Evaluating the Effects of Nitrogen Fertilization on Cascade Hop Yield

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Introduction

Hop production in non-traditional growing regions continues to strengthen. Areas that were once decimated by hop diseases, such as downy mildew, have reemerged and are thriving. Although climate in the North Central region still poses challenges, new developments in pesticides and cultivar selections have mitigated some of these risks.

Hop production in Iowa has intrigued many Iowa landowners wishing to diversify from traditional crops (corn and soybean). However, few resources are available to beginning hop growers due to limited research involving cultural management of hop plants in the North Central region. There is nutrient information available for growing hops, with limited research on appropriate rates, therefore the recommendations span a wide range. In 1960, it was determined that 100 lb available N/acre was the most efficient for Fuggle grown in Oregon. In 2011, it was determined rates could vary between 80–200 lb N/acre depending on organic matter content. In order to maintain quality, N form and number of applications should be considered, especially in soils prone to leaching. Over application or highly mobile forms of N can cause significant amounts of N to be lost via leaching. Although single nitrogen fertilizer applications have shown to be as effective as split applications, split applications should be considered where leaching is an issue.

Improper N use not only affects costs, but also can significantly affect the environment. In addition to watersheds being affected, over application of nitrogen can lead to increased arthropod pest damage (two-spotted spider mite, hop aphid) and disease incidence (powdery mildew, verticillium wilt).

To mitigate the risk of over application of N, specific recommendations should reflect soil and climatic conditions typical of the region. In response to these challenges, research investigating the response of the hop plant to varying levels and form of N fertilization are underway.

Materials and Methods

Seven levels of N fertilizer were applied in a split granular application to observe the response. Urea was selected as the N form and applied at 0, 50, 100, 150, 200, 250, and 300 lb N/acre. First application was applied at bine training stage and the remaining half of each treatment was applied when the bines reached 9 ft (halfway up the trellis). Experiment was conducted using a randomized complete block design with five nine-plant replications for each treatment.

Five combinations of three N forms were applied in split applications. Three forms of N were applied at 150 lb N/acre: granular urea (Urea), granular calcium nitrate (CN), and liquid urea ammonium nitrate (UAN). A nitrogen stabilizer (Instinct II) was applied to the entire plot in an attempt to prevent the ammonium forms of N from being transformed by nitrifying soil bacteria. Combinations included Urea/UAN, CN/UAN, Urea/Urea, CN/CN, and UAN/UAN. Experiment was conducted using a completely randomized design with four nine-plant replications for each treatment.

All plants were irrigated throughout the season as needed. Data collected included survival rate, plant weight, yield/plant, and yield/acre. Plant weight was determined by weighing fresh cut hop plants prior to running through the mechanical harvester. After cones were stripped from the bines, fresh cone weight was recorded and yield/plant was determined based on dry matter content. Yield/acre is reported as an estimate [(cone dry weight/treatment ÷ live plants/treatment) x 1,000 plants]. Hop cones were harvested by block using a mobile harvester (Hopharvester, Inc.). Only preliminary yield data is presented in this paper and should not be used without the author's consent.

Results and Discussion

Every effort was made to collect all cones and each treatment was harvested the same in random order to minimize confounding variables. Overall plant growth (plant weight) increased with nitrogen concentration (Table 1). Plants that received 0 and 50 lb of N/acre had reduced growth and lower yields compared with plants that received 100 and 300 lb/acre of N. However, there was no significant difference between 100, 150, 200, 250, and 300 lb N rates, regardless of parameter measured. Subsequently, N applied at 50, 100, 150, and 200 lb N/acre did not increase cone yields compared with the 0 lb/acre rate.

No significant differences were seen between the N forms (Table 2).

Harvest totals for 2017 were slightly lower than expected for third-year plants in the rate trial, but yield/acre was on par for the plants in the N form trial. Overall, the trend for increased yield with increasing N fertilizer can be detected; however, climatic conditions throughout the season could have blurred these effects. In 2017, the season started with heavy rains followed by record highs, and the season ended under drought conditions. Further analysis of N found in both soil and soil water may provide evidence of the amount of N being utilized by the crop versus leached out of the system.

Table 1. Effect of nitrogen concentrations on hop yield.

Nitrogen rate[z]	Survival rate (%)[y]	Plant weight (lb)	Yield/plant (lb)	Yield/acre (lb)[x]
0	89%	43.2 b	4.0 b	510.8 c
50	96%	44.1 b	5.1 b	588.5 bc
100	100%	72.5 a	6.7 a	749.7 ab
150	98%	64.8 ab	5.9 ab	666.4 abc
200	96%	65.9 ab	6.1 ab	716.8 abc
250	93%	61.9 ab	5.8 ab	694.8 abc
300	96%	71.0 a	7.2 a	851.8 a

[z]Urea: lb N/acre; N treatments were applied in split applications, with the first at bine training stage and the second application when bines reached halfway up the trellis (9 ft).
[y]Survival rate: percent plant survival.
[x]Yield/acre: estimated yield/acre at 1,000 trees/acre.
[w]Means (within a column) with the same letters are not statistically different according to Tukey's HSD ($\alpha = 0.05$).

Table 2. Effect of nitrogen form on hop yield.

Nitrogen form[z]	Survival rate (%)[y]	Plant weight (lb)	Yield/plant (lb)	Yield/acre (lb)[x]
Urea:Urea	97%	32.0 a[w]	8.1 a	923.7 a
Urea:UAN	97%	31.9 a	7.2 a	829.4 a
CN:CN	97%	35.4 a	8.3 a	953.1 a
CN:UAN	100%	35.4 a	8.6 a	952.5 a
UAN:UAN	97%	32.3 a	7.6 a	870.5 a

[z]N forms applied at 150 lb/acre in split applications (first at bine training stage and the second application when bines reached halfway up the trellis): Urea:Urea (75 lb N as urea:75 lb N as urea?); Urea:UAN (75 lb N as urea/75 lb N as urea ammonium nitrate?); CN:CN (75 lb N as calcium nitrate:75 lb N as calcium nitrate); CN:UAN (75 lb N as calcium nitrate:75 lb N as urea ammonium nitrate); UAN:UAN (75 lb N as urea ammonium nitrate:75 lb N as urea ammonium nitrate).
[y]Survival rate: percent plant survival.
[x]Yield/acre: estimated yield/acre at 1,000 trees/acre.
[w]Means (within a column) with the same letters are not statistically different according to Tukey's HSD ($\alpha = 0.05$).