2014

Hops Crowning Trial

Heather Darby
University of Vermont, heather.darby@uvm.edu

Julian Post
University of Vermont

Lily Calderwood
University of Vermont

Erica Cummings
University of Vermont

Scott Lewins
University of Vermont

See next page for additional authors

Authors
Heather Darby, Julian Post, Lily Calderwood, Erica Cummings, Scott Lewins, Susan Monahan, and Sara Ziegler

NORTHWEST CROPS & SOILS PROGRAM

2014 Hops Crowning Trial

Dr. Heather Darby, UVM Extension Agronomist
Julian Post, Lily Calderwood, Erica Cummings, Scott Lewins, Susan Monahan and Sara Ziegler
UVM Extension Crops and Soils Technicians
(802) 524-6501

Visit us on the web at www.uvm.edu/extension/cropsoil

UNIVERSITY OF VERMONT EXTENSION
CULTIVATING HEALTHY COMMUNITIES

2014 HOPS CROWNING TRIAL

Dr. Heather Darby, University of Vermont Extension
heather.darby[at]uvm.edu

As the acreage of hops continues to rapidly expand in the northeast, there is a great need for production knowledge specific to our region. Downy mildew has been identified as the primary pathogen plaguing our hop yards. This disease causes reduced yield, poor hop quality, and can cause the plant to die. Control measures that reduce disease infection and spread while minimizing the impact on the environment are desperately needed for the region. Mechanical control is one means to reduce downy mildew pressure in hop yards. Scratching is a practice initiated in the early spring when new growth has just emerged from the soil. The first shoots have an irregular growth rate and are not the most desirable for producing hop cones later in the season. Removal of this new growth through mechanical means helps to remove downy mildew inoculum that has overwintered in the crown. The top of the crown itself can be removed to further eliminate overwintering downy mildew. This practice is typically referred to as "Crowning". While crowning is known to be effective in the Pacific Northwest, there is no established time frame for crowning in the Northeast. The goal of this project was to evaluate the impact of crowning/scratching at two different time periods on hop downy mildew pressure as well as hop yield and quality.

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 a randomized complete block with 10' x 35' plots (each plot had 7 hills). Plots were replicated 3 times. Main plots consisted of two varieties. Cascade served as a moderately resistant cultivar and Nugget served as a downy mildew susceptible treatment. Split plots were two crowning dates. Crowning was completed in 2014 on two different dates, 14-Apr and 12-May in order to establish an optimal crowning date. A control treatment was left with no crowning. Crowning was performed using a DR trimmer fitted with a modified, blunted metal blade (Figure 1).

Figure 1: Crowning blade

In mid-May, late May and mid-July, basal and aerial spikes were counted for each plot. Fungicides were sprayed when the forecast predicted downy-mildew-favorable weather (warm and moist) (Table 1). The fungicides used in the research yard in 2014 were Champ WG (Nufarm Americas Inc, EPA Reg. No. 55146-1), and Regalia (Marrone Bio Innovations, EPA Reg. No. 84059-3). Champ WG is 77% copper

hydroxide and works as a control measure against downy mildew in hops. When copper hydroxide is mixed with water, it releases copper ions, which disrupt the cellular proteins of the fungus. Regalia is a broad spectrum bio-fungicide that works by stimulating the plant's natural defenses. The active ingredient is extracted from giant knotweed (*Fallopia sachalinensis)*. All pesticides applied were OMRI-approved for use in organic systems and were applied at rates specified by their labels using a Rear's Manufacturing Nifty Series 50-gallon stainless steel tank utility sprayer with PTO driven mechanical agitation, a 3-point hitch, and a Green Garde® JD9-CT spray gun.

Table 1. 2014 Spray schedule in the organic hop crowning trial, Alburgh, VT.

Date	Downy Mildew control	Broad spectrum disease control
	Champ WG	Regalia
21-May	X	X
2-Jun	X	X
9-Jun	X	X
16-Jun	X	X
24-Jun	X	X
3-Jul	X	X
7-Jul	X	X
14-Jul	X	X
28-Jul	X	X

The hop yard was irrigated weekly in July and August at a rate of 3900 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#irrigation.

Hop harvest was targeted for when cones were at 20-25% dry matter. At harvest, hop bines were cut in the field and brought to a secondary location to be run through our mobile harvester. Picked hop cones were weighed on a per plot basis, 100-cone weights were recorded, and moisture was determined using a dehydrator. 100 cones from each plot were assessed for incidence of downy mildew. They were also assessed for severity of browning due to disease on a scale of 1-10, 10 being worst. All hop cones were dried to 8% moisture, baled, vacuum sealed, and then placed in a freezer. Hop samples from each plot were analyzed for alpha and beta acids in our lab using spectrophotometry as per the American Society of Brewing Chemists (ASBC) Method of Analysis entitled Hops 6a. Hop Storage Index (HSI) was also measured using the ASBC Method of Analysis detailed in Hops 12.

Yields are presented at harvest moisture and at 8% moisture on a per acre basis. Per acre calculations were performed using the spacing in the UVM Extension hop yard crowning trial section of 872 hills per acre. Yields were analyzed using the GLM procedure in SAS and brew values were analyzed using the PROC MIXED procedure in SAS with the Tukey-Kramer adjustment, which means that each cultivar was analyzed with a pairwise comparison (i.e. 'Cluster' statistically outperformed 'Cascade', Cascade statistically outperformed 'Mt. Hood', etc.). Relationships between variables were analyzed using the GLM procedure.

RESULTS

Using data from a Davis Instruments Vantage Pro2 weather station at Borderview Research Farm in Alburgh, VT, weather data was summarized for the months spanning from the 2013 harvest to the 2014 harvest.

The 2014 growing season (March-September) experienced 5325 GGD's, which were 25 less than the 30 year average (1981-2010 data). Precipitation was above average during the growing season (Table 2).

Table 2. Temperature, precipitation, and Growing Degree Day summary, Alburgh, VT, 2014.

Alburgh, VT	March	April	May	June	July	August	September
Average temperature (°F)	22.2	43.0	57.4	66.9	69.7	67.6	60.6
Departure from normal	-8.9	-1.8	1.0	1.1	-0.9	-1.2	0.0
Precipitation (inches)	1.70	4.34	4.90	6.09	5.15	3.98	1.33
Departure from normal	-0.51	1.52	1.45	2.40	1.00	0.07	-2.31
Growing Degree Days (base 32°F)	25	330	789	1041	1171	1108	860
Departure from normal	25	-54	33	27	-27	-31	2
Based on weather data from a Davis Instruments Vantage Pro2 with WeatherLink data logger. Historical averages are for 30 years of NOAA data (1981-2010) from Burlington, VT.							

Hop Cultivar x Crowing Date Interactions

There were few interactions between cultivar and date of crowning, indicating the cultivars responded the same regardless of date. There were only two varieties evaluated so caution should be taken when interpreting this data. Based on our experience, short season varieties would be more impacted by later crowning than longer season varieties.

Effect of Crowning Date

There were very few infected basal spikes observed in the early season. All plots were scouted twice in May and 1 or less basal spikes were recorded for each treatment. The number of downy mildew aerial spikes recorded in mid-July was highest in the April 14th crowning date (Figure 1). It is unclear why earlier crowned treatments were more susceptible to downy mildew.

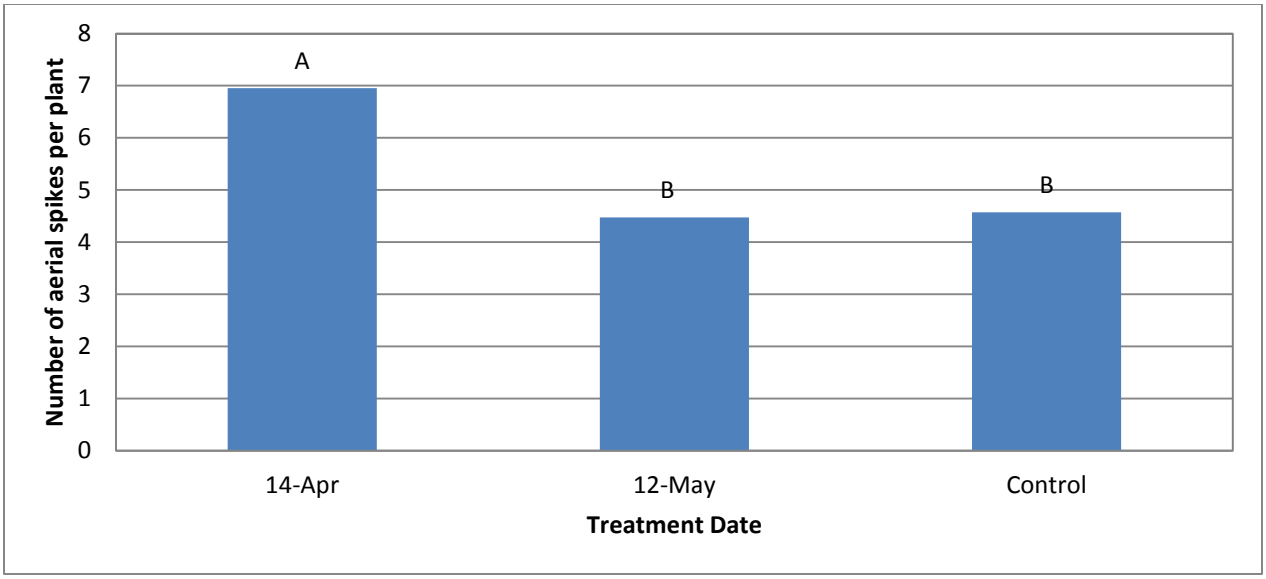

Figure 1: Effect of crowing date on the number of downy mildew infected aerial spikes, Alburgh, VT, Mid-July 2014. Treatments with the same letter are not significantly different from each other.

The date at which hops were crowned had little impact on downy mildew, hop yield, and hop quality (Table 3).

Table 3. Yield and quality performance of hops crowned on 3 dates, Alburgh, VT, 2014.

Crowning Date	Alpha acids %	Beta acids %	HSI	Yield @ 8% moisture lbs ac^{-1}	100 cone weight g	Cones with downy mildew %	Browning severity
14-Apr	**12.0**	**7.85**	0.24	**868**	17.1*	**33.7**	3.83
12-May	11.8	6.94	0.24	788	14.8	37.8	4.17
Control	10.9	6.78	**0.23**	790	**17.1***	34.7	**3.67**
LSD	NS	NS	NS	NS	1.1	NS	NS
Trial mean	11.7	7.24	0.24	816	16.3	35.4	3.89

Treatments indicated in **bold** had the top observed performance.

LSD – Least significant difference.

NS = No significant difference.

* Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

As Figure 2 shows, hops crowned in May yielded smaller cones. The April 14th treatment reached the top of the trellis by mid-June along with the control, ahead of the May 12th treatment which lagged behind a few days. Interestingly, the harvest yield was not much different, meaning that the May treatment produced more cones and caught up with the other treatments despite its smaller cone size (Table 3).

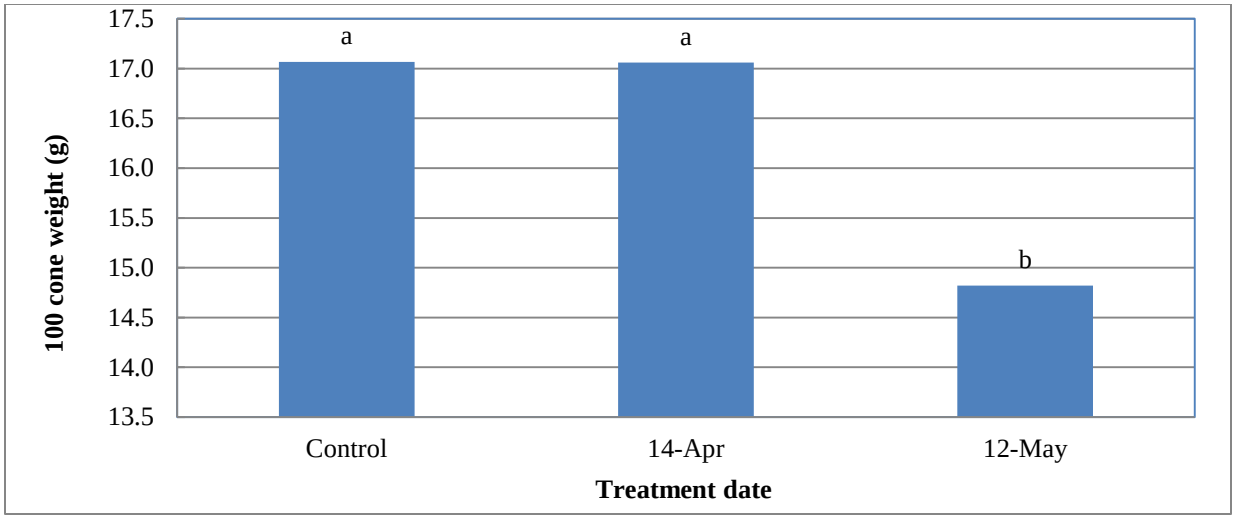

Figure 2: Effect of crowning date on hop 100 cone weight, Alburgh, VT, 2014. Treatments with the same letter are not significantly different from each other.

Effect of Cultivar

Cultivars were significantly different in yield, quality and level of downy mildew (Table 4). Nugget had more downy mildew infected cones as compared to Cascade. These cultivar differences were expected considering Nugget is considered more susceptible to downy mildew than Cascade.

Table 4. Effect of hop cultivar on yield and quality. Alburgh, VT, 2014.

Cultivar	Alpha acids %	Beta acids %	HSI	Yield @ 8% moisture lbs ac^{-1}	100 cone weight g	Cones with downy mildew %	Browning severity 1-10 scale
Cascade	8.52	**8.90**	0.23	**879**	**16.9**	**20.3**	**2.56**
Nugget	**14.8**	5.59	0.25	752	15.7	50.4	5.22
p-value	***	***	**NS**	*	*	***	***
Trial mean	11.7	7.24	0.24	816	16.3	35.4	3.89

Treatments indicated in **bold** had the top observed performance.

p-value, *, **, *** indicates significance at the 0.05, 0,01, and 0,001 probability levels.

NS = No significant differences.

* Treatments indicated with an asterisk did not perform significantly worse than the top-performing treatment in a particular column.

DISCUSSION

Mechanical removal of downy mildew in the hop plant through crowning is a proven practice in the west where hops are primarily grown. However, we have little data to indicate if this practice is effective in the east. We also do not know how late a hop plant can be crowned in this region as typically our growing season is shorter than the primary hop growing regions. Logically, a later crowning date has more chance of eliminating all downy mildew because it allows more time for the pathogen to emerge. However, it also sets the plant back more than an earlier crowning date because more material is being cut back later in the spring. The data from this year suggests that waiting until a later date, while not very detrimental in

terms of yield, creates only a slight decline in downy mildew infested cones. It is worth noting that the crowning done in this trial was on the gentle side compared to some practices. A more aggressive crowning may yield different results. Other crowning methods scratch the entire length of the plant bed instead of targeting individual plants. It would be interesting to see how the results differ with that strategy.

ACKNOWLEDGEMENTS

The UVM Extension Crops and Soils Team would like to thank Borderview Research Farm and staff for their generous help with the trials. We would like to thank Conner Burke, Julija Cubins, Hannah Harwood, Ben Leduc, Laura Madden, Dana Vesty and Emily Whalen for their assistance with data collection and entry. This work is made possible through funding provided by the USDA Hatch Initiative and The Environmental Protection Agency.

Any reference to commercial products, trade names, or brand names is for information only, and no endorsement or approval is intended.

UVM Extension helps individuals and communities put research-based knowledge to work.