Hops Production in New England

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Hops were a major crop in the Northeast in the early 1800s, before disease pressure and the appeal of the Pacific Northwestern climate drew the hops industry to the other side of the county. Currently, New England is home to over 175 high quality microbreweries. Public interest in sourcing local foods is also extending into beverages, and the current demand for local and organic brewing ingredients is quickly increasing. Sourcing local beer making ingredients is difficult and there are only a handful of examples to draw from in the area. The breweries in New England want locally grown hops to create niche brews for local markets. This demand has created a niche market potential for many farmers. Brewers and cicerones (the beer equivalent of wine's *sommeliers*) state that like grapes, hops are influenced by climate and *terroir*, with different regions producing different characteristics of the same variety based on soil type and micro, meso, and macro climatic factors. With this in mind, the potential of a specialty Northeastern, completely local brew is very exciting, especially under consideration of the exploding *localvore* movement. In 2009, UVM Extension was awarded a USDA Organic Agriculture Research and Extension Initiative grant in partnership with Washington State University, Colorado State University, and Michigan State University. The goal of this grant is to develop agronomic recommendations for organic hops production for the Northeast. Much has changed since hops were last grown in this area in the 1800s, with many new disease resistant varieties available and a better understanding of pest lifecycles. With this in mind, in August of 2010, UVM Extension planted a hops variety trial at Borderview Farm in Alburgh, VT. The UVM Extension hopyard is evaluating 19 widely available hop varieties. One goal of this project is to determine hop varieties that demonstrate disease and pest resistance in combination with high yields, and also present desirable characteristics to brewers. Another goal of the project is to develop outreach materials that will assist new growers with successfully growing hops. These materials include information on how to construct and maintain a hopyard, how to properly fertilize, and how to identify and manage pests of hops. All materials can be found at www.uvm.edu/extension/cropsoil/hops/. The results presented below are from the first year of production.

Item	Amount	Cost
5/16 cable	6750 ft	$ 1,850
Poles	65	$ 2,098
Turnbuckle, 3/4" x 12"	37	$ 589
4' ground anchors	40	$ 560
Haven Grips cable pullers	2	$ 166
Cable cutter	1	$ 66
Cable clamps	300	$ 197
Stone (to secure posts)	10 yards	$ 460
Total material costs		$ 5,985
Hydraulic post hole digger rental		$ 339
Labor	65 man hours	
Tractor and lift	32 hours	
Tractor and loader to set poles	13 hours	
Tractor and auger to set anchors	3 hours	

MATERIALS AND METHODS

The replicated research plots were located at Borderview Farm in Alburgh, VT on a Benson rocky silt loam. The hopyard was constructed in the spring of 2010, with a finished height of 16 feet using 20' x 6" larch, tamarack and cedar posts. Aircraft cable (5/16") was used for trellis wires. A complete list of materials and videos on the construction of the UVM Extension hopyard can be found at www.uvm.edu/extension/cropsoil/hops. The materials and cost for the ¾ acre hopyard are listed in the table.

The prior crop was an alfalfa/grass crop. The hop beds were prepared by first moldboard plowing only the area where the hops were to be planted. The area was then rototilled to further break up the soil to prepare for planting. This left a strip of grass/alfalfa between the rows of hops. The tillage was implemented prior to construction of the hopyard. Once the hopyard was constructed there were two vegetative hop cuttings planted per hill on August 4th, 2010. The experimental design was a randomized complete block with three replicates; treatments were varieties. Hills of hops were planted 7 feet apart, and rows were spaced at 10 feet. Each plot consisted of five consecutive hills. From planting to harvest, plants were watered with drip irrigation as needed. In-row rototilling and hand weeding was used to control weeds, and as the weeds were brought under control, rows were trained with two strings of coir (coconut fibre) per hill, fertilized, and mulched with hardwood mulch. Pro-Gro® 5-3-4 and Probooster® 10-0-0 (North Country Organics) were applied to give 50 lbs plant available N, 40 lbs P, and 80 lbs K per acre. Boron was also applied at a rate of 10 lbs/acre. As the previous crop had been plowed-down legume/alfalfa we calculated 25 lbs of additional N credit. On June 6 and 7, Chilean nitrate was sidedressed at the rate of 50 lbs N.

On June 13, 2011, downy mildew (*Pseudoperonospora humuli*) was identified, and Regalia (Marrone Bio Innovations, EPA Reg. No. 84059-3), an extract of *Reynoutria sachalinensis*, was sprayed three days later using a Fimco 45 gallon trailer sprayer equipped with a hand gun and pulled by a John Deere 20 hp riding lawn mower. Regalia® is labeled for use on hops against both powdery mildew (*Podosphaera macularis*) and downy mildew, and is a plant extract that is used to help bolster a plant's natural defense mechanisms. It was applied as per label specifications. Starting on June 29, 2011, three leaves per hill and two hills per plot were scouted weekly for presence of insect pests, diseases, and beneficial insects. Potato leafhoppers (*Empoasca fabae*) and two-spotted spider mites (*Tetranychus urticae Koch*) were identified in the hopyard and determined to be above economic threshold. Economic thresholds for potato leafhoppers in hops has not been documented, but with an in-depth literature review, it was determined that two leafhoppers per leaf was economically damaging to organically grown hops. Economic thresholds for two-spotted spider mites has been determined in the Pacific Northwest to be 1-2 spider mites per leaf in June, or 5-10 per leaf in July. Regalia was again sprayed as a preventative measure against downy mildew, and was tank-mixed with Pyganic (McLaughlin Gormley King Company, EPA Reg. No. 1021-1771) and Aza-Direct (Gowan, EPA Reg. No. 71908-1-10163). All are OMRI-approved for use in organic systems, and were applied at rates specified by their labels. Hop harvest was targeted for when cones were between 20 and 25% dry matter. Hop bines were cut in the field and brought to the barn to be handpicked on a table. Harvest date by variety can be found in Table 1. Hop cones from each plot were sent to Alpha Analytics in Yakima, WA where they were analyzed for alpha and beta acids. Yields are

presented at harvest moisture and at 8% moisture on a per hill and per acre basis. Per acre calculations were performed using the spacing in the UVM Extension hopyard of 70 ft^2 per hill, 622 hills/acre. In all tables, the top performing variety can be found in bold. Varieties that were not significantly lower in performance than the highest variety in a particular column are indicated with an asterisk.

RESULTS

Harvest was targeted for when hop cones were between 20 and 25% dry matter (Table 1). Cluster outperformed all other varieties, averaging 3.58 lbs/hill at harvest moisture, and 0.74 lbs/hill at 8% moisture, or 2,228 lbs/acre at harvest and 459 lbs/acre at 8% moisture (Table 2). Liberty was the worst performing variety, although statistically not different from Centennial, Crystal, Fuggle, Glacier, Liberty, Mt. Hood, Perle, Saaz, Santiam, Sterling, Tettnang, and Vanguard (Table 2).

Table 1. Dry matter by harvest date and variety.

Variety	Date harvested	Dry matter %
Cascade	24-Aug-11	22.0
Cascade	26-Aug-11	22.6
Centennial	2-Sep-11	23.7
Chinook	2-Sep-11	23.3
Chinook	6-Sep-11	23.5
Cluster	11-Aug-11	19.1
Cluster	12-Aug-11	18.9
Crystal	12-Sep-11	21.2
Crystal	14-Sep-11	21.4
Fuggle	24-Aug-11	23.6
Fuggle	6-Sep-11	22.0
Galena	31-Aug-11	24.0
Glacier	6-Sep-11	22.1
Glacier	8-Sep-11	23.1
Glacier	14-Sep-11	25.8
Liberty	2-Sep-11	*
Mt. Hood	2-Sep-11	21.4
Newport	14-Sep-11	25.1
Nugget	6-Sep-11	22.7
Perle	2-Sep-11	25.3
Saaz	24-Aug-11	23.7
Santiam	6-Sep-11	19.2
Santiam	14-Sep-11	22.5
Sterling	13-Sep-11	21.4
Sterling	14-Sep-11	23.6
Tettnang	31-Aug-11	24.3
Tettnang	2-Sep-11	23.2
Vanguard	31-Aug-11	26.5
Vanguard	2-Sep-11	21.9
Willamette	31-Aug-11	25.6

Table 2. Yields at harvest moisture and at 8% moisture by variety.

*indicates not enough sample available.

Variety	Yield at harvest moisture		Yield at 8 % moisture	
	lbs/hill	lbs/ac	lbs/hill	lbs/ac
Cascade	1.71	1060	0.41	254
Centennial	0.44	273	0.11	70.0
Chinook	1.20	747	0.30	189
Cluster	**3.58***	**2230***	**0.74***	**459***
Crystal	0.37	232	0.09	53.8
Fuggle	0.13	77.8	0.03	19.3
Galena	1.87	1170	0.49	303
Glacier	0.87	539	0.22	138
Liberty	0.02	12.3	0.00	0.0
Mt. Hood	0.53	329	0.12	76.7
Newport	1.54	959	0.41	257
Nugget	1.40	870	0.35	217
Perle	0.07	43.2	0.02	12.0
Saaz	0.05	28.4	0.01	7.3
Santiam	0.31	193	0.06	40.4
Sterling	0.05	31.9	0.01	7.9
Tettnang	0.08	48.9	0.02	12.6
Vanguard	0.37	227	0.09	58.8
Willamette	1.60	993	0.41	256
Mean	0.84	526	0.20	127

Brewing values for select varieties are presented in Table 5. Some varieties did not yield enough sample to be tested for brewing values. Alpha acid percentages for Cluster, Cascade, Galena, and Vanguard fell within industry averages. Nugget and Willamette exceeded industry alpha acid averages (Figure 1). Beta acid levels for Centennial, Cluster, Crystal, Mt. Hood, Newport, Nugget, and Santiam all fell within the industry averages. Cascade, Chinook, Fuggle, and Willamette all had beta acid levels higher than industry averages (Figure 2).

DISCUSSION

The UVM Extension hopyard was planted in August of 2010, putting the yard a stage of maturity between one and two year old plants. According to Jason Perrault, a fourth generation hop grower who presented at the UVM Extension 2010 Winter Hops Conference, first-year yields are generally assumed to be approximately 50% of a mature yard's yields, although some varieties perform better in the first and second year. Some varieties, such as Cluster and Galena, yielded well for first year-plants. Other varieties, namely Santiam, Fuggle, Tettnang, Perle, Sterling, Saaz, and Liberty, did not thrive nor yield well. Hops, like grapes, have *terroir*: their brewing characteristics and oil content are reflective of their microclimate. Hops grown on the East Coast, even though genetically the exact same, will not be like hops in the Pacific Northwest due to different soils and different climates. Hops grown in the Northeast will present unique brewing characteristics. It is important to evaluate hops in different localities to develop geographically specific profiles for varieties that grow well in those regions.

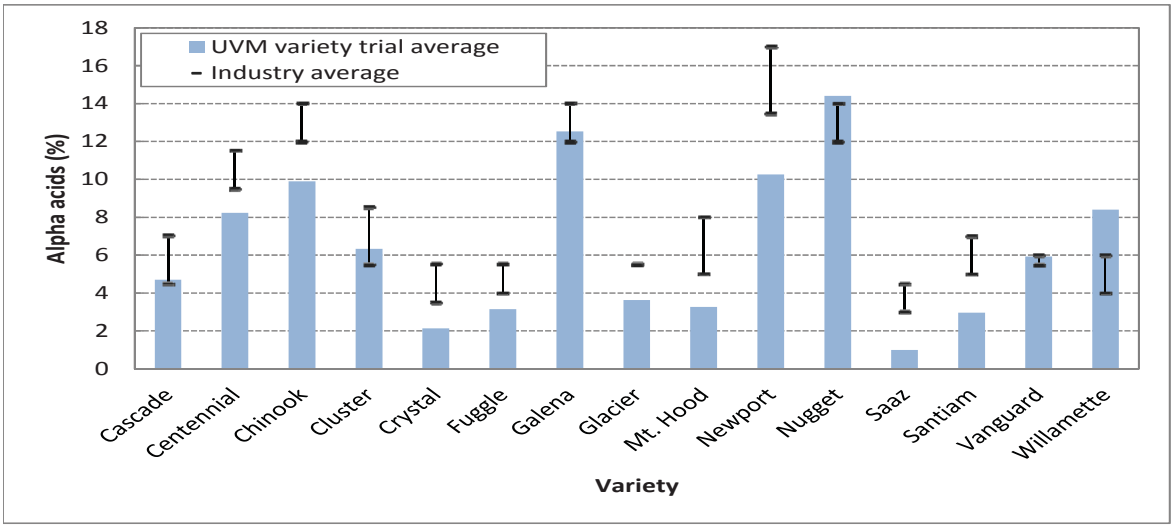

Figure 1. Alpha acid levels from the UVM Extension hopyard compared to industry averages calculated from values presented by Hopunion CBS, LLC and Yakima Chief, Inc.

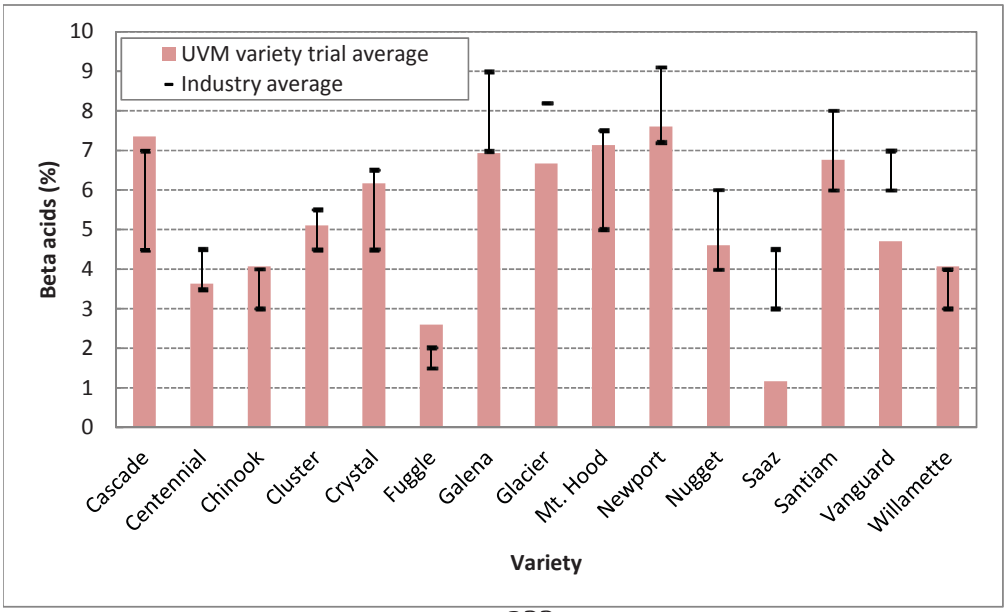

Figure 2. Beta acid levels from the UVM Extension hopyard compared to industry averages calculated from values presented by Hopunion CBS, LLC and Yakima Chief, Inc.