DEFICIT IRRIGATION IN VINEYARDS OF WASHINGTON STATE

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ABSTRACT

In Washington State the primary wine grape producing areas lie within the rainshadow of the Cascade Range and receive little precipitation throughout the year and especially during the summer. Wine grape producers take advantage of the arid conditions and use irrigation management to control vine growth and vigor. The precise control of irrigation timing and amount also affects the wine making characteristics of the fruit produced. A Cabernet Sauvignon (*Vitis vinifera* L) vineyard was used to better understand the effect of timing and duration of irrigation deficits on the phenolic composition of grapes and wine for the 2008, 2009 and 2010 vintages.

INTRODUCTION

The control of vine growth and vigor through irrigation management is a standard practice in the production of red wine grapes in Washington State. In the spring, irrigation managers closely monitor soil water content and vine vigor as the canopies develop and begin to apply irrigation once certain predetermined conditions of vine growth are met. The amount of water applied during each subsequent irrigation cycle is based on soil water content, pan evaporation, expected weather conditions and canopy size. Regulated deficit irrigation (RDI) protocols typically use 0.7 of estimated full vine evapotranspiration as a guideline for determining the amount of irrigation water to apply.

At Ste. Michelle Wine Estates (SMWE), extreme deficit irrigation protocols have been developed for the purpose of providing the company's winemakers with more blending options. Under these protocols, the amount of irrigation water applied is one-half the amount that would be applied under standard RDI management practices. Wine made from grapes grown under these extreme deficit protocols is typically distinguishable in blind tastings from wine made from grapes grown under standard RDI practices.

To determine the fruit and wine characteristics produced when wine grapes are grown under extreme irrigation deficits, Cabernet Sauvignon vines were managed under four deficit irrigation treatments in a replicated trial. The treatments included a standard RDI irrigation regime and three extreme deficit treatments and used vine phenological development as the basis for the timing and duration of the extreme deficit treatments. Berry size, anthocyanins and tannins were measured at harvest while levels of polymeric pigments and concentrations of anthocyanins and tannins were evaluated at pressing. A trained tasting panel has begun to evaluate the 2008 and 2009 vintage wines but the 2010 vintage has not yet been bottled.

METHODS

A drip-irrigated Cabernet Sauvignon vineyard near Mattawa, Washington was used to evaluate the effect of timing and duration of irrigation deficits on grape and wine phenolic composition during the 2008, 2009 and 2010 vintages. The 10.5 acre vineyard was planted to own-rooted vines in 1981 at a density of 622 vines acre^{-1} in a north-south row orientation and trained to a bi-lateral cordon with a three-wire trellis and a sprawled canopy. According to SMWE standard management practices, the entire block was irrigated early in both growing seasons to provide sufficient water to develop a canopy with shoots of 3 - 4 ft. Also, during either May or June of both years, excess shoots and leaves were removed by hand from all vines to provide optimal canopy light penetration for the production of quality fruit. The experimental design used in the trial was a randomized complete block with four replicates and four irrigation treatments. The irrigation treatments were 1) control; 2) early deficit; 3) véraison deficit; and 4) full-season deficit with evaporation from a Class A pan located approximately 0.5 miles from the vineyard used as a basis for the treatments. The deficit treatments were designed to impose severe water stress on the vines during the treatment periods. During 2008, 2009 and 2010, the irrigation treatments commenced on July 3, June 19 and July 6, respectively, after the growth of most shoots in the block had slowed and some vines were beginning to shed tendrils. The control treatment represented the normal RDI practices employed in the vineyard and consisted of applying 0.7 of estimated full vine evapotranspiration (ET) during each weekly irrigation cycle through harvest. Irrigation was withheld in the full season deficit treatment until August 16, July 14 and August 18 in 2008, 2009 and 2010, respectively, when most shoot tips had died and turned brown and almost all tendrils had dropped from the shoots. Subsequently, the full season deficit was irrigated at 0.35 of ET (i.e. one-half as much water as the control) until harvest each year. The véraison deficit treatment was treated identically to the control treatment prior to reaching full véraison and then was irrigated at 0.35 of ET until harvest. Lastly, the early deficit treatment was treated identically to the full season deficit treatment until full véraison and then was irrigated at 0.7 ET through harvest. The vines were machine harvested and wines were made in duplicate from each treatment by combining two of the vineyard replicates at a commercial winery (1.7 ton lots). The wines from each irrigation treatment were made using identical winemaking protocols to enhance vineyard treatment influences in the finished wines. Tannin and anthocyanin content and berry weight of the fruit were measured at harvest. Weekly samples were taken from the fermenting musts and from the finished wines to evaluate tannins, anthocyanins and the formation of polymeric pigments. The 2008 and 2009 wines were bottled in the summers of 2009 and 2010, respectively, but the 2010 vintage wine has not yet been bottled. Sensory analysis by a trained tasting panel has begun for the 2008 and 2009 vintage wines and will be conducted in the future for the 2010 vintage.

RESULTS AND DISCUSSION

At harvest, early and full season deficits consistently reduced berry size by 15 - 20% (Figure 1). Fruit grown under the full season deficit had greater skin tannins and anthocyanins while fruit grown under the véraison deficit had the least (Figure 2). Seed tannins did not differ between the early and full season deficits but were higher in these two treatments than in the control and véraison treatments (Figure 3). The experimental wines generally mirrored the results found in the fruit, with anthocyanins and tannins concentrations being statistically higher under the full season deficit (Figure 4). There were no differences in anthocyanin concentration between the control, early and véraison deficit wines but there were lower concentrations of tannins in the control and véraison deficit treatment wines (Figure 4). Wine from the véraison treatment had reduced small polymeric pigment content than did wines from the other three treatments while the full season deficit treatment produced wines with the highest levels of large polymeric pigments (Figure 5).

Laboratory analysis of both the fruit and wine show significant differences in anthocyanins, tannins and polymeric pigments between the irrigation treatments. The evaluation of the wines by a trained tasting panel is ongoing and will determine if the effects of the irrigation treatments are perceptible in the finished wines.

SUMMARY

This research shows that subjecting Cabernet Sauvignon vines to deficit levels of irrigation had a significant effect on tannin and anthocyanin concentrations of the fruit. While the effects observed in the fruit were less pronounced in the wines, significant differences in wine tannin, anthocyanin and polymeric pigment content were caused by the irrigation treatments. These results show that the extreme deficit irrigation protocols developed by SMWE do produce wines with distinct differences when subjected to laboratory analysis. It is expected that the effect of the irrgation treatments will be confirmed in sensory analysis by a trained tasting panel.

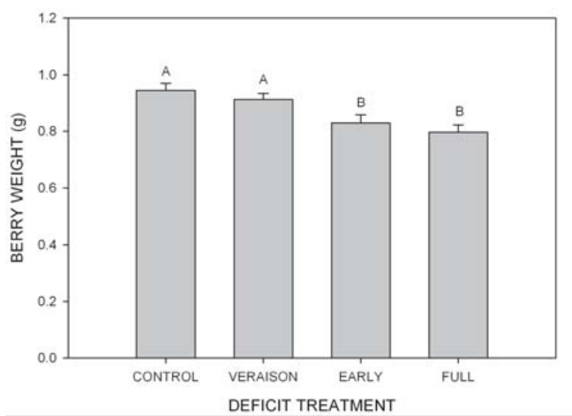

Figure 1. The effect of deficit treatment on berry weight (± standard error) over three consecutive vintages (2008-2010). Letters designate significant differences (Fisher's LSD $p<0.05$).

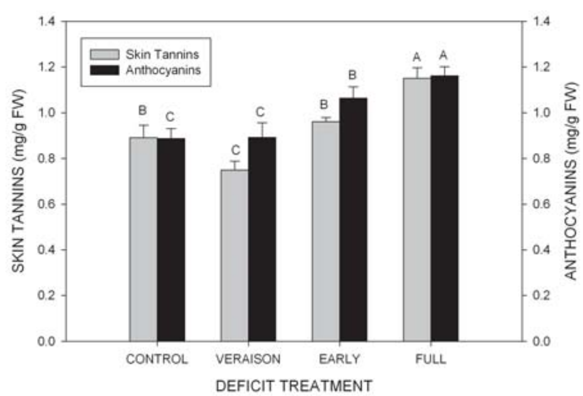

Figure 2. Effect of the deficit irrigation treatments on skin tannins and anthocyanins (± standard error) measured on a weight basis over three consecutive vintages (2008-2010). Letters designate significant differences (Fisher's LSD $p<0.05$).

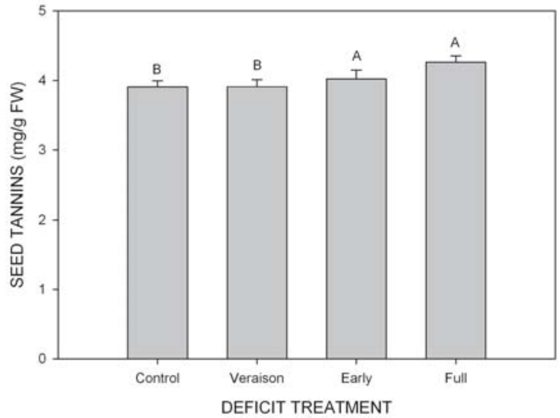

Figure 3. Effect of the deficit irrigation treatments on seed tannins (± standard error) measured on a weight basis over three consecutive vintages (2008-2010). Letters designate significant differences (Fisher's LSD $p<0.05$).

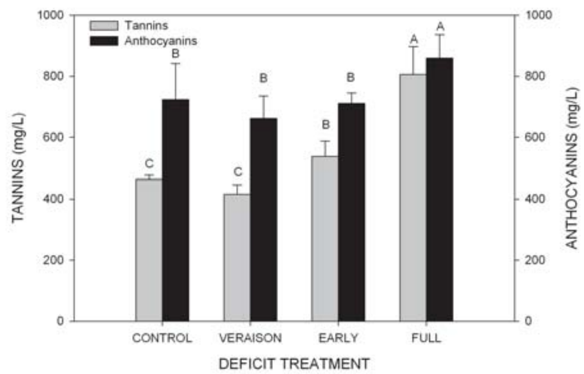

Figure 4. Effect of the deficit irrigation treatments on anthocyanin and tannin concentration (± standard error) of wines at press over three consecutive vintages (2008-2010). Letters designate significant differences (Fisher's LSD $p<0.05$).

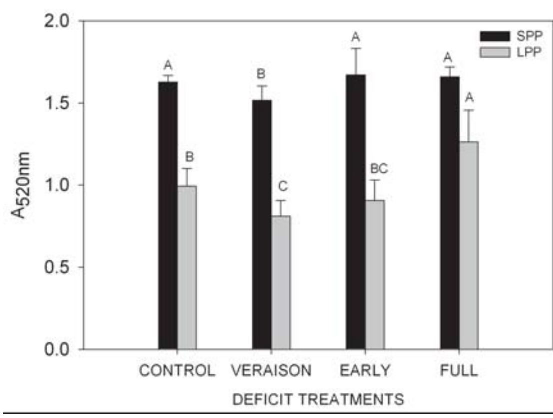

Figure 5. Effect of the deficit irrigation treatments on the small and large polymeric pigment content (SPP and LPP, ± standard error) of wines at press made from fruit with varied imposed water deficits over three consecutive vintages (2008-2010). Letters designate significant differences (Fisher's LSD $p<0.05$).

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