Environmental Influence on Hop Alpha Acid Content

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Objectives

The aim of the study is to examine whether certain environmental factors influence the amount of alpha acids in a hop, *Humulus lupulus*.

Background

Understanding what affects the production of alpha acids in a hop plant is vital information to hop farmers, brewers, and consumers. Female hops are used in the brewing process because they contain lupulin glands that are filled with resins and essential oils, which contain properties that are favored for distinct taste profiles in beer. The overall taste, aroma, and perceived bitterness of beer are determined by the combination of these chemical compounds. The alpha acid percentage is an important quality parameter for marketing in the hops industry as well as determining a finished beer's International Bittering Units (IBU). Packaged hop's alpha acid percentage are expressed as a weight/weight % at 10% moisture content.

Methods

A representative soil sample was taken around each individual hop plant at their respective farm, using a soil sampler probe.

The PRS® probes measured nutrient uptake rates for the following soil nutrients:

- NO3-, NH4+, K, P, Ca, Mg, S, Zn, B, Mn, Cd, Al, Fe, Pb, and Cu.

Simple linear regression is used to test if any individual soil nutrient was associated with alpha acid percentages.

Geographic features at each farm, such as slope aspect, are examined to understand the microclimate at each farm.

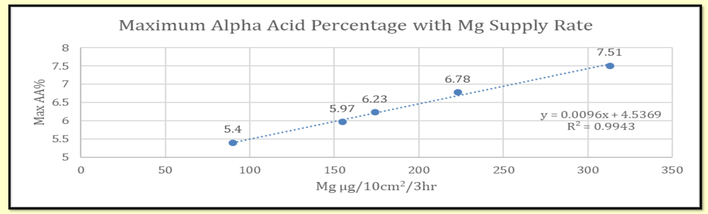
Data on alpha acid percentages for each Cascade hop sample were quantified by Dr. Lares' research group in the Chemistry Department of Sonoma State University.

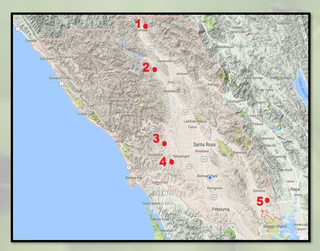
Results

PRS(tm)-probe supply rate (micro grams/10cm²/burial length)

Sample	NO3-N	NH4-N	Ca	Mg	K	P	Fe	Mn	Cu	Zn	B	S	Pb	Al	Cd	MaxAA%
April 4 2017																
Redwood Hill Farm	131	2	566	162	362	13.1	1.4	1.8	0.3	0.8	0.2	32	0	5.3	0	4.89
Warm Spring Wind Farm	85	1	639	177	120	5.8	1.1	1.8	0	0.8	0	26	0.3	3.5	0	7.51
BiRite Farms	58	0	871	236	52	7.4	2	1.1	0.1	1.1	0.6	53	0	9	0	6.78
Eric's Farm	6	0	311	83	41	1.3	0.9	0.1	0.1	0.3	0.4	8	0.1	5.8	0	5.4
Fogbelt Farm	190	1	1405	150	119	1.4	2.1	6.1	0.8	0.8	1.4	482	0.1	10.1	0	6.23
BiRite Farms (2015)	31	0	477	169	66	2.1	1.1	6	0	0.6	0.1	38	0	3.1	0	5.97
Eric's Farm (2015)	25	0	446	73	42	2.2	1.2	0.2	0.1	0.3	0.7	6	0	6.9	0	N/A
Septmember 2 2017																
Redwood Hill Farm	44	7	406	100	186	8.7	2	2.8	0.5	0.7	0.9	35	0.1	7	0	4.89
Warm Spring Wind Farm	30	3	1253	313	97	7.2	3.3	3.9	0.3	1.3	1	312	0.9	8.6	0	7.51
BiRite Farms	34	1	918	223	53	6	2.5	12.3	0.2	1.4	0.4	53	0.1	8.1	0	6.78
Eric's Farm	26	1	503	90	36	0.9	0.8	2.1	0.7	0.1	0.1	21	0.1	2	0	5.4
Fogbelt Farm	190	4	1200	174	162	0.6	3.1	16	1.7	2.4	0.2	527	0.2	4.8	0	6.23
BiRite Farms (2015)	14	3	610	155	66	5.1	1.2	11.1	0.3	1.3	0.2	47	0.1	2.9	0	5.97
Eric's Farm (2015)	82	0	732	111	39	1	1.2	5.1	1.2	0.3	0.3	40	0	5.6	0	N/A

Soil Nutrient	Post-Growing Season (Sept 2)		Pre-Growing Season (Apr 4)	
	acid:nutrient response rate	Correlation Coefficient	acid:nutrient response rate	Correlation Coefficient
Mg	0.0096	0.997	0.0131	0.900
Al	0.2566	0.952	0.0709	0.279
B	2.0527	0.927	0.0976	0.068
Fe	0.5939	0.831	0.5939	0.819
Ca	0.0019	0.799	0.0006	0.296
Pb	1.8254	0.793	-3.9167	0.596
P	0.2052	0.772	0.1698	0.594
Zn	0.3951	0.401	2.15	0.788
S	0.0013	0.360	-0.00009	0.022
K	0.0046	0.282	-0.0038	0.176





Location

- The farms of each hop plant are located at Sonoma (BiRite Farms), Cloverdale (Eric's Farm), Healdsburg (Fogbelt Farm), and Sebastopol (Warm Spring Wind Farm and Redwood Hill Farm).
- Two of the hop plants were planted in 2015, while the remaining five hop plants were planted in 2016.

Conclusion & Future Studies

The soil nutrient supply rates for Mg, Al, B, Fe, Ca, Pb, and P produced the highest correlations with alpha acid content. Future studies should take multiple sets of soil samples during the growing season from late-July to September to account for the time period of peak alpha acid growth, account for fertilizer amendments, and gather a larger sample size. Furthermore, environmental variables such as temperature, precipitation, relative humidity, sunlight hours, amount of surrounding vegetation, soil type, soil pH level, CEC, slope aspect, slope steepness, irrigation, styles of farming, and different uses and types of home-made fertilizers were not accurately measured. Future studies should measure or control these variables and use them in the regression analysis.

References

Pavlovic, V., et al. "Environment and Weather Influence on Quality and Market Value of Hops." Plant Soil Environment, vol. 58, 25 Aug. 2011, pp. 155–160.
"PRS Technology." Relationship to Plant Uptake | Western Ag Group of Companies, 2018, www.westernag.ca/innovations/technology/relationshiptouptake.

Thanks to

NORCAL HOP GROWERS ALLIANCE

SONOMA STATE UNIVERSITY

Geography Department
Chemistry Department