IMPACT OF RED BLOTCH DISEASE ON CABERNET SAUVIGNON AND MERLOT GRAPE AND WINE COMPOSITION AND WINE SENSORY ATTRIBUTES.

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Abstract:

Context and purpose of the study: Grapevine Red Blotch disease (RB) is a recently discovered disease that has become a major concern for the viticulture and winemaking industry in California, USA. The causal agent, Grapevine Red Blotch Virus (GRBV) was identified in 2011 and its presence was confirmed in several states in the US, in Canada, and in Switzerland. It has been demonstrated that RB compromised the regulation of ripening by suppressing specific ripening events, altering the expression patterns of transcription factors and causing hormonal imbalances in Zinfandel. For the last 4 years, our research group have been focusing on the impact of RB on grape and wine composition and wine sensory properties. Our prior work demonstrated that RB decreases sugar accumulation and delayed color development in the berry, resulting in wines with lower ethanol and anthocyanin concentration, thus affecting sensory attributes. The aim of this study was to determine the impact of RB on grape and wine composition and sensory properties when grapes were harvested sequentially.

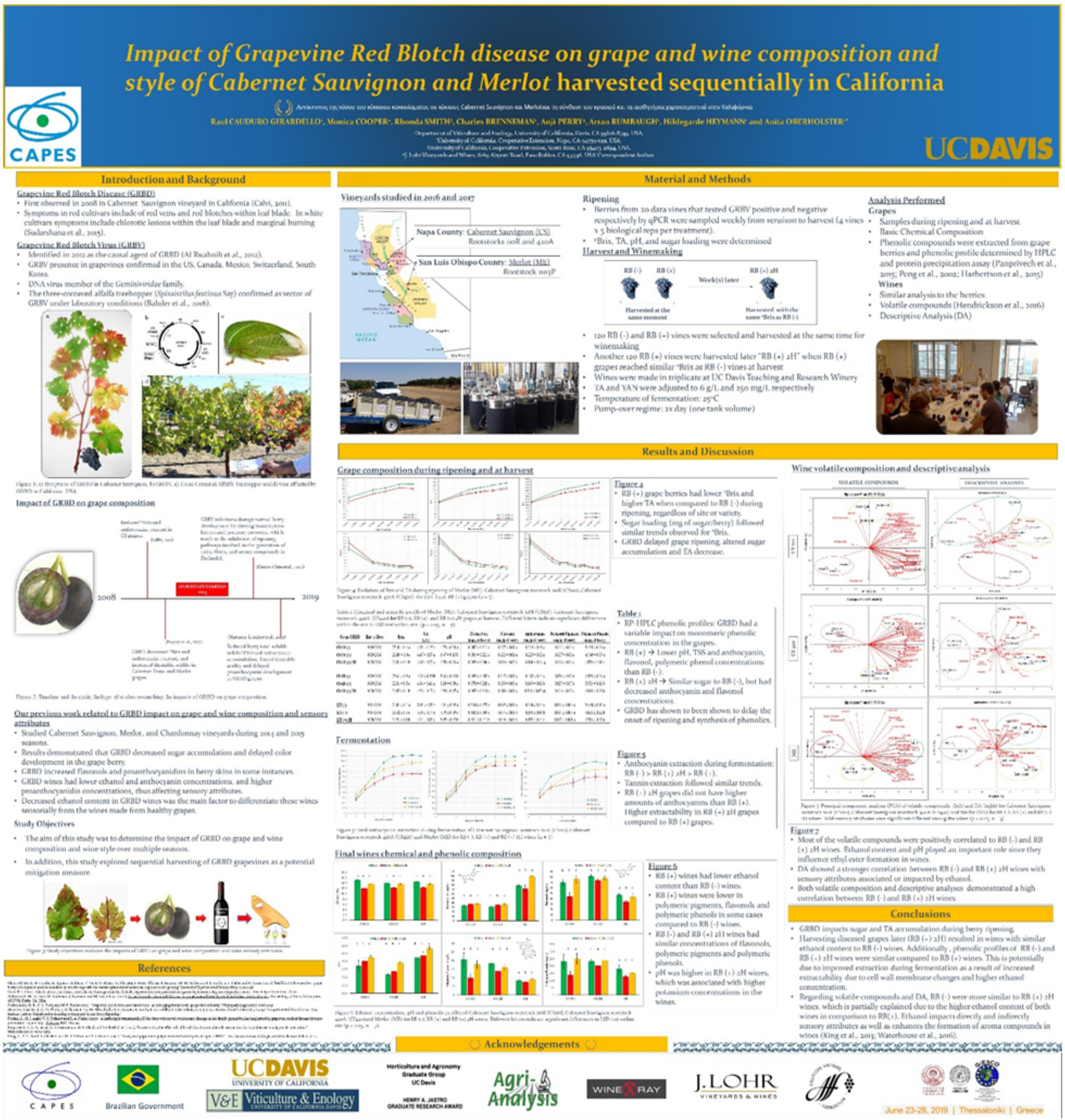
Material and Methods: Cabernet Sauvignon and Merlot vineyards from two traditional grape growing regions in California, Napa Valley and Paso Robles respectively were selected in the 2016 and 2017 season. Grape berries from infected (RB +) and healthy (RB -) grapevines were collected weekly from *veraison* to harvest. RB (+) grapevines were harvested sequentially at two-time points: (1) at the same time as healthy vines – but lower Brix, and (2) later when Brix was similar to those of the healthy grapes at harvest. Brix, pH, titratable acidity (TA), sugar loading, phenolic composition by protein precipitation assay and RP-HPLC and volatile composition by HS-SPME-GC-MS were determined on grapes. Wines were made in triplicate from healthy, RB symptomatic*, and second harvest RB symptomatic* grapes and analyzed for % EtOH v/v, volatile acidity, TA, free and bound SO_2, phenolic composition by RP-HPLC and protein precipitation, and volatile composition by HS-SPME-GC-MS. Wine sensory properties were determined by descriptive analyses.

Results: Chemical analysis demonstrated that RB impacts berry composition by increasing TA and decreasing Brix, sugar loading, anthocyanins, altering phenolic composition and sensory attributes. Wines made from RB (+) grapes harvested later had higher pH than wines made from healthy and first harvested RB (+) fruit. On the other hand, wines made from second harvest grapes from symptomatic vines showed less impact of the disease, producing wines with chemical, phenolic and volatile profiles as well as sensory properties more similar to wines made from healthy fruit when compared to wines made from first harvest RB (+) fruit.

*Grapevines showing RB disease symptoms

Keywords: Red Botch disease, grape composition, wine composition, phenolics, sensory

1. Introduction.


Impact of Grapevine Red Blotch disease on grape and wine composition and style of Cabernet Sauvignon and Merlot harvested sequentially in California
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Introduction and Background
Grapevine Red Blotch Disease (GRBD)
First observed in 2008 in Cabernet Sauvignon vineyard in California (Calvi, 2011).
Symptoms in red cultivars include of red veins and red blotches within leaf blade. In white cultivars symptoms include chlorotic lesions within the leaf blade and marginal burning (Sudarshana et al., 2015).
Grapevine Red Blotch Virus (GRBV)
Identified in 2012 as the causal agent of GRBD (Al Rwahnih et al., 2012).
GRBV presence in grapevines confirmed in the US, Canada, Mexico, Switzerland, South Korea.
DNA virus member of the Geminiviridae family.
The three-cornered alfalfa treehopper (Spissistilus festinus Say) confirmed as vector of GRBV under laboratory conditions (Bahder et al., 2016).
Impact of GRBD on grape composition
2008
2019
Our previous work related to GRBD impact on grape and wine composition and sensory attributes
Studied Cabernet Sauvignon, Merlot, and Chardonnay vineyards during 2014 and 2015 seasons.
Results demonstrated that GRBD decreased sugar accumulation and delayed color development in the grape berry.
GRBD increased flavonols and proanthocyanidins in berry skins in some instances.
GRBD wines had lower ethanol and anthocyanin concentrations, and higher proanthocyanidin concentrations, thus affecting sensory attributes.
Decreased ethanol content in GRBD wines was the main factor to differentiate these wines sensorially from the wines made from healthy grapes.
Study Objectives
The aim of this study was to determine the impact of GRBD on grape and wine composition and wine style over multiple seasons.
In addition, this study explored sequential harvesting of GRBD grapevines as a potential mitigation measure.
References
Material and Methods
Vineyards studied in 2016 and 2017
Napa County: Cabernet Sauvignon (CS)
Rootstocks 110R and 420A
San Luis Obispo County: Merlot (ME)
Rootstock 1103P
PACIFIC OCEAN
Ripening
Berries from 20 data vines that tested GRBV positive and negative respectively by qPCR were sampled weekly from veraison to harvest (4 vines x 5 biological reps per treatment).
°Brix, TA, pH, and sugar loading were determined
Harvest and Winemaking
RB (-)
RB (+)
Week(s) later
RB (+) 2H
Harvested at the same moment
Harvested with the same °Brix as RB (-)
120 RB (-) and RB (+) vines were selected and harvested at the same time for winemaking
Another 120 RB (+) vines were harvested later "RB (+) 2H" when RB (+) grapes reached similar °Brix as RB (-) vines at harvest
Wines were made in triplicate at UC Davis Teaching and Research Winery
TA and YAN were adjusted to 6 g/L and 250 mg/L respectively
Temperature of fermentation: 25°C
Pump-over regime: 2x day (one tank volume)
Analysis Performed
Grapes
Samples during ripening and at harvest
Basic Chemical Composition
Phenolic compounds were extracted from grape berries and phenolic profile determined by HPLC and protein precipitation assay (Panprivech et al., 2015; Peng et al., 2002; Harbertson et al., 2015)
Wines
Similar analysis to the berries
Volatile compounds (Hendrickson et al., 2016)
Descriptive Analysis (DA)
Results and Discussion
Grape composition during ripening and at harvest
Figure 4
RB (+) grape berries had lower °Brix and higher TA when compared to RB (-) during ripening, regardless of site or variety.
Sugar loading (mg of sugar/berry) followed similar trends observed for °Brix.
GRBD delayed grape ripening, altered sugar accumulation and TA decrease.
Table 1
RP-HPLC phenolic profiles: GRBD had a variable impact on monomeric phenolic concentration in the grapes.
RB (+) → Lower pH, TSS and anthocyanin, flavonol, polymeric phenol concentrations than RB (-).
RB (+) 2H → Similar sugar to RB (-), but had decreased anthocyanin and flavonol concentrations.
GRBD has shown to been shown to delay the onset of ripening and synthesis of phenolics.
Fermentation
Figure 5
Anthocyanin extraction during fermentation: RB (-) > RB (+) 2H > RB (+).
Tannin extraction followed similar trends.
RB (+) 2H grapes did not have higher amounts of anthocyanins than RB (+). Higher extractability in RB (+) 2H grapes compared to RB (+) grapes.
Final wines chemical and phenolic composition
Figure 6
RB (+) wines had lower ethanol content than RB (-) wines.
RB (+) wines were lower in polymeric pigments, flavonols and polymeric phenols in some cases compared to RB (-) wines.
RB (-) and RB (+) 2H wines had similar concentrations of flavonols, polymeric pigments and polymeric phenols.
pH was higher in RB (+) 2H wines, which was associated with higher potassium concentrations in the wines.
Wine volatile composition and descriptive analysis
VOLATILE COMPOUNDS
DESCRIPTIVE ANALYSIS
Figure 7
Most of the volatile compounds were positively correlated to RB (-) and RB (+) 2H wines. Ethanol content and pH played an important role since they influence ethyl ester formation in wines.
DA showed a stronger correlation between RB (-) and RB (+) 2H wines with sensory attributes associated or impacted by ethanol.
Both volatile composition and descriptive analyses demonstrated a high correlation between RB (-) and RB (+) 2H wines.
Conclusions
GRBD impacts sugar and TA accumulation during berry ripening.
Harvesting diseased grapes later (RB (+) 2H) resulted in wines with similar ethanol content to RB (-) wines. Additionally, phenolic profiles of RB (-) and RB (+) 2H wines were similar compared to RB (+) wines. This is potentially due to improved extraction during fermentation as a result of increased extractability due to cell wall membrane changes and higher ethanol concentration.
Regarding volatile compounds and DA, RB (-) were more similar to RB (+) 2H wines, which is partially explained due to the higher ethanol content of both wines in comparison to RB(+). Ethanol impacts directly and indirectly sensory attributes as well as enhances the formation of aroma compounds in wines (King et al., 2013; Waterhouse et al., 2016).
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