Red Hills of Lake County Cabernet Sauvignon Shows Great Promise
Beckstoffer Vineyards New High-End Farming Initiatives

Introduction

After two decades of cultivating quality Cabernet Sauvignon in Lake County, Beckstoffer Vineyards envisioned taking the fruit and subsequent wines to unprecedented levels of color, aroma, mouthfeel and overall quality. Handpicked, well-respected vintners took part in a three-year program (2016, 2017 and 2018) devoted to uncovering the potential of both the Amber Knolls and Crimson Ridge Vineyards, working with Cabernet Sauvignon and to a lesser extent Malbec winegrapes. One acre allocations were donated to each participating winemaker with the caveat that all measures necessary would be applied to drive quality in the finished wines.

The Amber Knolls and Crimson Ridge Vineyards are located in the Red Hills AVA which is known for rolling mountain ranges comprised of unique volcanic soils, intense solar radiation and picturesque landscapes. The summers are hot and dry with a strong diurnal shift. Following the onset of fall, cooler days and nights help promote and retain intense flavor development. The cumulative effect of ideal climate along with porous soils offer the potential for building a world class winegrowing region.

In 2017, the Beckstoffer team took extraordinary measures to quantify the impacts of cultural practices and distinctive *'terroir'* on berry chemistry (the results presented later).

Combined with first-rate winemaking practices from the selected participants, the Beckstoffer team and collaborating winemakers have, so far, been successful in driving grape and wine quality across the majority of allocations. The results will be unveiled in 2019.

Climate

The Amber Knolls and Crimson Ridge Vineyards are tucked within the Red Hills AVA which is located in the County of Lake bordering the southeastern perimeter of Clear Lake. It is adjacent to Napa, Mendocino, Sonoma and Yolo Counties and comprised of distinct mountain ranges. The weather parallels typical Mediterranean climates where summers are generally hot and dry and winters cool and wet. On an average year, the area receives approximately 51 inches of rainfall. The predictable rainy season provides ideal growing conditions for *Vitis vinifera* (Cabernet Sauvignon, Malbec, Sauvignon Blanc, etc.) since these varieties are susceptible to various mildew infections when growing seasons are wet and humid.

Temperature is a critical factor in the development of quality winegrapes. If temperatures are excessively high, key phenolic compounds can be inhibited, degraded and even diluted over a larger sink of fruit (Keller 2010, Van Leeuwen and Darriet 2016). The grapevines can better handle extended warm days as long as appropriate cultural practices are implemented. However warm nights can greatly affect winegrape quality, especially during the later stages of development (Koshita et al. 2007).

During the peak summer days at both the Amber Knolls and Crimson Ridge Vineyards, diurnal shifts swing in excess of 40 degrees Fahrenheit, where the warmest days exceed 100^{F} and will drop below 60^{F} during the night. The dramatic difference in temperature is critical for cultivation of premium winegrapes and is sustained to a lesser degree through harvest. This marked diurnal shift is one of the

driving factors separating the Red Hills AVA from some of the other up and coming Cabernet Sauvignon growing regions.

As the Amber Knolls and Crimson Ridge Vineyards approach the final stages of maturation (late October/early November) both day and night temperature significantly plummet. These cooler temperatures can assist in retention of key compounds in the winegrape that are expressed in the winemaking process (Rienth et al. 2014), as long as rain events are minimal. Some of these components are incredibly sensitive to warm nights. Furthermore, relatively warm weather is also known to influence acid retention in the winegrape, where warmer climates are known to drive down total acidity (Keller 2010, Mozell and Thach 2014).

Growing degree-days (GDD) is a common formula for calculating temperature's influence on plant growth potential and vigor. The Amber Knolls and Crimson Ridge Vineyards align with other high quality areas in nearby regions. In 2017, the Amber Knolls Vineyard accumulated approximately 3880 GDD, while the Crimson Ridge Vineyard accumulation was slightly greater at 3979 GDD. In 2017, both vineyards accumulated more heat accumulation units when compared to an average year. Historically, these vineyards mirror some of the well-known mountainous Napa Valley AVA's like Stag's Leap, and they are slightly greater in heat accumulation than valley AVA's like St. Helena and Calistoga (Jones 2014).

The area, also known for having some of the highest air quality reports in the state (Gearhart 2017), encounters less diffusion of solar radiation from potential pollutants allowing greater interception of light. This is traditionally a positive attribute, but the high levels of solar radiation emphasize proper canopy management.

Soils

Development of a grapevine begins in the soil. The Red Hills AVA is comprised of well-drained volcanic soils rich in native materials ideal for Brix accumulation while simultaneously driving strong minerality and aromatic potential in the fruit. The Amber Knolls Vineyard, located approximately 45 miles north of Calistoga on the south side of Highway 29, has relatively thin topsoil and is rich with obsidian rock that lends itself to rapid drainage after rain and irrigation events. The predominant soil type being Glenview-Arrowhead complex which is defined as a well-drained, extremely gravelly loam on obsidian hillsides (SSURGO).

Northwest of the Amber Knolls Vineyard and situated on the south face of Mount Konocti rests the Crimson Ridge Vineyard, this site also has a thin topsoil primarily composed of gravel with an abundance of large boulders beneath the shallow topsoil. The predominant soil type being Benridge-Konocti association which is defined as well-drained, cobbly loam on andesite, basalt and dacite, 'lava rock' mountains (SSURGO). These well-drained soils afford management the opportunity to control vine vigor with strict irrigation regimes, taking advantage of phenologically timed stress events to drive down berry size and concentrate key fruit chemistries.

The Amber Knolls Vineyard reaches altitudes of nearly 2500' with slopes between 15-20% incline. The Crimson Ridge Vineyard peaks in excess of 2600' with some of the steepest slopes ranging between 25-30%. The combination of sheer slope aspect and soil type greatly assist in the development of robust Cabernet Sauvignon and aromatic Malbec.

Potentially the greatest and one of the most defining distinctions between the Amber Knolls and Crimson Ridge Vineyards compared to other famous hillside vineyards is the increase in uniformity of the parent material. The regional volcanics, obsidian and lava rock, have been deposited as recently as 10,000 years ago (USGS) from eruptions of Mount Konocti and form a continuous crust of porous rock across the vineyard landscapes. This is atypical for most California AVA's, where a vast number of hillside vineyards are composed of alluvial fans where differences in weathered material can impart variability across changing elevations.

Rootstock and Scion Selections

The Beckstoffer management team has decades of experience and insight looking into the impacts of rootstocks and scion selection on quality parameters. Proper rootstocks selection, based on water use efficiency, vigor and rate of maturation, help management optimize winegrape quality. Considering the rock-laden mountainsides, a few of the rootstocks that have been selected for cultivation include 110R, 101-14 Mgt and 1103P.

A clone that imparts smaller berry size and looser cluster architecture is an equally important feature. The Beckstoffer team has had success with both FPS and ENTAV clones. The driving factors in clonal selection were increased skin to pulp ratio and aromatic potential.

Cultural Practices

Opinions vary, but it can be argued that the two of the greatest means of influencing berry quality are through applied water and canopy management techniques. These practices are known to alter berry size and canopy microclimate.

California trials with deficit irrigation as a treatment have repeatedly demonstrated the ability to decrease berry size and increase the skin to pulp ratio (Nelson et al. 2016). Simultaneously, deficit irrigation has been shown to limit shoot elongation and vine vigor, thus affecting *PAR* (photosynthetically active radiation) transmittance in the fruiting zone.

Dependent upon the participating winemaker, irrigation stress was pushed to what some growers would consider uncomfortable. A few blocks, for all intents and purposes, were dry farmed and only irrigated to preserve the vine integrity prior to excessive heat events. For example, a highly stressed block would achieve pre-veraison leaf water potentials (LWPs) downwards of -17 bars. Those stress levels were decreased post-veraison and were maintained at -14 to -15 bars stress level. To put these measurements in context, a well-watered grapevine would routinely have a LWP stress level in the -8 to -10 bars range, thus the observed stress levels were nearly twice as negative in comparison.

Similar to water stress, canopy management techniques like leaf removal, shoot positioning and shoot hedging are also known to affect *PAR* transmittance and canopy microclimates. Efficacy of both irrigation stress and canopy management strategies are highly dependent upon timing and can vary depending on seasonal conditions.

Leaf removal requests varied by winemaker. Practices ranged from aggressive defoliation in the fruiting zone to tunnel leaf removal (clearing out congestion, but leaving a leaf layer to protect fruit from direct sunlight) to no leaf removal at all. Timings of leaf removal strategies also varied by participant and ranged from being implemented at bloom to several weeks post-veraison.

Hedging and shoot positioning strategies were assessed and varied from winemaker to winemaker. Each participant with a slightly different school of thought and each allocation with a different outcome in berry chemistry and final wine style.

The learnings gained in 2016 and 2017 have afforded both participating winemakers and the Beckstoffer management team the ability to hone cultural practices in an effort to maximize quality in the Amber Knolls and Crimson Ridge Vineyards. These practices were altered and optimized based upon vintage, trial and error, slope aspect, soil type and overall winemaker preferences. General goals were to optimize light within the fruiting zone, decrease berry size, limit excessive dehydration and promote key berry chemistries.

Grape and Wine Analysis

In addition to winemakers tasting notes, being able to quantify fruit and wine chemistry is the final step in assessment of treatments. Specific chemical markers were selected to form a grape chemistry panel in 2017 and that panel will likely be expanded in 2018. In addition to the traditional chemistry metrics, more insightful chemical components were analyzed. Some of the berry chemistry components measured in 2017 included; tannins, anthocyanins, catechin and total phenolic content. In 2018, the team will look to expand the panel even further.

Similarly, wine chemistry contents were quantified in both 2016 and 2017. Some of the key components were total anthocyanins, polymeric anthocyanins, quercetin glycosides, tannins, catechin and epicatechin. These components measure wine color as well as mouthfeel and ability to age.

Results/Conclusion

Results were dependent upon winemaker and applied treatments, but it is safe to say that a major positive increase in winegrape quality was attained. It is clear that yield losses are unavoidable in the quest to attain superior quality fruit in both the Amber Knolls and Crimson Ridge Vineyards. As a wide-ranging average, yields were reduced by approximately 20% where a 5.5 tons per acre (TPA) block was reduced to about 4.5 TPA. Yield losses were dependent upon winemaker requests and ranged from 15-60% decrease in TPA. Berry chemistry quality metrics were generally greater with increased cultural practices where color, astringency and negative attributes were positively influenced. Wine chemistries were compared against vintages and results were highly dependent upon winemaking style.

*Below are berry and wine chemistry panels from a select few participants. Not all results are shown in an attempt to retain anonymity and avoid bias in the forthcoming début.

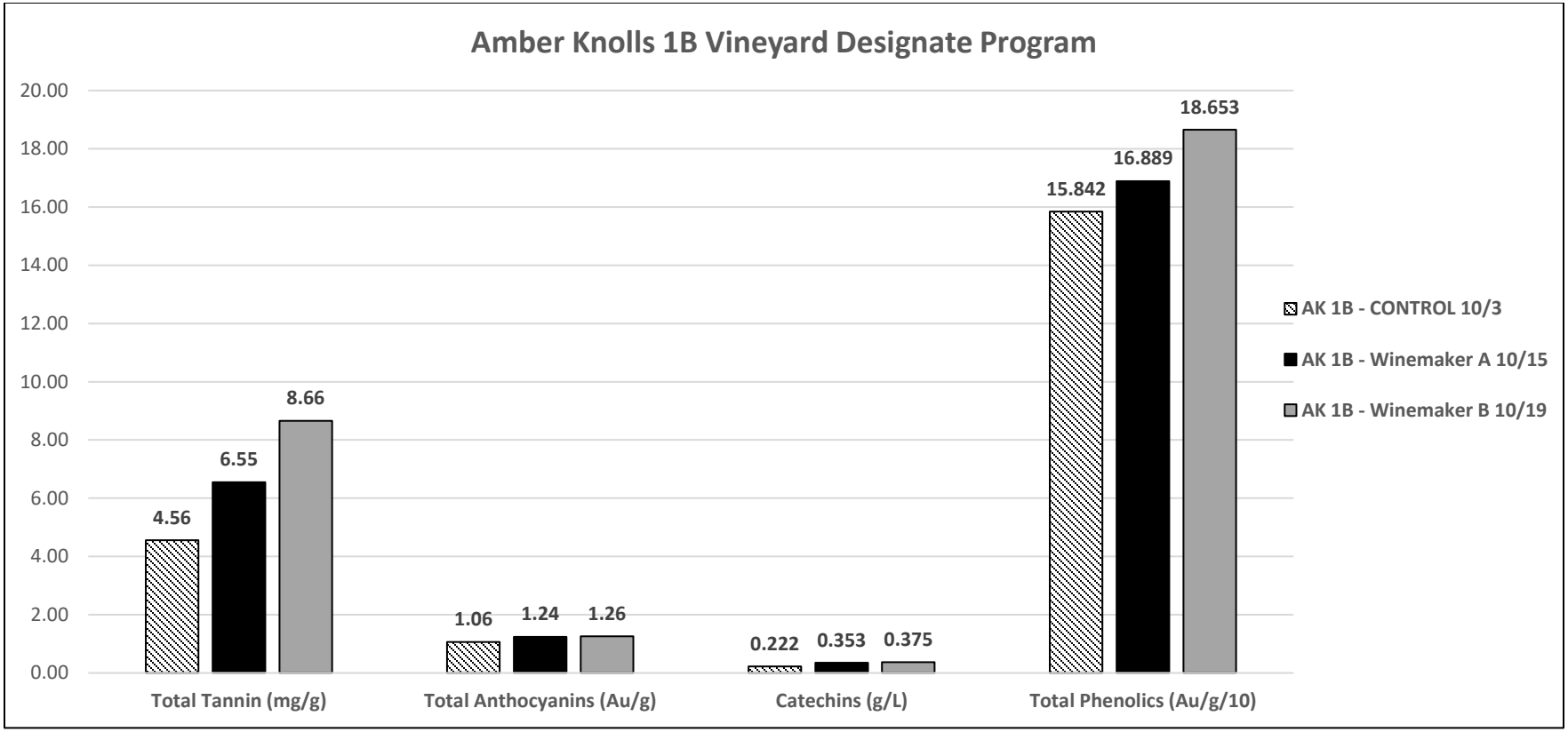

Figure 1. Amber Knolls 1B Berry Chemistry Panel – Harvest 2017.

Cabernet Sauvignon 337/1103P planted in 1999. Winemaker A and B received reduced applied water from fruit-set through veraison, maintained -13 to -14 bars stress level up to veraison and lowered the stress level post-veraison. Both treatments received more aggressive pruning in an attempt to alleviate congestion and promote spur spacing. Winemaker A kept laterals on the afternoon side to promote UV protection and weak shoots were removed, while strong shoots were positioned to alleviate congestion. Winemaker A and B had the fruiting zone tunnel leafed in an attempt to retain one leaf layer external to the fruiting zone to promote dappled light and avoid over-exposure. Crop load was adjusted and thinned to 2 clusters per strong shoot, 1 cluster small shoot, and weak shoots were removed. Targeted and achieved decreased berry size and increase skin to pulp ratio, weight < 1.0 grams per berry. Control was farmed to standard practices.

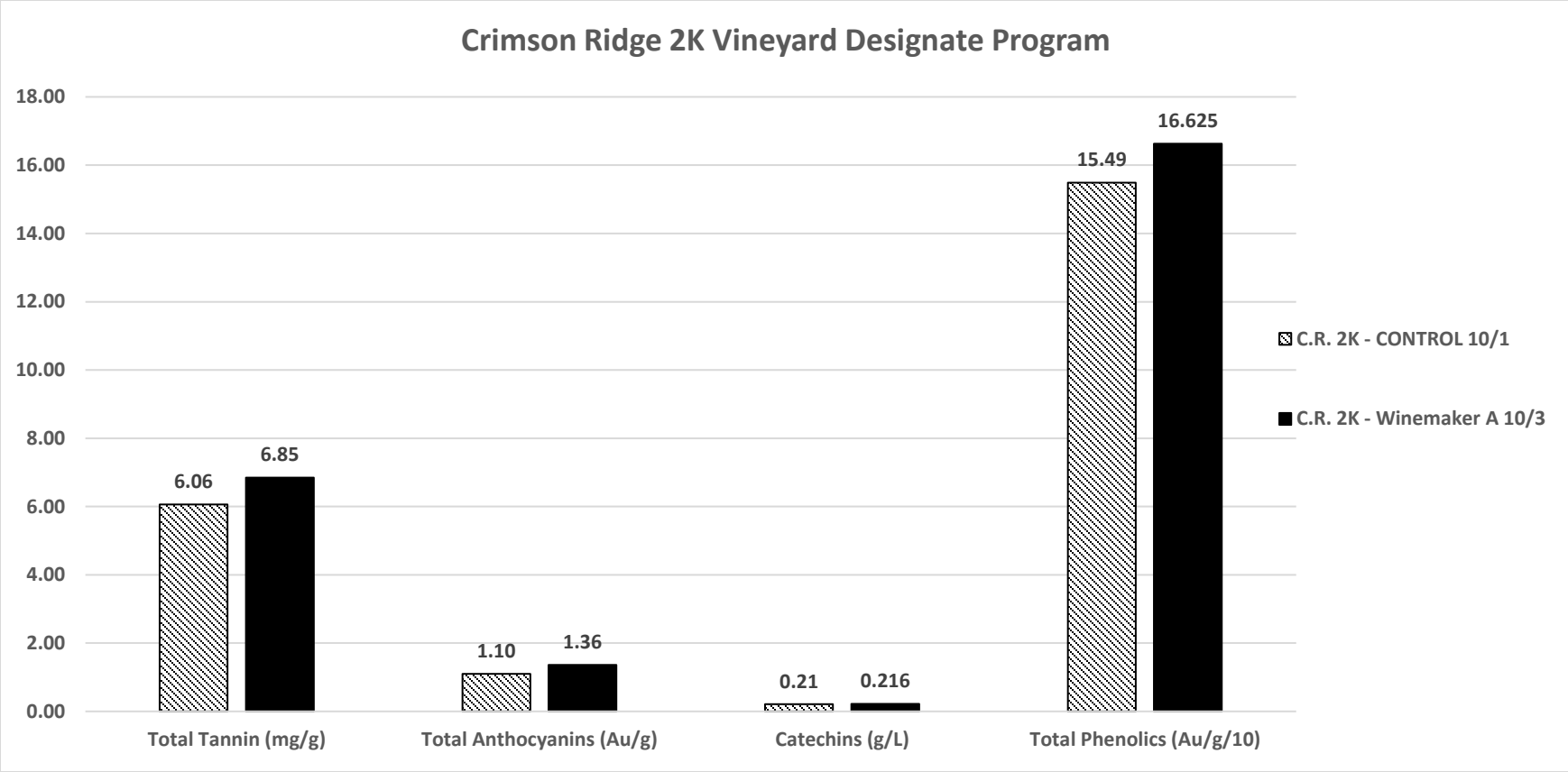

Figure 2. Crimson Ridge 2K Berry Chemistry Panel – Harvest 2017.

Cabernet Sauvignon 338/101-14 planted in 2013. Aggressive reduction in applied water from fruit-set through veraison -15 to -16 bars stress, maintain slightly lower stress levels post-veraison -13 to -14 bars stress. More aggressive pruning to promote spacing and decrease congestion. Tunnel leafed, 1 leaf layer to protect against over-exposure. Box hedged two weeks post-veraison. Crop load was adjusted and fruit was thinned, 2 clusters per strong shoot, 1 cluster per small shoot, and removal of weak shoots. Cluster de-clumping and green drop at 75% veraison. Targeted and achieved increased skin to pulp ratio, berry weight < 1.0 grams per berry. Control was farmed to standard practices.

	concentration in wine **(mg/L)**	**chemical compound**	**concentration** in wine **(mg/L)**	
2016	25	**gallic acid**	25	**2017**
	25	**catechin**	11	
	21	**epicatechin**	14	
	728	**tannin**	960	
	24	**caftaric acid**	9	
	5	**caffeic acid**	9	
	47	**quercetin glycosides**	47	
	8	**quercetin**	10	
	134	**malvidin glucoside**	118	
	58	**polymeric anthocyanins**	93	
	265	**total anthocyanins**	283	
	207	**monomeric anthocyanins**	190	
	0.2	**resveratrol**	1.5	

Table 1. Amber Knolls 1C Wine Chemistry Panel - Vintages 2016 and 2017.

Cabernet Sauvignon 4/1103P planted in 2002. The 2016 vintage received reduced applied water from fruit-set through harvest -12 to -13 bars. More aggressive pruning compared to control in an attempt to promote spacing and decrease congestion. Fruiting zone denuded 2 weeks post-veraison, shade clothes installed prior to heat events. Green drop at 50% veraison. The 2017 allocation received a greater amount of reduced applied water from fruit-set through veraison -14 to -16 bars stress and management maintained slightly lower stress levels post-veraison -11 to -13 bars stress. Canopy and crop load management paralleled 2016 practices. Control wines were not present.

Image 1. Amber Knolls Vineyard, picture taken in late October 2016.

Image 2. Crimson Ridge Vineyard, picture taken in late March 2017.

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