Evaluating the Effects of Nitrogen Fertilization on Hop Yields

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Ashly Senske, graduate research assistant
Diana Cochran, assistant professor
Department of Horticulture

Introduction

Hops is a non-traditional crop, yet interest and acreage in Iowa continues to grow, especially with the increasing number of craft breweries in the state and region. Due to the crop's non-traditional status, fertility and management guidelines have not been optimized for the region's environment and soil.

Hops has the potential to be an excellent perennial specialty crop in the region. Expansion of this crop would result in the diversification of a currently homogenous agricultural landscape. However, due to the lack of research concerning hop farms in Midwestern soil and conditions, growers are wary about expanding or starting operations.

Fertility management is especially understudied, with most evidence being anecdotal and coming out of the prominent historical growing regions—the U.S. Pacific Northwest and Germany. Although hops has been shown to have relatively high nitrogen requirements, recommendations vary from 50 to 300 lb/acre. Under-application of nitrogen (N) can result in decreased yields and decreased plant health. Over-application can lead to negative environmental impacts, such as N leaching, as well as increased costs for growers. Therefore, more work is needed to determine the optimal amount of fertilizer to maximize yield and decrease losses in order to make recommendations for Iowa's specific environment and soils.

Materials and Methods

N rate. Seven nitrogen fertilization treatments were compared: 0, 50, 100, 150, 200, 250, and 300 lb/acre. Nitrogen fertilizer was applied as granular urea in split applications with the first application at bine training, the other applied when plants are halfway up the trellis (approximately 9 ft). Treatments were replicated five times in a randomized complete block design with nine plants/replication.

N form. Three forms of N fertilizer were compared: calcium nitrate (CN), urea (U), and urea ammonium nitrate (UAN). Five combinations of the three N forms were evaluated: U:UAN, CN:UAN, U:U, CN:CN, and UAN:UAN. Each treatment combination was applied in split applications (similar to N rate treatments) at a rate of 150 lb/acre. A nitrogen stabilizer was applied to the entire plot to ensure equal timing of nitrogen availability to all treatments. Treatments were replicated four times in complete randomized design with nine plants/replication.

Plants were irrigated throughout the season as needed. Data collection included survival rate, plant weight, and cone yield. Hops were harvested using a mechanical mobile hop harvester (Hop Harvester, Inc.).

Results and Discussion

N rate. Overall plant fresh weight increased with N concentration (Table 1). Yield was similar for plants receiving 50 to 250 lb of N/acre. Plants receiving 0 lb of N/acre had lower yields, and those receiving 300 lb of N/acre had higher yields. Overall yield per acre was not significantly different for any treatment. Plant biomass also was significantly different for the 0 and 300 lb of

N/acre treatments with no differences for any treatment between 50 lb of N/acre and 250 lb of N/acre.

N form. No significant differences were seen in yield/plant between N forms (Table 2). Yield/acre varied by treatment with the CN:UAN and UAN:UAN combinations producing significantly different yields than the other forms. There was no significant difference in plant biomass between treatments.

Yield was lower in 2018 compared with previous years. This most likely was due to the unseasonable spring weather, which delayed emergence. Plants emerged later, bines were trained later, and fertilizer applications were made in shorter intervals. This resulted in the bines not reaching the top of the trellis system before beginning flowering midsummer, leading to an overall decrease in yield for the season.

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Table 1. Effect of soil-applied nitrogen concentrations on cone yield.

Nitrogen rate (lb/acre)[z]	Survival rate (%)	Plant biomass (lb)[y]	Yield/plant (lb)[x]	Yield/acre (lb)[w]
0	93%	21.4 b[v]	9.0 b	256.2 a
50	98%	29.9 ab	12.6 ab	345.0 a
100	98%	32.6 ab	13.7 ab	380.5 a
150	100%	31.3 ab	11.9 ab	320.6 a
200	100%	35.9 ab	14.6 ab	388.5 a
250	93%	31.1 ab	13.0 ab	378.3 a
300	98%	41.7 a	17.2 a	447.9 a

[z]Nitrogen rate: each N (granular urea) rate treatment was applied in split applications.
[y]Plant biomass: weight of plant before stripping cones.
[x]Yield/plant: dried cones ÷ number of plants/treatment.
[w]Yield/acre: estimated yield/acre at 1,000 plants/acre.
[v]Means (within a column) with the same letters are not statistically different according to Tukey's HSD ($\alpha = 0.05$).

Table 2. Effect of soil-applied nitrogen form on cone yield.

Nitrogen form[z]	Survival rate (%)	Plant biomass (lb)[y]	Yield/plant (lb)[x]	Yield/acre (lb)[w]
Urea:Urea	100%	34.2 a[v]	3.5 a	396.6 ab
Urea:UAN	100%	31.5 a	3.3 a	408.9 ab
CN:CN	100%	41.7 a	4.2 a	472.5 ab
CN:UAN	100%	38.5 a	4.4 a	494.9 a
UAN:UAN	98%	24.5 a	2.9 a	314.6 b

[z]Nitrogen form: applied in split applications at 150 lb/acre; Urea = granular urea; UAN = urea ammonium nitrate (liquid); CN = calcium nitrate (granular).
[y]Plant biomass: Harvested plant was weighed before being run through the harvester.
[x]Yield/plant: dried cones ÷ the number of plants/treatment.
[w]Yield/acre: estimated yield/acre at 1,000 plants/acre.
[v]Yield/plant: dried cones divided by the number of plants/treatment.
[v]Means (within a column) with the same letters are not statistically different according to Tukey's HSD ($\alpha = 0.05$).