# Understanding the Ripening Chemistry of Cold-Hardy Wine Grapes to Predict Optimal Harvest Time

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The chemical composition of *Vitis vinifera* cultivars has been extensively researched, but little is known of the chemical composition of cold-hardy cultivars. We monitored fruit composition in 11 cultivars to determine how heat unit accumulations affected changes in fruit chemistry during the 2010 and 2011 growing seasons.

Tackling the intricate question of when to harvest can be difficult, and the chemical composition of grape berries has generally been accepted as the primary factor determining harvest time. Most growers and winemakers use soluble solids (mainly sugar) content or pH as harvest indicators and others may rely simply on taste. Growers want to capture the optimal balance between sugars, acids, and flavor that will contribute to sensory quality, stability, and alcohol potential of wine. The chemical composition of grapes continuously changes as the berry develops from fruit set to harvest. The grape ripening process after veraison includes a decrease in organic acids and an increase in sugars, berry weight, and pH. Developing a dynamic profile of the ripening process by tracking these changes will guide harvest decisions, leading to optimal grape maturity and improved wine quality.

**Acids and sugars.** Important indicators of grape maturity are titratable acidity (TA), pH, and soluble solids (°Brix), which measure the organic acid and sugar content. The most abundant organic acids in grapes are tartaric and malic acids. High amounts of malic acid can lead to undesirable effects on TA, pH, and wine sensory quality. Fortunately, malic acid concentrations decline after veraison, which contributes to the desired decline of TA. Tartaric acid is generally the most abundant organic acid and does not typically decrease after veraison. Glucose and fructose make up 99% of the total soluble solids and concentrations increase from veraison through maturity. Soluble solids are measured using a refractometer and expressed in °Brix and reflect the relative "sugar weight" of a juice sample (1.0 degree Brix is denoted as 1.0% sugar by weight). Measuring TA, pH and soluble solids is vital for determining optimal grape harvest times.

**Research methods.** Our objective was to identify and quantify organic acids and sugar composition of fruit from wine grape cultivars throughout fruit maturation. Grape berry samples of eleven wine grape cultivars (Table 1) were harvested every 8 to 10 days from early August to mid October during the 2010 and 2011 growing seasons at the University of Minnesota Horticultural Research Center in Chaska, MN. Samples of 40 berries at each harvest date were divided into 4 replicates of 10 berries that were weighed and juiced. Juice samples were measured for soluble solids, TA and pH. Analysis of variance and Least Significant Difference (LSD) were used as statistical analysis procedures to determine when harvest date no longer had a significant effect on grape maturity indicated by changes in °Brix, TA, and pH.

photo: David L. Hansen, University of Minnesota
Vignoble Le Mernois Vineyard and Winery

**Results.** As grape berries near maturity, the accumulation of soluble solids and degradation of organic acids begins to slow down and concentrations become nearly stable. When TA and °Brix plateau, the berry has reached the range of peak maturity. By expressing the harvest date in terms of accumulated heat units expressed as growing degree days (GDD), we are able to compare soluble solids, TA, and pH data from years that had quite different weather conditions. For example, 2010 was cool and wet compared to the hot and dry growing season of 2011. When comparing the two years of data to GDD, they showed nearly identical trends, supporting the use of GDD to track these measurable components (Fig 1). In both 2010 and 2011, TA and °Brix leveled off at approximately 2555 GDD, which was on Sept. 8th in 2010, and Aug. 29th in 2011.

**Observations.** Concentrations of organic acids, sugars, and berry weight were measured to predict peak maturity. By applying this technique to the grape cultivars in this study, we were able to make several notable observations:

- Peak maturity range occurred later than the historical harvest time (in terms of GDD accumulation) in most locations.
- In this study, *Vitis vinifera* cultivars matured later with respect to soluble solids, °Brix and pH.

- TA for 'St. Pepin' and 'St. Croix' plateaued much earlier than their corresponding soluble solids.
- °Brix plateaued earlier than TA in most U of M cultivars, which was unlike all other cultivars.
- 'Marquette' reached peak maturity between 2550 – 2650 GDD.
- 'Frontenac' reached peak maturity between 2575 – 2725 GDD.
- 'Frontenac gris' reached peak maturity between 2530 – 2700 GDD.
- 'La Crescent' reached peak maturity between 2515 – 2630 GDD.

**Take home message.** By determining the concentration of sugars and acids during fruit ripening relative to growing degree days, we found that 2500 to 2725 GDD are needed to fully ripen cold climate wine grapes to peak maturity in east central Minnesota. Although this is true for Chaska, growing locations in the Northeast may not accumulate as many GDD and optimal maturity ranges may occur earlier.

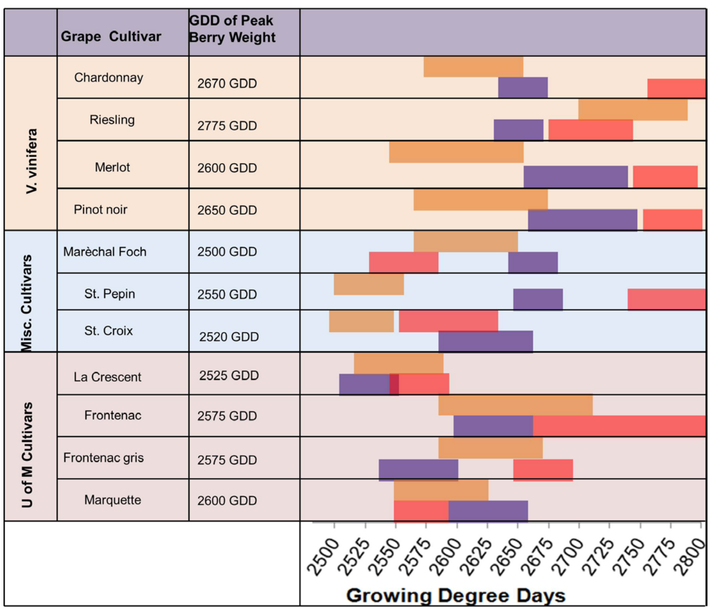


*Table 1. Colored boxes indicate when there is no longer a significant change in °Brix, pH, and TA in respect to GDD, highlighting the range of peak maturity for each trait in grapes grown in Chaska, MN. Peak weight is the maximum weight achieved during the harvest season.*

Change in the chemical composition of cold-hardy wine grape cultivars depends on many factors including growing location, cultivar, and amount of heat units accumulated over a season. These results will vary from site to site, but the same method used in this study can be applied and tracked in any vineyard. Knowing how many GDD have accumulated at harvest in prior years can help guide harvest decisions and allow growers to estimate the number of days to harvest.

Physiological maturity often differs from optimal harvest parameters. Wine styles or flavor may be more important than optimal maturity when determining harvest time. For example 'St. Croix' is generally harvested according to flavor before the soluble solids reach their peak range, but grapes should hang longer if a sweeter wine is desired. Whatever harvest indicator is used, it is important to consider the many factors involved and the changes the grapes undergo. Complete knowledge in the timing and range of variation for these measurable components should be used as a tool when determining harvest time.

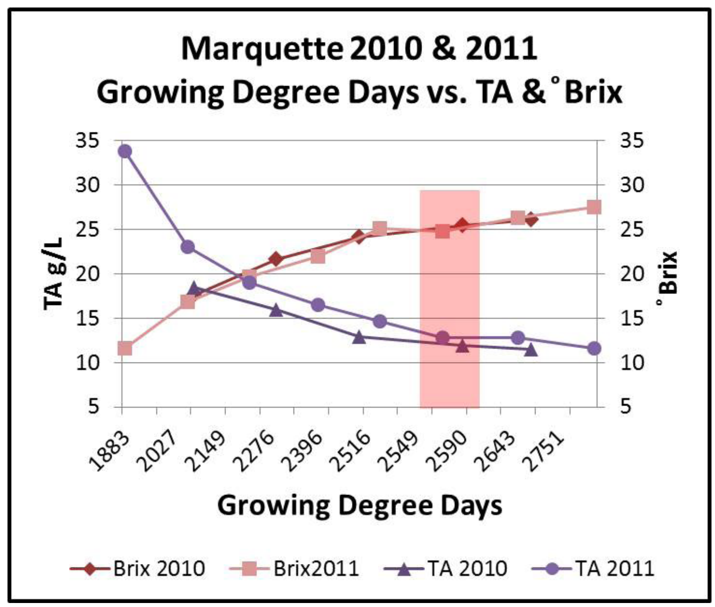


*Figure 1. Changes in soluble solids (°Brix) and TA show the variation of sugar and organic acid concentrations throughout 'Marquette' grape ripening in Chaska, MN. Harvest dates were converted to corresponding accumulated heat units expressed as growing degree days (GDD). The red shaded area indicates the range of peak maturity.*

## Web Sites Offering Growing Degree Day Calculations

**Minnesota and Wisconsin:**
- http://climate.umn.edu/cropddgen/ (MN)
- http://agwx.soils.wisc.edu/uwex_agwx/thermal_models/many_degree_days_for_date (WI)

**Northeast:**
- http://newa.cornell.edu/index.php?page=degree-days (NY)

**Dakotas:**
- http://climate.sdstate.edu/awdn/archive/degreedays.asp (SD)
- http://ndawn.ndsu.nodak.edu/corngdd-form.html (ND)

**Universal:**
- http://www.weather.com/outdoors/agriculture/growing-degree-days/