EFFECTS OF MECHANICAL LEAFING AND DEFICIT IRRIGATION ON CABERNET SAUVIGNON GROWN IN WARM CLIMATE OF CALIFORNIA

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Abstract:

Context and purpose of the study – San Joaquin Valley accounts for 40% of wine grape acreage and produces 70% of wine grape in California. Fruit quality is one of most important factors which impact the economical sustainability of farming wine grapes in this region. Due to the recent drought and expected labor cost increase, the wine industry is thrilled to understand how to improve fruit quality while maintaining the yield with less water and labor input. The present study aims to study the interactive effects of mechanical leafing and deficit irrigation on yield and berry compositions of Cabernet Sauvignon grown in warm climate of California.

Materials and methods – Field grown spur-pruned Cabernet Sauvignon vines grafted on Freedom rootstocks trained on quadrilateral cordons were included in this study. Two (water deficit) × three (mechanical leafing) factorial trial with a split block design, replicated in 5 times, was applied in 2018. Ten rows of vines (200 vines per row) were divided into two groups and each group was assigned to one of water deficit treatments as the "main plot". Three mechanical leafing treatments were allocated randomly in the "main plot" as the "sub plot". Two levels of water deficits included: 1) "sustained deficit irrigation" with 80% ETc from fruitset to harvest; 2) "regulated deficit irrigation" with 50% ETc from fruitset to veraison and 80% ETc from veraison to harvest. Three mechanical leafing treatments using the cut-suck type mechanical leafer to remove basal leaves on the "morning" side of the canopy included: 1) bloom leafing (stage EL-21); 2) pea size leafing (stage EL-31); 3) no leafing. Six vines in each "sub plot" were labeled as data vines.

Results – Leafing at bloom and pea size reduced about 8% of total leaf area as the comparison of control, however, bloom leafing only resulted in the temporary improved fruit-zone light exposure, while water deficit treatment did not cause any significant difference on leaf area. Water deficit had a bigger impact on yield than leafing with 20% yield reduction resulted from severe water deficit, and no impact on yield was found from leafing. The yield reduction was mainly driven by reduced cluster weight associated with the smaller berry size. Similar result was also found for leaf area/fruit ratio, while all the ratios fell in the previously published optimal range.As for berry composition, water deficit reduced titratable acidity and 3-isobutyl-2-methoxypyrazine (IBMP) while improving berry anthocyanins. Bloom leafing improved berry anthocyanins and increased IBMP. Resulted wine color was also improved by water deficit and bloom leafing. **Key words:** Mechanical leafing, Water deficit, Yield, Fruit quality, Wine chemistry

1. Introduction.

Effect of Mechanical Leafing and Deficit Irrigation on Cabernet Sauvignon in the San Joaquin Valley

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Abstract

Water deficit and basal leaf removal have been studied extensivenly in the warm climate to improve fruit quality and water use efficiecny. Berry anthocyanin accumulation can be improved by water deficit and leafing through increasing the berry skin/pulp ratio and upregulating its biosynthesis. Green flavor, e.g., 3-isobutyl-2-methoxypyrazine (IBMP), can also be reduced by the manipulation of water deficit and leafing. Anthocyanins and green flavor are the two most imporatnt quality parameters for Cabernet Sauvignon grown in the San Joaquin Valley (SJV) Midday leaf water potential (ψ) and fruit-zone photosynthetically active radiation (PAR) were measured weekly at the onset of bloom. Water deficit significantly decreased per vine yield by 20% through the reduced cluster number and berry size, and lowered pruning weight without significantly affecting total leaf area. As for berry composition, water deficit reduced titratable acidity and IBMP while improving berry anthocyanins. Leafing didn't impact any yield components in our study while improving berry anthocyanins and increasing IBMP when leafing was conducted at bloom. Resulted wine color was improved by water deficit and bloom leafing.

Introduction

San Joaquin Valley (SJV) has 40% wine grape acreage and crushes 70% grape in CA. Industry has focused on production historically to produce value priced wine (≈$5/bottle). However, the strong demand for premium wine (>$9/bottle) and sluggish demand for value priced wine have motivated industry to improve the berry quality to meet the demand for wine market. Berry anthocyanins and green flavor compounds are key quality parameters besides total soluble solids (TSS) and organic acids. However, hot climate in the SJV tends to promote berry anthocyanins and acids degradation. In order to improve water use efficiency and enhance berry quality, a field trial in 2018 using water deficit and mechanical leafing was conducted in a commercial vineyard in Madera, CA.

Method

- Cabernet Sauvignon on Freedom rootstock in a commercial vineyard at Madera was used in 2018. Madera is a hot climate growing region (>4000 GDD, based 50 °F).
- Row x vine spacing:10'x4' with southwest-northeast row (45° angle). Vines were trained with spur-pruned quadrilateral cordon under the "California Sprawl" system.
- Two-way factorial split-block design was applied with two levels of irrigation and three timings of mechanical leafing, replicated in 5 times, and 6 vines were designated as an experimental unit.
- Deficit irrigation was applied: 1) sustainable deficit irrigation (SDI): 80% ETc from berryset to harvest; 2) regulated deficit irrigation (RDI): 50% ETc from berryset to veraison, and back to 80% ETc from veraison to harvest.
- Timing of mechanical leafing: 1) bloom; 2)berryset; 3) no leafing (Figure 1).
- Midday leaf water potential and fruit-zone PAR were measured weekly after onset of bloom (Figure 2).

Figure 2. Midday LWP and fruit-zone PAR

Results

- Regulated deficit irrigation improved the harvest berry anthocyanins and reduced the harvest berry IBMP level.
- Regulated deficit irrigation did reduce approximately 20% of final yield in comparison of sustainable deficit irrigation through reduced berry size and cluster number (Table 1).
- Mechanical leafing had no impact on final yield in our first year of study and leafing at bloom only did expose the fruit-zone for approximately one week (Figure 3).
- Mechanical leafing at bloom yielded the highest harvest berry anthocyanins and slightly increased the harvest berry IBMP content (Table 2 and Figure 4).

Figure 1. Mechanical leafing on "morning" side of canopy at berryset

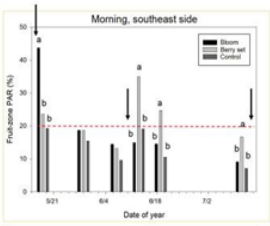

Figure 3. Fruit-zone PAR (%) on "morning" side of canopy and the arrow indicates leafing

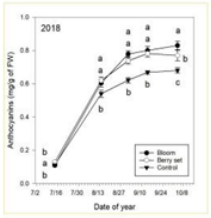

Figure 4. Weekly berry anthocyanins (mg/g of berry fresh weight) after veraison

Table 1. Harvest Cabernet Sauvignon Yield Components Resulted from Water Deficit

Deficit Irrigation	Yield (tons/acre)	Cluster no./vine	Cluster weight (g)	Berry weight (g)	Berry no./cluster	Leaf area (m^2/vine)	Leaf area/fruit (m^2/kg)	Pruning weight (kg/vine)
SDI	12.4	66	175	1.1	156	7.0	0.62	1.2
RDI	9.9	58	159	1.0	158	7.0	0.76	1.1
p-value (<0.05)	*	*	*	*	–	*	*	*

Table 2. Harvest Berry Composition Resulted from Leafing

Timing	Berry anthocyanins (mg/g of FW)	Phenolics (au/g of FW)	IBMP (ng/kg of FW)
Bloom	0.83 a	0.22 a	2.4 a
Berryset	0.77 b	0.20 b	1.7 b
No leafing	0.68 c	0.17 c	1.9 b

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