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RESEARCH SUMMARY

Balancing nitrogen: Application rates and methods in blueberries

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Production Type
- Berries

Practice Benefit(s)
- Improved nutrient management
- Improved soil health

Research Location
- Agassiz, B.C.

KEY TAKEAWAYS

- **Applying nitrogen (N) fertilizer at rates higher than current Provincial recommendations can reduce blueberry fruit yield, affect fruit taste, and create unfavourable soil conditions for plant growth.**
- The negative effects of high N fertilizer rates on blueberry fruit yield and the decline in soil pH were more noticeable with fertigation compared to broadcast applications.
- It may also be possible to use N application rates lower than current recommendations without compromising blueberry fruit production, but this has yet to be tested.

Figure 1. Blueberries in the fall. Photo by Charitha Jayasinghege.

HOW CAN THIS RESEARCH BE USED?

- Growers could save on fertilizer costs by applying N at no more than current Provincial recommended rates, while maintaining yields and protecting soil quality.
- Monitoring soil pH and electrical conductivity (a measure of salt levels) can help growers manage/improve growing conditions. Long-term N fertilization can make the soil too acidic and salty for blueberry production. This is especially important when using ammonium sulfate, as it can lower soil pH more rapidly than urea.
- N application rates lower than those tested in this study have the potential to further reduce fertilizer costs and the negative effects of ongoing fertilization. Lower N rates could be tested on a small scale first to confirm that fruit yield wouldn't be negatively affected.

WHY WAS THIS RESEARCH DONE?

Highbush blueberries are adapted to grow best in acidic soils with a pH between 4.2 and 5.5. These acidic soils have lower nutrient availability, so blueberries have adapted to use nutrients efficiently with minimal needs. In commercial farming, however, blueberries are given N fertilizer each year to maximize fruit production. Blueberries live and produce fruit for 20 to 30 years, but most research on N use in blueberries has been short-term, lasting only two to four years. This has prompted an important question: How does N fertilization affect blueberry production in the long term?

RESEARCH SUMMARY

To answer this question, we studied how different rates and methods (broadcast and fertigation) of N application affected fruit yield, fruit acidity, plant nutrient levels, and soil characteristics after 12 to 13 years. Based on the Government of British Columbia's (B.C.) '*Blueberry Production Guide: Nutrient Management*', **we tested four different N application rates: no N applied (*'0x'*), the recommended N rate (*'1x'*), 1.5 times the recommended rate (*'1.5x'*), and 2 times the recommended rate (*'2x'*)** (see Table 1 below for exact rates).

WHAT WAS THE OUTCOME?

High nitrogen rates tend to reduce fruit yield and fruit acidity

In the blueberry plants at age 13 years, yield was not statistically different between any of the N application rates (Figure 2). However, at age 12 years, there were notable difference in fruit yield between the different N application rates:

- **The highest average yield (22,076 kg/ha) was achieved with granular (broadcast) N application at *'1x'* (recommended rate).**
- **Applying N through fertigation at the *'2x'* rate resulted in the lowest average yield (13,873 kg/ha).**
- Average blueberry yield when no N was applied (17,486 kg/ha) was not statistically different from any of the other N application rates.

These yields were all within the range of typical yields for the region (around 13,000-22,000 kg/ha). However, applying too much N (at *'2x'* the recommended rate) led to significantly reduced yields. Given that yields were relatively similar whether no N was applied or N was applied at the recommended rate, growers could consider whether the cost of fertilizer is worth the nominal yield gains. Fruit acidity, an important factor in taste, was also affected by N rates. High N application rates, regardless of the application method, generally resulted in less acidic fruit. Less sour blueberries can be positive or negative depending on fruit quality standards and how big the change is (i.e. too little acidity can also be undesirable).

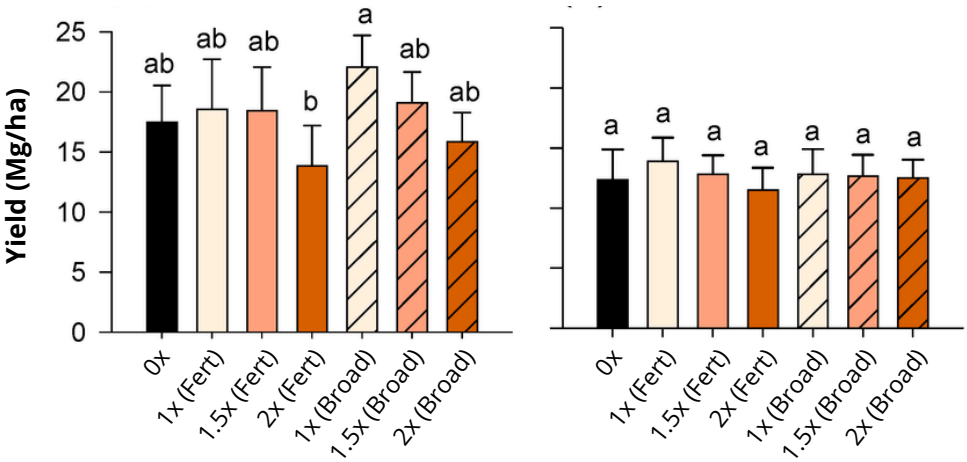

Figure 2. Average fruit yield at blueberry plant ages 12 **(left)** and 13 years **(right)** under different fertilization rates and types. 'Fert' = fertigation. 'Broad' = broadcast application. Mg = megagrams, 25 megagrams = 25,000 kg. Application rates that are marked with different letters (a or b) are statistically different. © His Majesty the King 2024, figure adapted from https://doi.org/10.3390/horticulturae10111205

Figure 3: Left: Blueberry row with drip lines. In the process of fertigation, fertilizer is dissolved in water and sent out through these lines. **Right:** Blueberry harvest. Photos by Charitha Jayasinghege.

Long term high nitrogen rates reduce soil pH and increase soil salinity

Soil pH was measured when the blueberry plants were 12 and 13 years old. On average, the '*1x*' rate led to a soil pH of 4.2, which is the lower limit recommended for blueberries. Higher N rates (*'1.5x'* and *'2x'*) led to pH levels below 4.2, which is not ideal for blueberry plant growth. Similar trends were observed in deeper soil layers. N application, especially at higher rates, resulted in higher electrical conductivity values (a measure of salt levels) than plots where no N was applied. However, all the values remained at a safe level for blueberries (below 2000 µS/cm).

Application method influences fertilizer distribution and nutrient availability

When fertilizer was applied through broadcast, the mulch in the crop rows held on to a significant amount of N, which may gradually become available to plants as irrigation or rainfall dissolves the fertilizer. However, a considerable portion of this N could be lost into the air through a natural process that changes N into gas form. In contrast, fertigation allows N to pass through the mulch layer and down to the root zone more easily, making it more immediately available to plants. However, previous studies indicate that this N is more likely to be lost through leaching. While broadcast application resulted in slightly higher plant N levels, the differences were not always statistically significant.

Influence of nitrogen application on plant nutrient levels

Long-term N application reduced plant magnesium, calcium, and copper levels, although only copper reached deficiency levels (in response to the *'2x'* rate). This decrease is likely due to a drop in the soil's pH, which influences how well plants can absorb nutrients. Leaf N levels were within the recommended range in all application rates and types (fertigation and broadcast), except in *'0x'* where N reached deficient levels (below 1.4%).

WHAT'S NEXT?

To determine if N fertilizer use can be reduced in mature plants while maintaining maximum yield, a long-term study testing fertilizer rates lower than current Provincial recommendations is needed. It would also be valuable to look into adjusting N fertilization for mature blueberries based on the amount of fruit produced in the previous year. Studies have suggested that after a year with high yield, N levels in the plants might drop because the N is spent on producing berries. Therefore, we could think about applying more N after a high-yield year when a lot of fruit is produced (to replenish N levels), and less N after a low-yield year with a small harvest, in combination with leaf analysis to ensure that plant N is within the recommended levels.

HOW WAS THE RESEARCH DONE?

This study was conducted on a northern highbush blueberry cultivar, 'Duke', at the Agassiz Research and Development Centre in Agassiz, BC. The planting was established in 2008 according to local standards, with soil pH adjusted from 5.6 to 5.0 by applying elemental sulfur at 1120 kg/ha. Each planting row was irrigated using two drip lines suspended along its edges. We chose N application rates based on recommended rates in the Government of B.C.'s Blueberry Production Guide, which are based on 2470 plants/ha (988 plants/acre). We studied the following N application rates:

1. '1x / recommended N rate': Starting at plant age 6 years, N was applied at the recommended rate (1x). Before that, N was applied at half (0.5x) the recommended rate.
2. '1.5x N rate': Starting at plant age 6 years, N was applied at 1.5 times (1.5x) the recommended rate. Before that, N was applied at 1x the recommended rate.
3. '2x N rate': Starting at plant age 6 years, N was applied at two times (2x) the recommended rate. Before that, N was applied at 1.5x the recommended rate.
4. '0x N rate': No N was applied.

See Table 1 for application rates. Each application rate was replicated six times, and each research plot (replication) consisted of six blueberry plants. We used ammonium sulfate (21-0-0) for the N fertilizer and applied it either as a granular broadcast or dissolved in irrigation water for fertigation. All fertilizer treatments were applied as split applications:

- Broadcast treatments included three equal applications, applied monthly starting in late April or mid-May
- Fertigation treatments included 10 to 12 weekly, equal applications over the same period as broadcast.

We collected leaf samples in mid-August 2021 and measured plant nutrient levels through leaf nutrient analysis. We collected soil and sawdust samples in September 2020 and November 2021 and measured N levels in the soil and sawdust, and pH and electrical conductivity of the soil.

Table 1. N fertilizer application rates tested based on Provincial recommendations as of 2024. Application rates are shown for plant age 6 and onwards as the rates applied for younger plants were lower. Recommended rates reach a maximum of 115-155 kg N/ha for plants over 8 years old. We chose the higher rate (155 kg N/ha) to test in this study.

Year	Field age of blueberries	'1x rate' (kg N/ha)	'1.5x rate' (kg N/ha)	'2x rate' (kg N/ha)
2013	6	80	120	160
2014	7	100	150	200
2015	8	115	172.5	230
2016 to 2021	9-14	155	232.5	310

ABOUT THIS BRIEF

This brief is based on the following scientific journal article:

Jayasinghege, C. P. A., Bineng, C., & Messiga, A. J. (2024). Effects of long-term nitrogen fertilization and application methods on fruit yield, plant nutrition, and soil chemical properties in highbush blueberries. *Horticulturae, 10*(11). https://doi.org/10.3390/horticulturae10111205

Want to learn more?

- For questions regarding this study, contact Charitha Jayasinghege at charitha.jayasinghege@agr.gc.ca
- Find resources for blueberry nutrient management in BC at: https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides/berries/blueberries

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