Effects of Method and Level of N Fertilizer Application on Soil pH, EC, and Availability of NH_4^+ and NO_3^- in Blueberry

David Bryla[1], Rui Machado[2]*, and Amber Shireman[1]

[1]USDA ARS Horticultural Crops Research Unit, Corvallis, Oregon, USA
[2]Departamento de Fitotecnia, Universidade de Évora, Évora, Portugal

Background

Most blueberry fields are irrigated by sprinklers or drip. While both are effective, a major advantage of drip is the capability to fertigate (i.e., apply water-soluble fertilizers during irrigation). Numerous fertilizers are available for fertigation, but a product becoming increasingly popular is urea sulfuric acid. This product, sold under various names such as N-pHURIC is well suited to blueberry because 1) the urea breaks down quickly to NH_4^+ and 2) the sulfuric acid helps acidify the soil; blueberries prefer the NH_4^+ form of N over NO_3^- and grow best when soil pH is 4.2-5.5. The fertilizer is usually injected throughout the growing season until 1-2 months prior to dormancy.

Granular urea or other ammonium-based granular fertilizers, such as $(NH_4)_2SO_4$ or $NH_4H_2PO_4$, are often used with sprinklers. These products are typically applied in two or three split applications in the spring when N uptake by the plant is most active. Ammonium sulfate is the most acidifying of the group and is recommended when soil pH is above 5.0; urea or a blend of urea with $(NH_4)_2SO_4$ is recommended when pH is below 5.0.

Hart et al. (2006) recently updated the blueberry fertilizer guidelines for the northwestern U.S. and recommend applying 17-26 g of N per plant per year during first 4 years after planting, 110-160 kg·ha^{-1} per year the following 3 years, and 160-180 kg·ha^{-1} per year once the plants reach maturity (typically in 7-8 years). The rates were developed for granular product applied as a broadcast band in the row (or under the drip line of young plants) but do not necessarily apply to fertigation with liquid fertilizers.

Objective

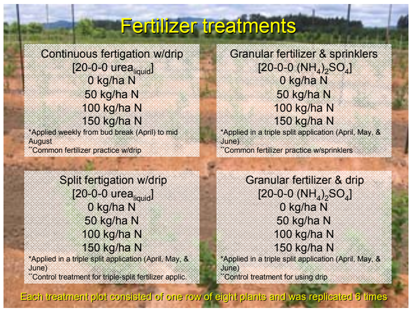
The objective of this study was to compare the effects of N fertigation and granular fertilizer application on growth and availability of soil N in a newly planted field of highbush blueberry.

Materials and Methods

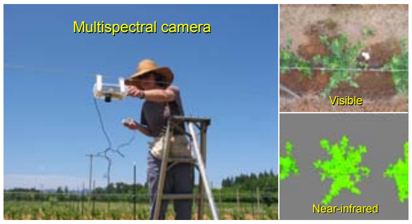
• Sixteen treatments were applied to 0.24-ha of 'Bluecrop' blueberry planted in April 2006. Treatments included: 4 fertilizer methods (2 fertigation & 2 granular fertilizer) x 4 rates of N application (0, 50, 100 & 150 kg·ha^{-1} N).

Fertigation treatments were irrigated by drip and injected with liquid urea fertilizer; continuous fertigation was applied weekly from bud break to ≈2 months prior to the end of the growing season while split fertigation was applied as a triple-split in April, May, and June.

Granular fertilizer treatments were fertilized with a triple-split (April, May, & June) of granular $(NH_4)_2SO_4$ and irrigated by micro-sprays (simulates sprinklers) or drip.



• Canopy cover was estimated on 30 Aug. 2006 and 28 Aug. 2007 from digital images captured using a multispectral camera. The camera was suspended from a marked trellis wire located ≈2.5 m above the plants and images were collected from every other plant in each plot, for a total of 135 images per date.



• Soil solution was extracted using hydrophilic porous polymer samplers and analyzed for NH_4^+ and NO_3^- concentrations and electrical conductivity (EC_w). Soil cores (2.5 cm x 30 cm) were also collected and analyzed for soil pH (1:2 soil:water).

Results and Discussion

• Canopy cover increased with N application, but the response differed among application methods (Fig. 1). In year 1, continuous fertigation produced the smallest plants at 50 kg·ha^{-1} N and the largest at 150 kg·ha^{-1} N. Leaf N analysis (data not shown) indicated that the other methods were less responsive than continuous fertigation to additional N. In fact, 47-50% of the plants died (due to salt stress) when fertilized at 150 kg·ha^{-1} N with granular fertilizer. None died with continuous fertigation. By year 2, continuous fertigation produced the largest plants at 100-150 kg·ha^{-1}.

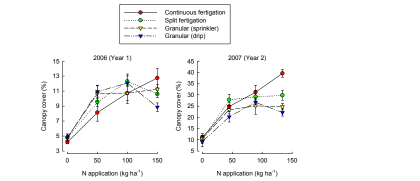


Fig. 1. Canopy cover (which indicates the relative size of young plants) was significantly affected each year by the level of N fertilizer application (P<0.01) as well as the interaction between method and level of application (P < 0.01).

• Soil pH was usually lower with sprinklers than with drip, even when no N fertilizer was applied; however, soil pH was also reduced with higher N applications and, in fact, was very similar between continuous fertigation and granular sprinkler treatments when 150 kg·ha^{-1} N was added (Fig. 2).

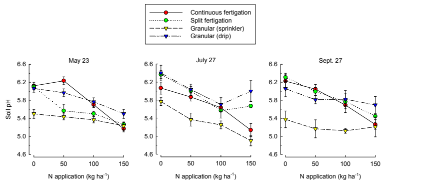


Fig. 2. Soil pH differed among N application methods (P<0.01) and declined with increasing fertilizer levels (P<0.01); the method x level interaction was also significant (P<0.05).

• Granular N application maintained much higher NH_4^+ concentrations than either of the two fertigation methods (Fig. 3). With granular fertilizer, concentrations peaked immediately after application, reaching levels as high as 138 ppm with drip and 662 ppm with sprinklers. Fertigation treatments, by comparison, never exceeded 10 ppm at any time during the season, even when plants were split fertigated. Granular fertilizer also resulted in higher concentrations of NO_3^- (data not shown), but since the ability of blueberry to acquire NO_3^- is limited, this may lead to more N leaching.

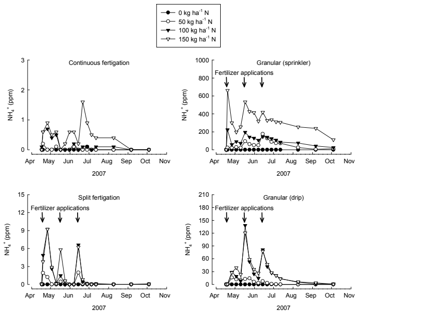


Fig. 3. Ammonium ion concentrations measured during the second growing season. Note the difference in the y-axis scale of each treatment. Each symbol represents the pooled average of six plots.

• Electrical conductivity (salinity) was also higher with granular fertilizer applications (Fig. 4). Blueberry is sensitive to EC_w >1.5-2.0 dS·m^{-1}. Electrical conductivity was often >2.0 dS·m^{-1} when granular fertilizer was applied but always <1.5 dS·m^{-1} with continuous fertigation.

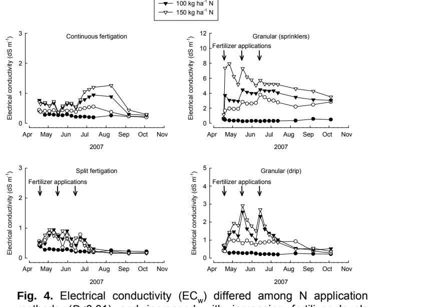


Fig. 4. Electrical conductivity (EC_w) differed among N application methods (P<0.01) and increased with increasing fertilizer levels (P<0.01); the method x level interaction was also significant (P<0.01) .

Conclusions

Early results indicated that fertigation in a new blueberry field was less efficient (i.e., less plant growth per unit of N applied) than granular fertilizer application when a low rate of N fertilizer was applied (50 kg·ha^{-1}), but it produced more growth when higher rates were applied (100-150 kg·ha^{-1}). Fertigation likely increased growth over granular fertilizer by reducing salt stress and maintaining safe and optimum levels of NH_4^+ within the root zone throughout the growing season. This study will continue for at least 3 more years to determine the effects of each treatment on fruit production.

Reference:

Hart, J., Strik, B., White, L. and Yang, W. 2006. Nutrient management for blueberries in Oregon. Ore. State Univ. Ext. Serv. EM8918