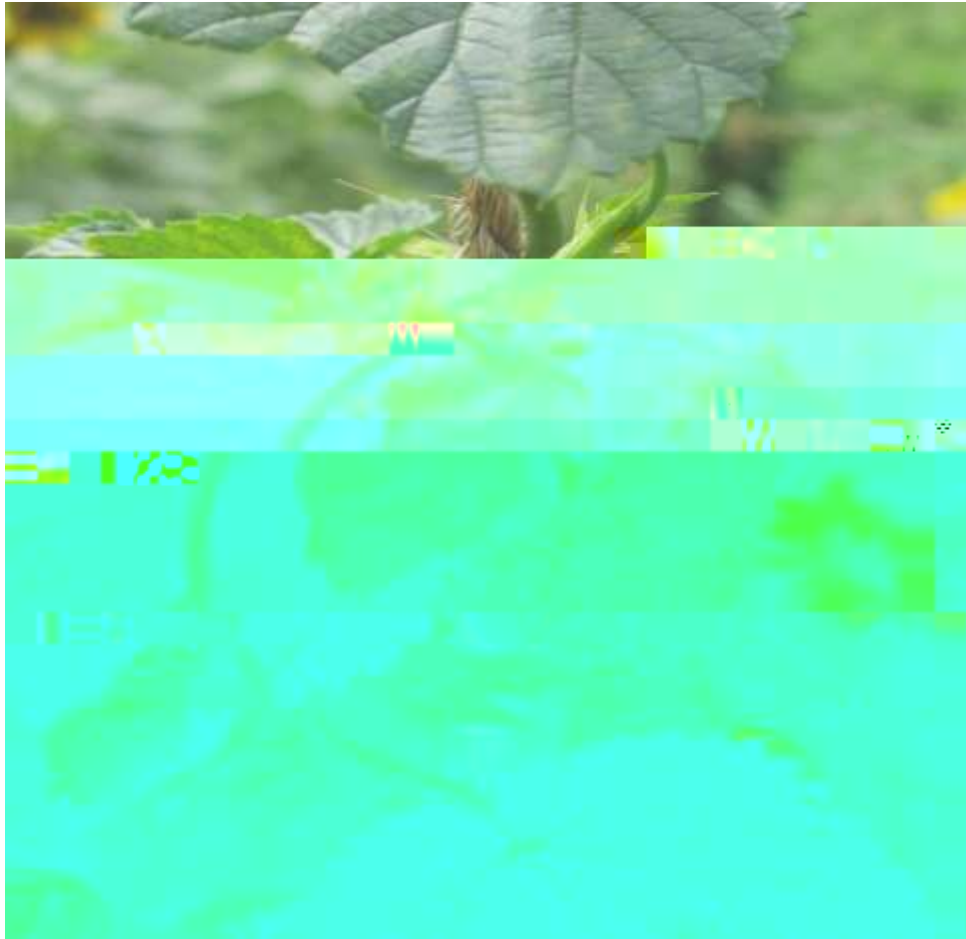


2016 Hop Optimal Irrigation Trial



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2016 HOP OPTIMAL IRRIGATION TRIAL

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Hops reportedly use about 610 to 715 mm (24 to 28 inches) of water per year (Evans 2003). Rainfall can contribute to this total, however, due to climatic variability, it is important that hops are irrigated regularly to combat moisture stress. Moisture deficit during the hop growing season has been shown to cause reductions in hop cone yield (Hnilickova et al. 2009). Irrigation systems can help to alleviate some of the potential drought stress, but timing of water application is just as important as the amount of water hops are receiving. Hops require the majority of their water in the critical period between training and flowering for optimal vegetative growth. The hop yard is irrigated through a well-fed drip irrigation system, which delivers 3000 gal ac⁻¹ each week, beginning in late May. Over the 14-week irrigation period, this equates to 1.54 inches of water, or 0.11 inches each week, which is well below the 23.5 inches required, adjusting for potential evapotranspiration. The goal of this project was to evaluate differences in yield, insect pests, and disease presence between plants at the Borderview Research Farm that were watered at the optimal level, and plants that were irrigated at the level sustained by the on-farm well.

MATERIALS AND METHODS

The replicated research plots were located at Borderview Research Farm in Alburgh, VT on a Benson rocky silt loam. The experimental design was randomized throughout the variety trial. Replicates were split between two varieties: Cascade and Nugget. Each plot was split into plants that received supplemental irrigation to meet hop water requirements and control plants that did not.

All plants received a weekly water baseline of 3000 gal ac⁻¹ through a drip line with emitters. Plants were scouted on a weekly basis for insect pests and symptoms of downy mildew, and they received fertilizer through fertigation and two side-dress applications. Other than additional watering, all plants were treated in the same manner.

The hop yard was irrigated weekly in July and August at a rate of 3000 gallons of water per acre. Detailed information as well as a parts and cost list for the drip irrigation system can be found at www.uvm.edu/extension/cropsoil/hops.

Fertigation (fertilizing through the irrigation system) was used to apply fertilizer more efficiently. Starting in late May, the hops received 4 lbs ac⁻¹ of nitrogen (N) through the irrigation system on a weekly basis until side shoots were observed.

At each fertigation application, 25 0 0 1 Tm Tm[811(ni)-4(BT1 0 0 1 215.33 533.76 Tm{0 0 1 Tm(c)9(s p)9(r-ca)8e f)-5(o(l)6(i)

Table 1. Total baseline water amount and supplemental irrigation, Alburgh, VT, 2016.

Week	Total rainfall inches	Total water applied inches plant ⁻¹	Supplementation amount	
			inches plant ⁻¹	gal ac ⁻¹
20-Jun	0.36	0.47	0.60	16,364
27-Jun	1.36	1.47	0.00	0.00
4-Jul	0.43	0.54	0.53	14,455
11-Jul	0.08	0.19	0.88	24,000
18-Jul	1.10	1.21	0.00	0.00
25-Jul	0.09	0.20	0.87	23,727
1-Aug	0.14	0.25	0.82	22,364
8-Aug	0.45	0.56	0.51	13,909
15-Aug	0.02	0.13	0.94	25,636
Total	4.03	5.02	5.15	140,455

Total water applied

(Marrone Bio Innovations, EPA Reg. No. 84059-3) is a broad spectrum biofungicide that is active against soil borne and foliar pathogens. The active ingredient is extracted from giant knotweed (*Fallopia sachalinensis*) and works by
Milstop (Bioworks Inc. EPA Reg. No. 70870-1-68539) is used as a preventative treatment for foliar diseases. It works by changing leaf surface pH and decreases the ability for fungal cell wall formation. Cease (Bioworks Inc. EPA Reg. No. 264-1155-68539) is used as a preventative treatment for foliar disease. Trilogy (Certis USA, LLC., EPA Reg. No. 70051-2) is a fungicide and miticide derived from neem oil. It acts a repellent and makes it difficult for fungi and insects to attack the plants.

Table 2. F

less rain than in a usual year. Overall, there were an accumulated 2653 Growing Degree Days (GDDs) this season, approximately 284 more than the historical 30-year average.

Table 3. Temperature, precipitation, and growing degree days summary, Alburgh, VT, 2016.

Alburgh, VT	March	April	May	June	July	August	September
Average temperature (°F)	33.9	39.8	58.1	65.8	70.7	71.6	63.4
Departure from normal	2.90	-4.90	1.80	0.00	0.10	2.90	2.90
Precipitation (inches)	2.50	2.60	1.50	2.80	1.80	3.00	2.50
Departure from normal	0.29	-0.26	-1.92	-0.88	-2.37	-0.93	-1.17

ment each week, Alburgh, VT, 2016.

ing season (Table 6). No leaf infection was found on either
ifferences between treatments for aerial spike presence.
and plants with supplemental irrigation had an average of

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ines, only bine nutrients were examined for this irrigation
t nutrients, and total plants should contain approximately

Quality parameters for Cascade hops were tested at the University of Vermont Hop Analysis lab (Table 8). The ideal alpha acid content for Cascade ranges between 5.50 and 9.00%; both treatments fell below the industry standard with a trial mean of 4.81%. The industry standard for beta acid levels in Cascade ranged from 6.00 to 7.50%. Both treatments fell within this range. The hop storage index represents the degree of oxidation, and has an ideal value of 0.200. Both treatments fell above this value, but were not statistically significant from each other.

Table 8: Impact of irrigation treatments on Cascade quality parameters, Alburgh, VT, 2016.

Treatment	Alpha acid %	Beta acid %	Hop storage index
Supplemental irrigation	4.76	7.30	0.25
Control	4.93	7.06	0.243
Trial mean	4.81	7.22	0.250
p-value (0.1)	0.426	0.561	0.498

Quality parameters for Nugget hops were also tested (Table 9). Ideally, Nugget hops alpha acid values range between 13.5 and 16.0%, and beta acid values should be between 4.40 and 5.50%. Irrigation and control treatments were below the industry standard for both values. The average hop storage index was above the standard 0.200, with a trial average of 0.237.

Table 9: Impact of irrigation treatments on Nugget quality parameters, Alburgh, VT, 2016.

Treatment	Alpha acid %	Beta acid %	Hop storage index
Supplemental irrigation	11.0	4.27	0.235
Control	11.5	4.03	0.237
Trial mean	11.4	4.08	0.237

