Enhancing Midwest Hop Productivity Using Photoperiodism: An On-Farm Research Project Video Transcript

In 2015, we planted hops on our farm in southern Ohio. We looked at hops as an opportunity to diversify the operation, where we also raised beef cattle, row crops, forages, and, at the time, burley tobacco, which was an industry that was changing rapidly.

We installed a hop yard with a twenty-foot high-trellis system that was about two acres and 1,800 plants. We chose our hop varieties based on conversations with local brewers and market research. To better access the craft brewing market, we converted an unused garage on the farm into a licensed, food-grade processing facility. Now, we work with local and regional craft brewers selling them hops that they use to create farm-to-glass local brews.

One of the challenges we've found raising hops in Ohio has been the growing conditions. We noticed for a few growing seasons that plants were flowering early, before they could reach an ideal height. One of the Extension specialists who we relied on for production information shared a study by the University of Florida testing a lighting system in a hop yard to delay flowering, and, ultimately enhance vegetative growth.

Day length is a significant factor in the timing of hop flowering. And flowering is a factor that impacts yield. The major hop growing region of the United States is the Pacific northwest where daylight hours differ from Ohio's daylight hours due to the difference in latitude.

We wanted to explore if the lighting system investigated by University of Florida would help in our growing conditions based on the challenges we had been experiencing. In 2021, we installed 240 LED bulbs designed specifically for flower regulation in plants over 1 acre or about 900 hop plants. The bulbs are designed for short-day length plants with a spectrum rich in red and white light.

We installed the lamps on commercial grade electrical light strings that we attached along the top cable of the trellis system with zip ties. Lamps were placed every 20 feet in a staggered pattern to reduce shadowing. Installation of the lighting system was labor intensive, requiring 3-4 people to install and supplies cost $13,000.

We connected the lighting system to the existing electric service near our hop yard, which is close to the farm's main barnyard. Electricity bills for the 2021 and 2022 growing seasons using lights were collected to track electricity usage and costs and to compare to prior years. In 2021, the lighting system was turned on each night around 7:30pm and turned off the following morning around 8am from early to mid June until July 31.

About 8-10 days after we stopped using the lights, the hop plants began to flower. Flowers develop into cones, which are harvested and processed for use in brewing.

In the 2021 growing season, most plants grew to the top of the trellis, a height of 20 feet. In comparison, the experimental hop yard at The Ohio State University South Centers, an agricultural research and Extension facility about 60 miles from our farm, measured their hop plants at about 15-20 feet the same season.

We fertilized the hops before new growth emerged using dry fertilize and then during the growing season via the irrigation system. In 2021, we applied 265 pounds of Nitrogen per acre. The hop yard at the OSU South Centers received 300 pounds of Nitrogen per acre.

We generally watered the hop yard every 7 days in 2021. We used an estimated 203,600 gallons of water, which we estimated was similar to the amount used in 2020. The lighting system added an additional input cost to our hop production – electricity. Based on 2021and prior years' electricity bills, we estimated that the lighting in the yard utilized 1,135 kWh of electricity with a cost of $136.79 for the season.

Based on what we learned in the 2021 growing season, we shifted the lighting period to earlier in the 2022 season, turning on lights overnight in late-May through mid-July. In 2022, all of the hop plants reached the top of the 20 foot trellis and the plants had significant lateral bine growth, which generally increases cone production. Using dry and liquid fertilizer in the irrigation system, we applied 247.44 pounds of nitrogen over the course of the 2022 season. The 2022 growing season was wet. We received just under 25 inches of rain at the farm from May through August, which meant we irrigated much less in the hop yard. We irrigated only five times over the course of the season using an estimated 68,000 gallons of water.

Again, using electric bills for the 2022 season compared to the year before the lights were installed, we estimated that the lights used about 660 kWh of electricity for a cost of $98.62.

In late September of 2021, we harvested approximately half of the Cascade variety hops before a quality analysis indicated they were well below industry standards for alpha and beta acid content. These lab results meant the hops were not usable in commercial craft brewing, so harvest was discontinued. However, based on the harvest that did take place, we estimated that the plants yielded about 0.46 pounds of wet hops per plant.

In 2022, we began harvesting the Cascade variety of hops about 15 days earlier than in 2021 in mid-September. This initial harvest yielded approximately 2 pounds of wet hops per plant. Harvest lasted 17 days with the yield per plant decreasing to a season total of 0.952 pounds of wet hops per plant. The quality of the hops harvested in 2022 exceeded industry standards for alpha and beta acid content.

In comparison, the Cascade variety at the hop yard at the OSU South Centers yielded 1.13 pounds of wet hops per plant in 2021.

Visually, the cones that developed under the lighting system were noticeably smaller than expected. The photograph on the left shows cones that grew on ornamental plants in the flower bed next to our barn while the cones on the right grew on plants under the lights in the hop yard.

Although we did not conduct rigorous statistical analysis of our results, we identified a handful of important takeaways from this project. First, the yield and quality in the 2021 season did not meet our expectations and underperformed compared to the yard at the OSU South Centers where they did not use lighting, but the 2022 season yielded a similar quantity of hops that exceeded industry standards for quality while using less nitrogen. In the future, we'd like to conduct more rigorous statistical analysis to better understand these differences.

While the lighting system was time and capital intensive to install, it was relatively inexpensive to operate during the season. The lighting also had an added benefit of allowing us to control and reliably predict the timing of hop harvest — and to even stagger plant maturity and harvest to spread the workload and infrastructure demands to better match our resources.

We also learned that the timing of the lighting is extremely important. While earlier in the season seemed to perform better, we still have questions around the best time in the season to start using lights, the optimal timing to stop the lighting, and the right timing for fertilizer applications when using lights. All things we hope to continue learning in future growing seasons.

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture, under agreement number 2020-38640-31522 through the North Central Region SARE program under project number FNC21-1303. USDA is an equal opportunity employer and service provider. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the U.S. Department of Agriculture.