- Improved nutrient management

Research Location
- Agassiz, BC

KEY TAKEAWAYS

- **Nitrification inhibitors**, applied through drip-fertigation, can **delay the conversion of ammonium** (preferred form of nitrogen for blueberries) **to nitrate**.
- The effect of nitrification inhibitors on blueberry yield and soil ammonium and nitrate concentrations was **inconsistent** in this three-year study.
- Further studies are needed to determine the **best timing** for nitrification inhibitor application that **aligns with the timing of blueberry nitrogen uptake**, such as early in the growing season and post-harvest.

Key Terms:
- *Nitrification: the conversion of ammonium into nitrate by bacteria in the soil.*
- *Nitrate: a form of nitrogen (made up of nitrogen and oxygen) that can be absorbed by plants.*
- *Ammonium: a form of nitrogen (made up of nitrogen and hydrogen) that can be absorbed by plants.*

Figure 1. Blueberries. Photo by UBC's Centre for Sustainable Food Systems.

HOW CAN THIS RESEARCH BE USED?

- While **more studies are needed** to determine the best timing of application, highbush blueberry growers can experiment with the application of nitrification inhibitors, applied by fertigation.
- Optimizing plant nitrogen uptake benefits both farmers and the environment by reducing the need for nitrogen fertilization.

WHY WAS THIS RESEARCH DONE?

The objective of this study was to assess the effects of nitrification inhibitors, applied with two nitrogen fertilizer rates (60 vs. 120 kg N/ha) and two fertigation systems (suspended vs. buried), on blueberry yield and soil nitrate and ammonium levels.

RESEARCH SUMMARY

In British Columbia (BC), ammonium sulfate is widely used for blueberry nitrogen fertilization. This fertilizer has two major advantages: first, it breaks down rapidly to ammonium, the preferred form of nitrogen for blueberries; second, sulfate maintains low soil pH favourable for blueberry growth (pH 4.5-5.5). However, recent studies have shown that fertilizer application above recommended rates increases soil salinity and reduces pH below suitable thresholds. Additionally, ammonium is not stable in the soil and is quickly converted to nitrate by soil microorganisms. Once converted, the efficiency in which blueberries take up nitrogen is very low and the nitrate ends up leaching out of the soil profile with irrigation and rain.

To slow the conversion of ammonium to nitrate, nitrification inhibitors, such as dicyandiamide (DCD) and Nitra-pyrin, can be used. However, for blueberry crops with sawdust mulch, it remains unclear whether applying a mix of fertilizer and nitrification inhibitors through drip-fertigation can successfully delay the conversion and improve plant nitrogen uptake.

WHAT WAS THE OUTCOME?

Overall, the effect of nitrification inhibitors on yield and ammonium and nitrate concentrations was not consistent in this three-year study. Multiple factors influenced the efficacy of the inhibitors. High irrigation during drier months moved the inhibitors faster down the soil profile, away from the microorganisms that they act on. Additionally, the lifespan of nitrification inhibitors is only around 6-16 days. At the same time, due to sufficient fertilization in the past, the plants had sufficient stores of nitrogen and did not absorb much of the ammonium before it was converted.

Figure 2. Highbush blueberries in the research field. Photo by Aimé Messiga.

Yield was affected by treatment in 2017 but not in 2016 or 2018. In 2017, nitrification inhibitors reduced yield by 11-21% compared to respective treatments without inhibitors. The lack of yield effects was partially due to sufficient nitrogen fertilization before this study, which resulted in robust and mature plants that were not limited by nitrogen. **Soil ammonium concentration was affected by treatment in 2016 but not in 2017 or 2018.** In 2016, the treatments that led to the highest ammonium concentrations were (Figure 3):

- Suspended irrigation with 60 kg N/ha and no inhibitors
- Suspended irrigation with 60 kg N/ha and inhibitors
- Suspended irrigation with 120 kg N/ha and inhibitors

The high ammonium concentration indicates that the nitrification inhibitors were effective at delaying the conversion of ammonium to nitrate. However, the accumulation of ammonium did not translate to a yield increase, indicating limited nitrogen uptake by plants.

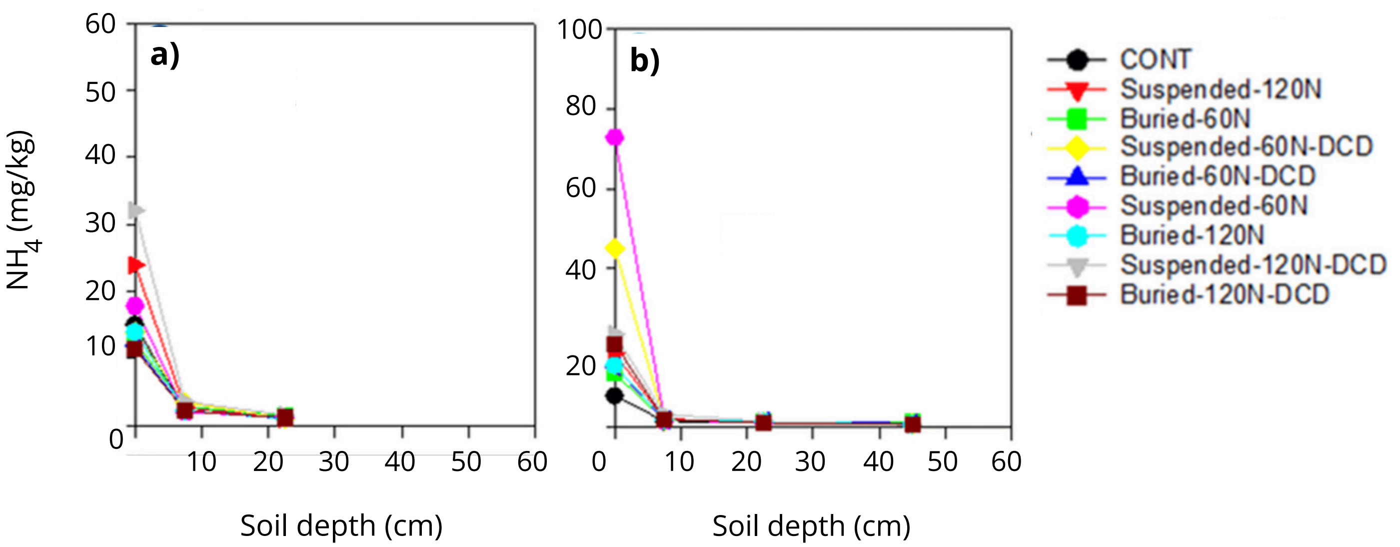

Figure 3. Ammonium (NH_4) concentration throughout the soil profile in *(a)* summer and *(b)* fall, 2016. 0 cm soil depth is the sawdust mulch layer. CONT = control, N = nitrogen, DCD = nitrification inhibitor.

WHAT'S NEXT?

Our results demonstrate that nitrification inhibitors applied through drip-fertigation systems can delay the conversion of ammonium to nitrate. However, the inconsistent effects from year to year and the lack of ammonium uptake by plants indicate the need for additional studies.

We applied fertilizer and inhibitors early in the growing season (April-May), however this might not have aligned with crop nitrogen needs. Future studies should identify the best timing for application that maximizes the efficacy of nitrification inhibitors. For example, nitrogen requirements may be higher during post-harvest when blueberry plants are generating new stem for the next season. Maximizing the time ammonium is present in the soil may also reduce the amount of fertilizer required, benefitting both farmers (reduced costs) and the environment (reduced nitrogen pollution).

HOW WAS THE RESEARCH DONE?

This research was conducted from 2016-2018 in a highbush blueberry crop established in 2006 at Agassiz Research and Development Centre. Nine treatments were used – eight combinations of fertilization and one "control" which had no fertilization and no nitrification inhibitors. To maximize their individual benefits, a combination of Nitra-pyrin and DCD was used as the nitrification inhibitor.

The treatments included:

1. Control – no fertilization, no inhibitors
2. Suspended, 60 kg N/ha, no inhibitors
3. Suspended, 60 kg N/ha, with inhibitors
4. Suspended, 120 kg N/ha, no inhibitors
5. Suspended, 120 kg N/ha, with inhibitors
6. Buried, 60 kg N/ha, no inhibitors
7. Buried, 60 kg N/ha, with inhibitors
8. Buried, 120 kg N/ha, no inhibitors
9. Buried, 120 kg N/ha, with inhibitors

Each treatment had four replications. Each replication consisted of five measurement plants with a guard plant on each end. We used urea (46-0-0) for the treatments without inhibitors and a stabilized urea fertilizer for treatments with inhibitors. Treatments were applied by fertigation and consisted of six equal applications beginning at bud break and continuing every week until the end of May.

For the suspended irrigation method, drip tape was installed on each side of the raised bed, 19 cm away from the centre of the plant row, and 0.6 m above the sawdust mulch. For the buried irrigation method, drip tape was buried under the sawdust mulch on each side of the raised bed, 19 cm away from the centre of the plant row.

Figure 4. Suspended drip lines (left) and buried drip lines (right). Photos by Aimé Messiga.

Plants were pruned in January and February every year according to industry standard, with a heavy pruning in 2017 for rejuvenation. To assess berry yield, we harvested berries twice a year between late June and late July. We collected soil samples in the spring, summer, and fall in each year of the study. For each series of soil samples, we collected the sawdust mulch layer by hand, then took four soil cores at a depth of 0-15 cm, 15-30 cm, and 30-60 cm. We analyzed ammonium and nitrate concentrations in the mulch samples. For the soil samples, we analyzed ammonium and nitrate concentrations, soil pH, and electrical conductivity (measure of salinity).

ABOUT THIS BRIEF

This brief is based on the following scientific journal article:

Messiga, A. J., Nyamaizi, S., Yu, S., & Dorais, M. (2021). Blueberry yield and soil mineral nitrogen response to nitrogen fertilizer and nitrification inhibitors under drip-fertigation systems. *Agronomy, 2144*(11). https://doi.org/10.3390/agronomy11112144

Want to learn more?

- For any questions regarding this research, contact Aimé Messiga at aime.messiga@AGR.GC.CA
- For more articles on blueberry nitrogen fertilization and fertigation check out:
  - Messiga, A.J., Dyck, K., Ronda, K., van Baar, K., Haak, D., Yu, S., Dorais, M. 2021. Nutrients leaching in response to long-term fertigation and broadcast nitrogen in blueberry production. Plants 9 : 1530. https://doi.org/10.3390/plants9111530
  - Messiga, A.J., Haak, D., Dorais, M. 2018. Blueberry yield and soil chemical properties response to fertigation and broadcast nitrogen in British Columbia, Canada. Scientia Horticulturae 230: 92-101. https://doi.org/10.1016/j.scienta.2017.11.019

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