Hop Selections for North Dakota

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Abstract

Hops, *Humulus lupulus,* is a dioecious, herbaceous perennial vine belonging to the *Cannabinaceae* family, along with the genre of *Cannabis* (hemp) and *Celtis* (hackberry). Hop flower or cone initiation is day length sensitive, therefore growth and development is most successful between the 35th and 50th latitude north and south. Hops has many consumptions other than for its most commonly known use of adding flavor and aroma to beer. Some of these uses include medicinal and cosmetic products, ornamental value, as well as a delicacy. Native hops, along with cultivars, grow successfully in North Dakota; however, there is a lack of research on the yield and quality of hop cultivars grown in the state. Desired acid and oil profiles of the hops are what give them marketability in the beer making process. The objectives of this project were to conduct and assess yield and quality of hop cultivars, and to recommend the best variety adaptations for our upper Midwestern climate. This investigation evaluated 12 different commercially available cultivars grown on a standard trellis in the semi-arid region of Western North Dakota. Variety adaptation for yield and quality was assessed for two growing seasons. The top yielding variety was 'Challenger'. The variety 'Spalt Select' was the least adapted to the western growing region in terms of both production and quality.

Materials and Methods

The trial grounds are located in the semi-arid region in North Western North Dakota in Williams County, 6.4 km west of Williston, ND. The type of trellising system that was chosen is called a high-trellis. Telephone poles 7.6 meters high were placed 1.2 meters into the ground, making the top of the trellis approximately 6.4 meters off the ground with galvanized aircraft cable strung between poles as the top wire. There are three high-trellis rows, spaced 4.6 meters apart; each representing one replication of 12 varieties in a randomized complete block design. A 1.27 cm poly irrigation line was suspended above the plants with one drip emitter installed at each plant. Varieties were chosen based off their commercial availability, as well as brew usage (see Table 1). The hops were planted in August 2014, with three plants from the same variety grown in each rep and evenly spaced 0.9 meters apart with a 2.1 meter buffer between varieties (Figure 1). Strings of baling twine were tied from the top trellis wire perpendicular to each plant with one string per plant. The twine was attached at the ground using w-shaped clips and an applicator (Figure 2). Three bines per plant were trained onto the twine in a clockwise direction (Figure 3). The bines were cut from the trellis using a telescoping tree pruner. Yields were collected from all of the plants using a Hopster 5P mechanical harvester (Figure 4). Harvest weights and harvest moistures were analyzed using data from one plant out of three in each rep. Harvest moistures were calculated using a subsample of known weight of cones at harvest, and drying the subsample down by microwave until the sample weight no longer fluctuated. This sample weight at 0% moisture was divided by the original harvest subsample weight and multiplied by 100 to give us percent moisture. One bulk sample from each variety was placed in a vacuum sealed bag and sent to a lab for Alpha Acid, Beta Acid and Hop Storage Index (HIS) testing. After harvest, the hops were placed in a dryer and weights were recorded after 24 hours.

Table 1. Shows variety information, brew usage, Alpha Acid ranges, Hop Storage Index, and harvest moistures.

Hops Variety Information									**WREC-2016**
Variety	Origin[1]	Brew Usage[2]	Typical Beer Style	Typical Alpha Acid Ranges	2015 Tested Alpha Acid	2016 Tested Alpha Acid	2015 Hop Storage Index[3]	2016 Hop Storage Index[3]	2016 Harvested Moisture
				---------- % ----------					---%---
Brewer's Gold	UK	B	Ale	8-10	3.2	7	0.25	0.26	71.3
Cascade	DM	A	American Pale Ale	5-7	3.1	3.7	0.21	0.20	73.0
Centennial	DM	D	American Pale Ale	9.5-11	6.3	10.8	0.24	0.25	72.0
Challenger	UK	D	English Ale	6.5-9	8.9	14.2	0.24	0.25	71.3
Galena	DM	B	English Ale	10-15	6.2	8.5	0.21	0.21	74.7
Glacier	DM	D	American Pale Ale	5.5	4.2	4.2	0.24	0.23	70.0
Mt. Hood	DM	A	Lager	4-7	3.0	3.1	0.22	0.21	74.0
Newport	DM	B	Barley Wine	13-17	2.4	6.7	0.25	0.25	73.5
Nugget	DM	B	Barley Wine	12-14	3.6	12.6	0.22	0.22	70.7
Spalt Select	GE	A	Bock	3-6.5	3.0	2.6	0.26	0.27	68.5
Willamette	DM	A	English Style Ale	4-6	2.0	3.0	0.26	0.27	72.3
Zeus	DM	B	Pale Ale	20	1.2	3.9	0.26	0.23	77.5
							Mean		72.4
							C.V. (%)		3.6
							LSD (10%)		3.7

[1]DM = Domestic, UK = United Kingdom, GE = German as reported by Hopunion LLC

[2]A = Aroma, B = Bittering, D = Dual purpose as reported by Hopunion LLC

[3]HSI is a non-dimensional number calculated by measuring the adsorption of an alkaline methanolic hop extract at two different wavelengths using UV spectrophotometric analysis. Normal range is from 0.25 for fresh hops and 2.5 for fully oxidized hops.

Figure 1. Three plants of each variety planted per rep

Figure 2. Stringing

Figure 3. Training

Figure 4. Harvesting

Results

Two years of hop growth and harvest data has been collected. The yield data is summarized from one plant per rep for each variety (Figure 5). Kilograms per Hectare is reported in comparison to that of national yields from the Pacific Northwest in Table 2. Hops are a perennial crop that reach maximum production after a minimum of three years. The results after two years have shown a few varieties to have desirable characteristics and yields for northwestern North Dakota, but more time is needed to determine full potential.

Table 2. Reported yields for primary US growing region and WREC yields.

Hops Variety Yields						**WREC-2016**
	2015 Reported Yield for Idaho[4]	2015 Reported Yield for Oregon[4]	2015 Reported Yield for Washington[4]	2015 Yield	2016 Yield	2 year Average
Variety	---------- Kg/Ha ----------					
Challenger	NR	NR	NR	2844	2721	2783
Galena	NR	NR	2206	2067	2079	2073
Cascade	1830	2235	2170	1821	3122	2472
Nugget	NR	2116	2160	1435	1155	1295
Newport	NR	NR	NR	1301	1040	1171
Centennial	NR	1515	1283	1165	1287	1226
Willamette	NR	1374	1129	1160	1852	1506
Glacier	NR	NR	1116	983	1570	1277
Brewer's Gold	NR	NR	NR	708	2099	1404
Zeus	3260	NR	3160	445	2203	1324
Mt. Hood	NR	1430	1198	379	747	563
Spalt Select	NR	NR	NR	199	1799	999
[4]USDA-NASS report prepared by Hop Growers of America			Mean	1209	1806	1508
NR= Not Reported			C.V. (%)	1.7	1.7	--
			LSD (10%)	654	929	--

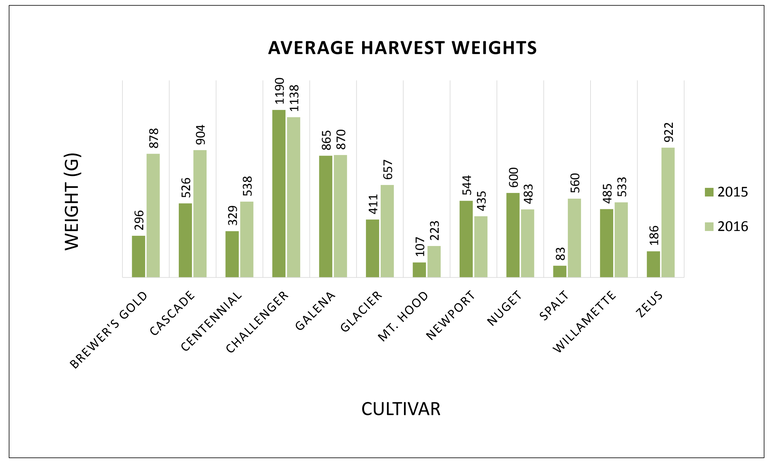

Figure 5. Comparison of the mean harvest weight per variety.

Figure 6. A cluster of hop cones.

Conclusions

These preliminary results indicate that hops can be successfully grown in the upper Midwest, however, more applied research is needed on hops in North Dakota. There are many things that influence the production of a commodity in any growing region. Costs of initial hopyard set-up, labor costs and post harvest processing are just a few of the economical factors involved in successful region-wide production. Nitrogen application, rates and timings; irrigation use and efficiency; availability of herbicides and their applications; appropriate soil mulches; training dates and harvest dates, as well as the multitude of disease and insect pests are all management practices that present research opportunities for this growing region.

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