2017

Hop Harvest Timing

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NORTHWEST CROPS & SOILS PROGRAM

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HOP HARVEST TIMING

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In the Northeast, hop harvest generally begins in mid-August and continues through mid-September. Harvest date is primarily dependent on the hop variety but weather can delay or hasten maturation and impact when harvest will occur. In addition to weather, various pests, such as spider mites and downy mildew, can similarly impact harvest timing. The time at which you harvest hops can affect the various qualities of your finished product. Alpha and beta acid content peaks before many essential oils have fully developed. Delaying harvest can provide time for these oils to develop but increases the amount of time the hops are left vulnerable to disease and fall rains which can result in degradation of resins.

Although typical harvest dates are well established for Europe and the Pacific Northwest, the Northeast experiences a distinct climate with unique growing conditions that can greatly impact the various resins and oils in hops. A general window for harvest timing can be gleaned from these other locations, but region specific information is required for producing a fully mature hop cone with the desired aroma and flavor profiles in the Northeast. Traditionally, harvest timing is determined by dry matter and resin content. This method encourages adequate acid production over aromatic oil production, thereby limiting options for end users. To better understand how factors such as cone smell, look and dry matter content correspond to the development of resin and oils, a harvest timing trial was initiated in 2017 in Northfield, MA. We aim to use these data to develop regional harvest timing standards that can assist hop growers in producing the highest quality hops.

MATERIALS AND METHODS

The harvest timing trial was initiated at Four Star Farms, LLC in Northfield, MA. Collection started two weeks prior to the farms' normal harvesting times for each variety. Eight different varieties were tested including Cascade, Centennial, Crystal, Magnum, Mt. Rainier, Nugget, Rakau, and Teamaker. Rakau, Teamaker, and Mt. Rainier are not included in the results due to small sample size or apparent mislabeling of varieties. Varieties that appeared to be delayed or advanced as a result of weather conditions were adjusted based on a sensory analysis of cones as well as tests for dry matter. Varieties that were newly grown on the farm were tested for maturity using similar sensory observations and by testing in relation to known maturation ranges for other previously grown varieties.

Sampling took place twice per week on Mondays and Thursdays (just after noon) starting between 11-Aug for the earliest maturing varieties and 9-Sep for the latest maturing varieties. Approximately 14-16 oz of hops were collected from random hop plants in each row at an approximate height of 3-9'. Samples were vacuum sealed and shipped to Alpha Analytics (Sunnyside, WA) for analysis. Each sample was tested for alpha acids, beta acids, HSI, dry matter and volatile oil profile. Oil profile analysis included an analysis of beta-pinine, myrcene, linalool, caryophyllene, farnesene, humulene, geraniol, and other minor oils which contribute to the overall flavor profile of each hop variety.

RESULTS

Table 1 shows a summary of the temperature, precipitation and growing degree day (GDD) summary. The 2017 growing season in Northfield, MA was fairly similar to Vermont growing conditions accumulating 2255 GDDs this season, 43 more than the historical 30-year average. Precipitation for the early part of the growing season was well above normal averages especially in May, where they experienced over 3" of rain above average.

Table 1. Temperature, precipitation and growing degree day summary. Northfield, MA, 2017.

2017 Northfield, MA	March	April	May	June	July	August	Sept
Average temperature (°F)	29.7	49	54.8	65.4	69.1	67.1	64.5
Departure from normal	1.45	-4.17	1.65	0.39	1.5	1.67	-3.86
Precipitation (inches)	2.52	3.18	6.52	4.64	2.5	4.3	2.42
Departure from normal	0.29	0.38	3.1	0.99	-1.67	0.43	-1.18
Growing Degree Days (base 50°F)	4	99	164	461	588	515	424
Departure from normal	4	99	-34	-14	-52	-66	106

Table 2 provides a summary of the analyzed oil characteristics and the aromatic qualities that they may contribute during the brewing process.

Table 2. Oil characteristics.

Oil	**Associated Scents**
β-pinene	Piney, green
Myrcene	Citrus, bright, green, resinous
Linalool	Floral, orange, citrus
Caryophyllene	Woody, spicy
Farnesene	Floral, herbal
Humulene	Piney, woody, herbal, spicy
Geraniol	Floral, bright

Harvest periods were broken down into early, normal, and late periods. The early period for Cascade was taken from 14-Aug through 21-Aug, normal harvest period is taken from 25-Aug through 5-Sep, and late harvest period is taken from 8-Sep through 18-Sep. Total analyzed oils for Cascade generally increased from early to late harvest periods, peaking during the late harvest period (Figure 1). The largest component was made up of myrcene which peaked during the normal harvest period and stayed relatively consistent through late harvest, as did caryophyllene. Whereas humulene and farnesene steadily increased as time went by. Cascade Alpha acids were consistent throughout the harvest and beta acids peaked slightly during the normal time period (Figure 2).

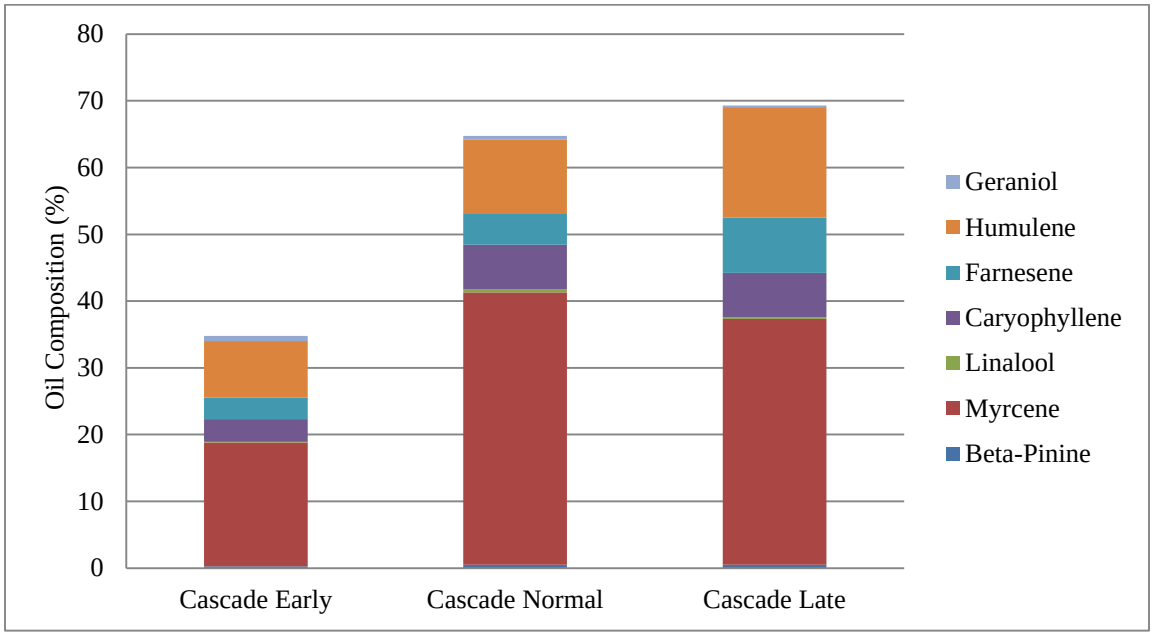

Figure 1. Cascade oil profile by harvest periods.

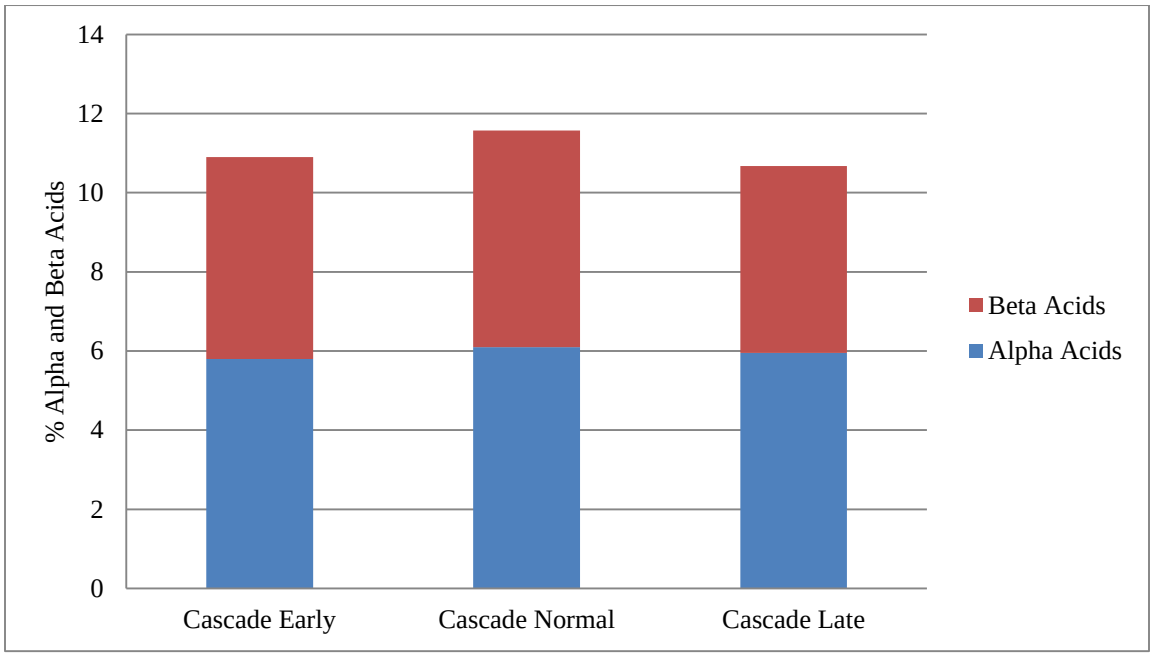

Figure 2. Cascade alpha and beta acids by harvest periods.

The early period for Magnum was taken from 14-Aug through 21-Aug, normal harvest period is taken from 25-Aug through 5-Sep, and late harvest period is taken from 8-Sep through 18-Sep. Total analyzed oils for Magnum generally increased from early to late harvest periods, peaking during the late harvest period (Figure 3). As with Cascade, the largest component of the oil profile was made up of myrcene. In Magnum the myrcene and caryophyllene levels steadily increased as time went by, whereas humulene peaked in the normal harvest period. Magnum resin levels were relatively consistent, with a slight drop off for beta acids during the late harvest period (Figure 4).

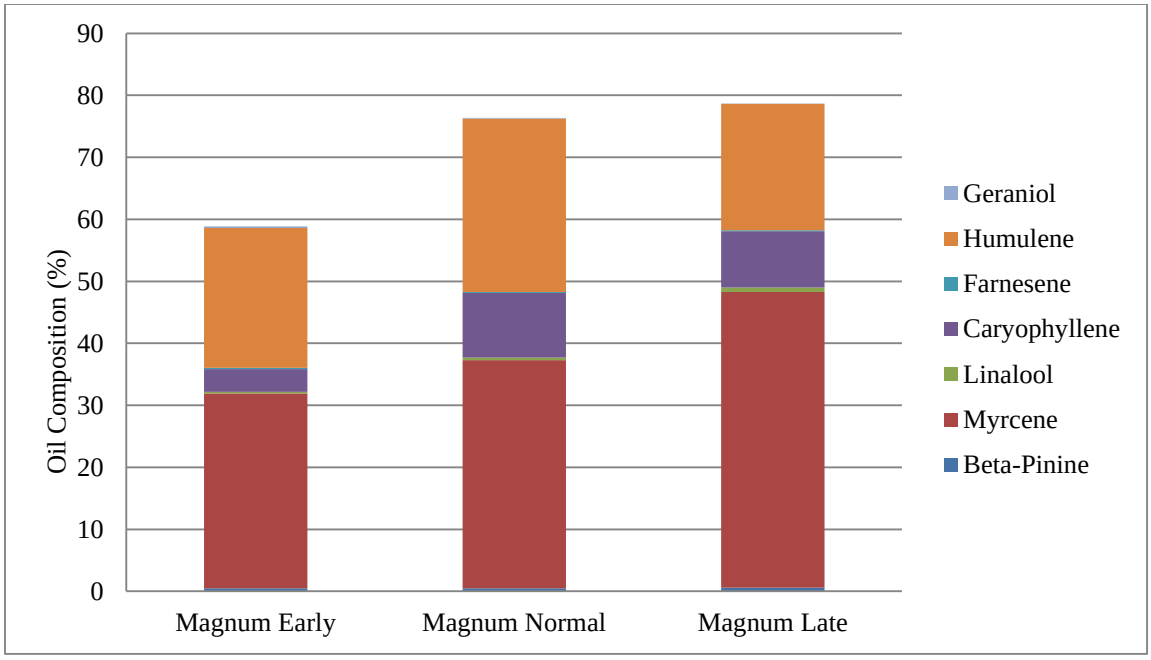

Figure 3. Magnum oil profile by harvest periods.

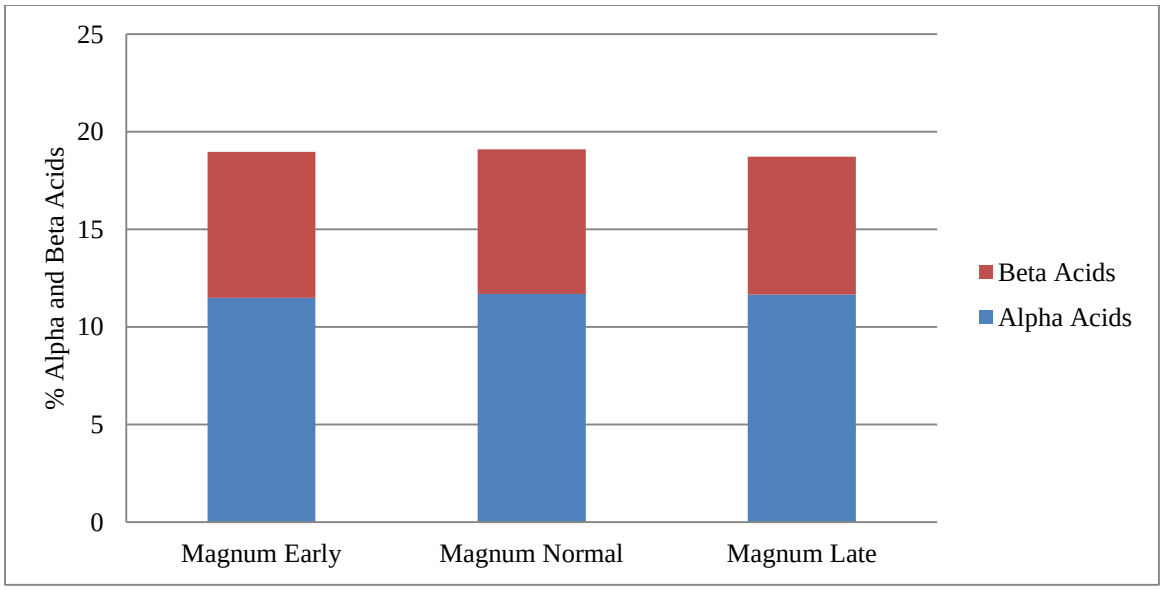

Figure 4. Magnum alpha and beta acids by harvest periods.

The early period for Nugget was taken from 18-Aug through 28-Aug, normal harvest period was taken from 1-Sep through 11-Sep, and late harvest period was taken from 15-Sep through 22-Sep. Total analyzed oils increased over time peaking during the late harvest period (Figure 5). Myrcene showed a noticeable increase over the harvest period whereas humulene peaked during the normal harvest period for Nugget. Resins for Nugget had increasing levels over the tested period and peaked during the late harvest window (Figure 6).

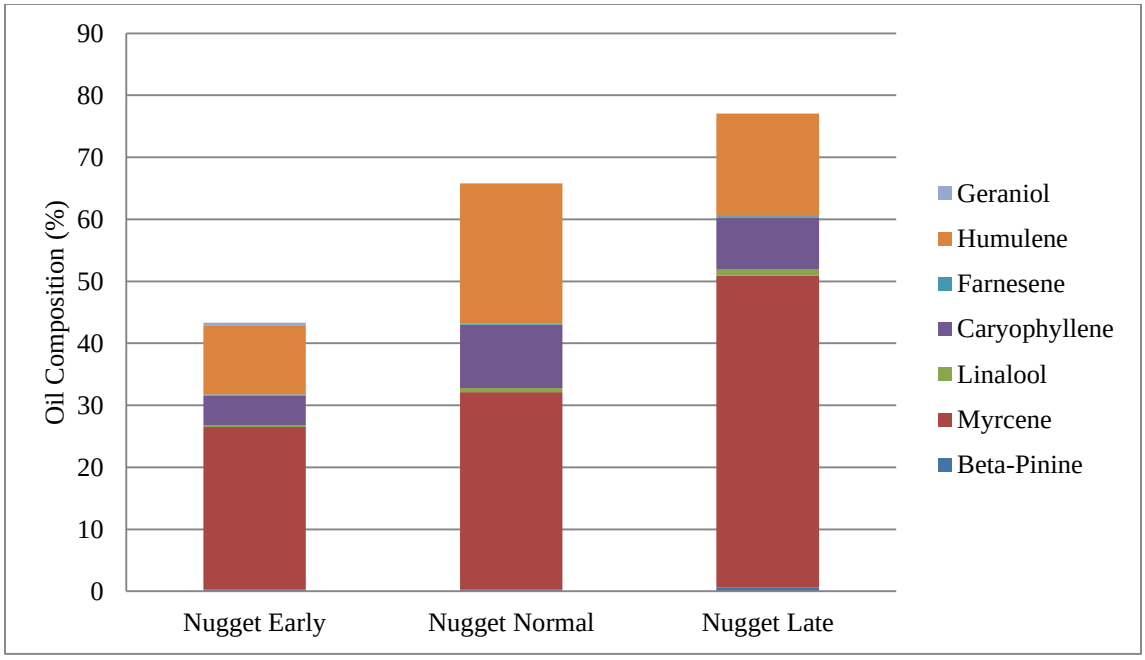

Figure 5. Nugget oil profile by harvest periods.

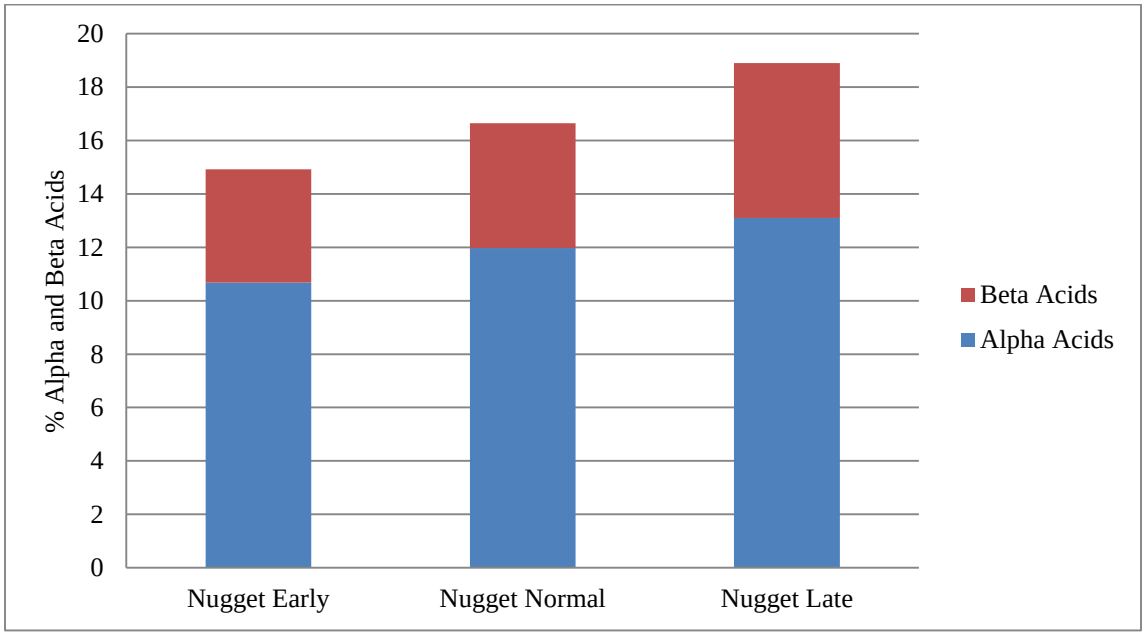

Figure 6. Nugget alpha and beta acids by harvest periods.

The early period for Centennial was taken from 11-Aug through 18-Aug, normal harvest period was taken from 21-Aug through 28-Aug, and late harvest period was taken from 1-Sep through 8-Sep. Total analyzed oils for Centennial were highest during the early period and showed fluctuations throughout harvest periods (Figure 7). Resins showed similar fluctuations with peak concentrations of alpha and beta acids during the early harvest period (Figure 8).

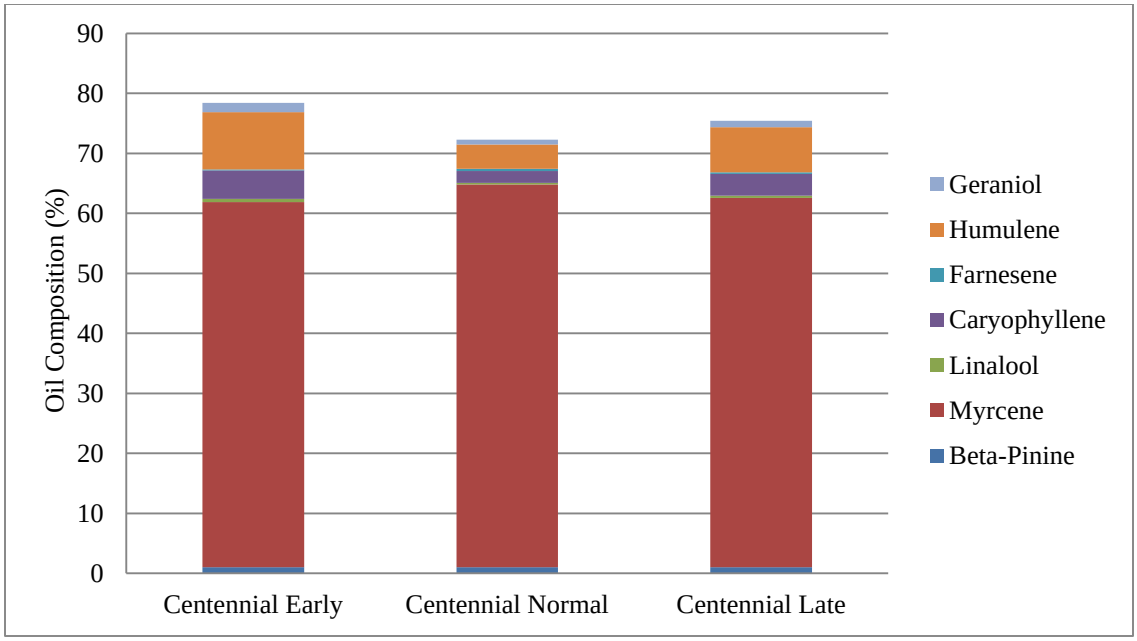

Figure 7. Centennial oil profile by harvest periods.

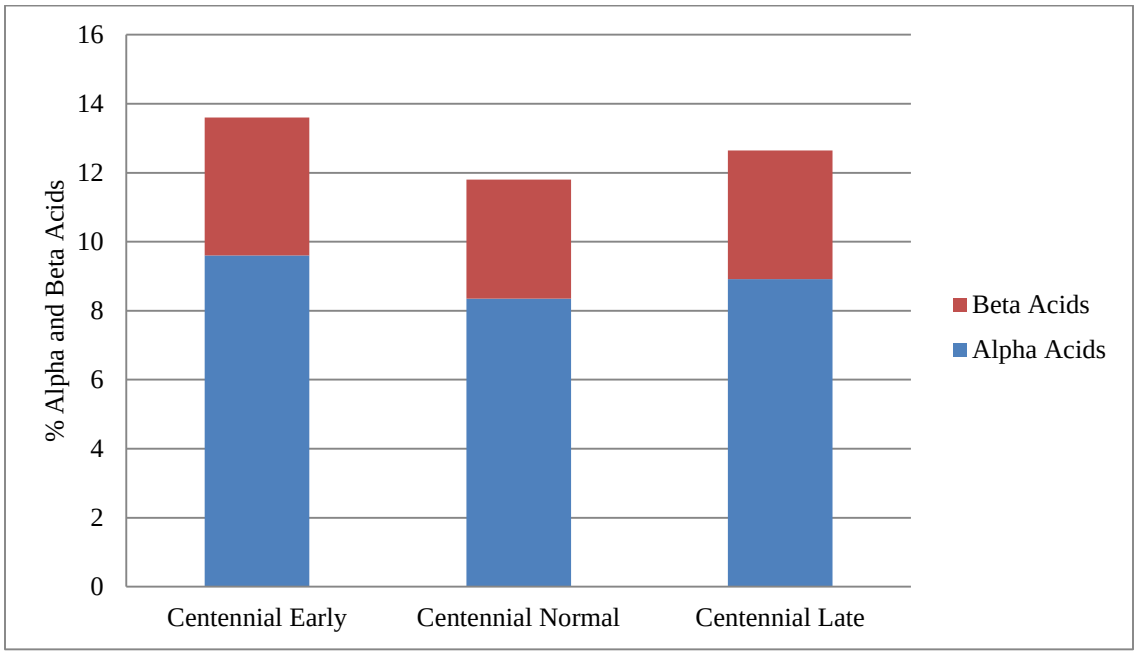

Figure 8. Centennial alpha and beta acids by harvest periods.

The early period for Crystal was taken from 21-Aug through 1-Sep, normal harvest period was taken from 5-Sep through 15-Sep, and late harvest period was taken from 18-Sep through 29-Sep. Total analyzed oils increased over time once peaking during the late harvest period. While myrcene continued to develop over time and peaked with the total oils, humulene, caryophyllene and geraniol were highest during the early harvest period (Figure 9). While beta acids remained fairly consistent across harvest periods, alpha acids appear to have peaked in the late harvest period (Figure 10).

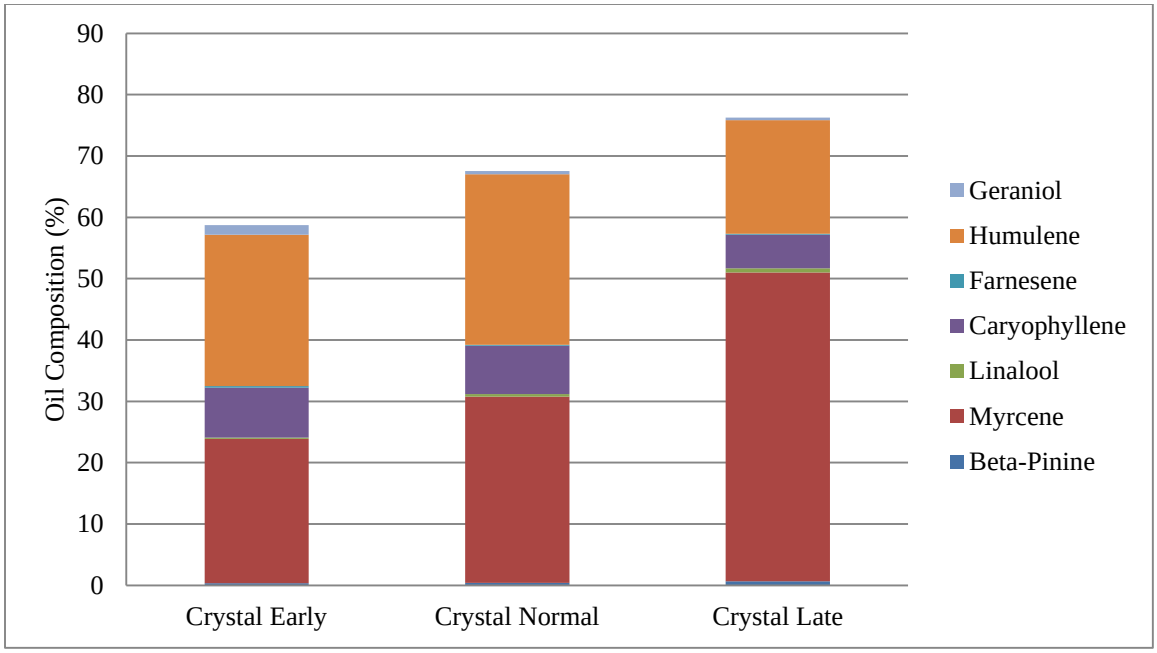

Figure 9. Crystal oil profile by harvest periods.

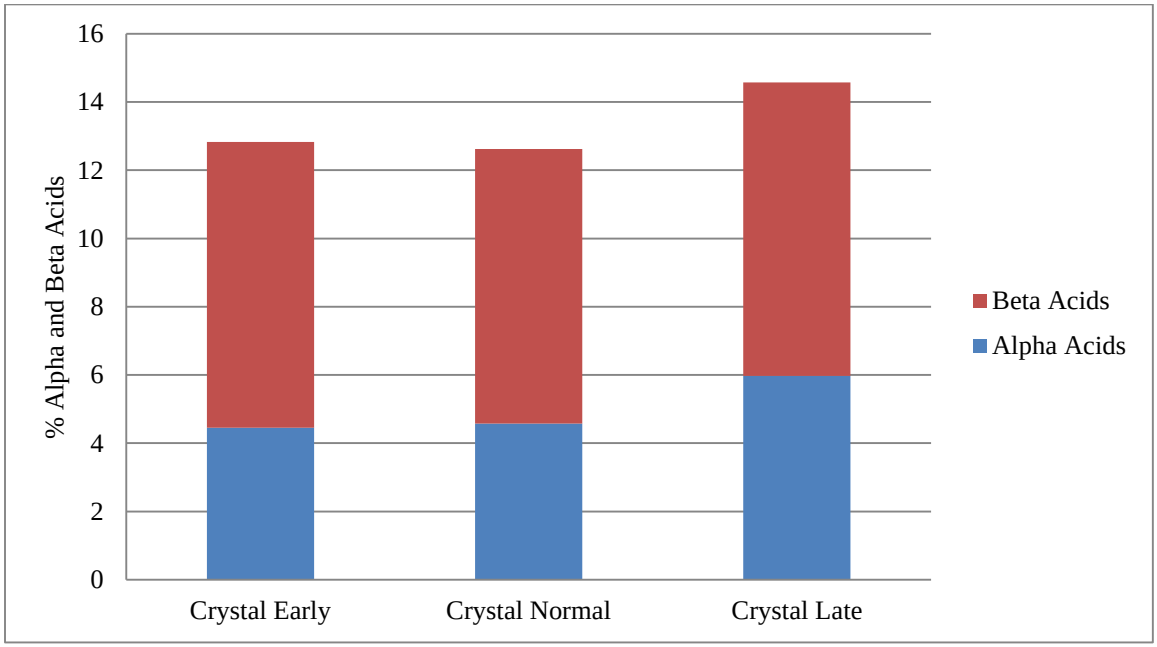

Figure 10. Crystal alpha and beta acids by harvest periods.

DISCUSSION

From the first year of the study, we noticed a general increase in the total analyzed oils from the early harvest period to the late harvest period for most varieties. Resin concentrations showed a bit more variation across varieties and harvest periods. In many cases, delaying harvest could lead to an increase in oil and resin levels contributing increase aromatics in hop cones, whereas other varieties suggest that we may benefit from an earlier harvest period to similarly maximize oils and resins.

Harvesting too early will also disrupt the various flavor constituents of hops as neither oils nor alpha and beta acids have had the ability to reach peak levels. However, harvesting too late can also reduce brewing quality and aroma through degradation and increased exposure to pests, diseases, and various weather conditions. Later harvested hops are also at risk of accelerated oxidation in storage through the loss of volatile aroma compounds. Later harvested hops usually suffer from shortened storability as do cones that have been damaged by diseases and or pests.

As we continue this study, we hope to determine how harvest timing can impact the various aromatic compounds that help to contribute to aromatic and flavor characteristics for hops. We also hope to provide additional insight on proper harvest timing to accentuate resins and oils in hops for farmers in the Northeast.

ACKNOWLEDGEMENTS

This project was supported by USDA SARE Grant LNE16-348. UVM Extension would like to thank Eugene L'Etoile and his staff at Four Star Farms, LLC in Northfield, MA for their generous help with the trials. We would like to acknowledge Nate Brigham, Erica Cummings, Kelly Drollette, Hillary Emick, Amanda Gervais, Matthew Sanders, Stuart Wolff-Goodrich, and Sara Ziegler for their assistance with data collection and entry. We thank the individual farms that allowed our team to collect and evaluate hop harvest timing. The information is presented with the understanding that no product discrimination is intended and no endorsement of any product mentioned or criticism of unnamed products is implied.

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