Grape and wine composition in a warming world – how rising temperatures will impact composition

Charles Sturt University

J.M. Gambetta[1*], B. Holzapfel[2,3], L.M. Schmidtke[3], A. Hall[3], J. Blackman[3]

[1]CSIRO, Werribee, VIC, Australia [2]New South Wales Department of Primary Industries, Wagga Wagga, Australia [3]Charles Sturt University, Wagga Wagga, NSW, Australia

Context and purpose of the study

Climate is one of the main drivers of spatial and temporal variability in grapevine physiology and therefore a key determinant of grape composition and final value. The world has warmed 1.1 °C since pre-industrial times, and the latest IPCC report indicates an additional 0.5 to 1.3 °C of warming by mid-century. Further warming will have marked consequences for wine and grape composition and quality, requiring adaptation strategies for growers and winemakers. Elevation directly impacts air temperature, and wine regions with large elevations provide ideal locations to study the effect of warming within a small area. The Canberra District wine region is characterised by its wide range of vineyard elevations (240-900 m), and is recognised as a producer of premium Riesling. The aim of this study was to evaluate the effect of ~1 °C differences in growing season temperatures on Riesling grape and wine composition and sensory attributes in three vineyards located at different elevations.

Materials and Methods

Trials were conducted during the 2017-19 vintages in three Riesling vineyards located at three altitudes (596 m, V1; 464 m, V2; and 800 m, V3) in the Canberra District wine region. Canopy and bunch temperature were monitored throughout the season using Tinytag sensors and thermocouples installed in the canopy and at bunch level respectively. At harvest (March – April), berry samples were collected for compositional analyses (TSS, TA, pH, YAN, carotenoids and chlorophyll) and for vinification. Winemaking was carried out in triplicate, using standard procedures until dryness. Wines were racked, cold stabilised, bottled and stored for three months until sensory and chemical analyses. Descriptive sensory analysis was performed by 8 trained assessors during two sessions according to Longo et al. (2018). Chemical analyses included alcohol content, TSS, TA, pH, and volatile composition measured by HS-SPME-GCMS.

Results

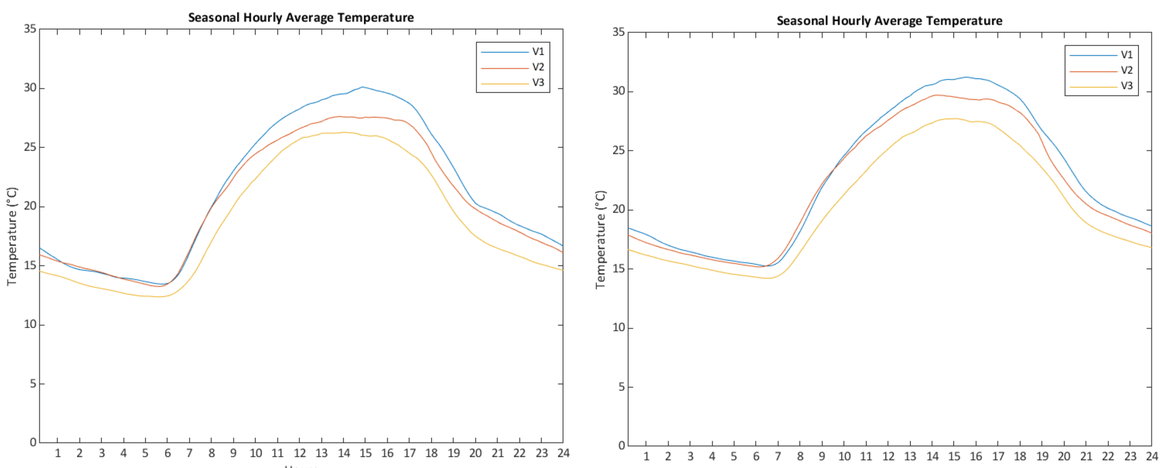

Figure 1 – Average daily temperatures at each vineyard during the 2017-18 (left) and 2018-19 seasons (right)

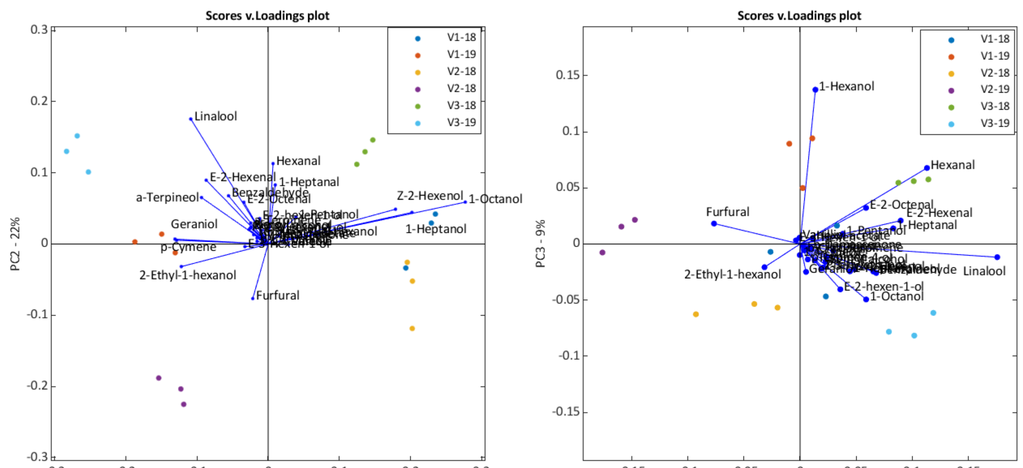

Figure 3 – PCA biplots of the volatile compounds measured in grapes at harvest for the 2018 and 2019 harvests.

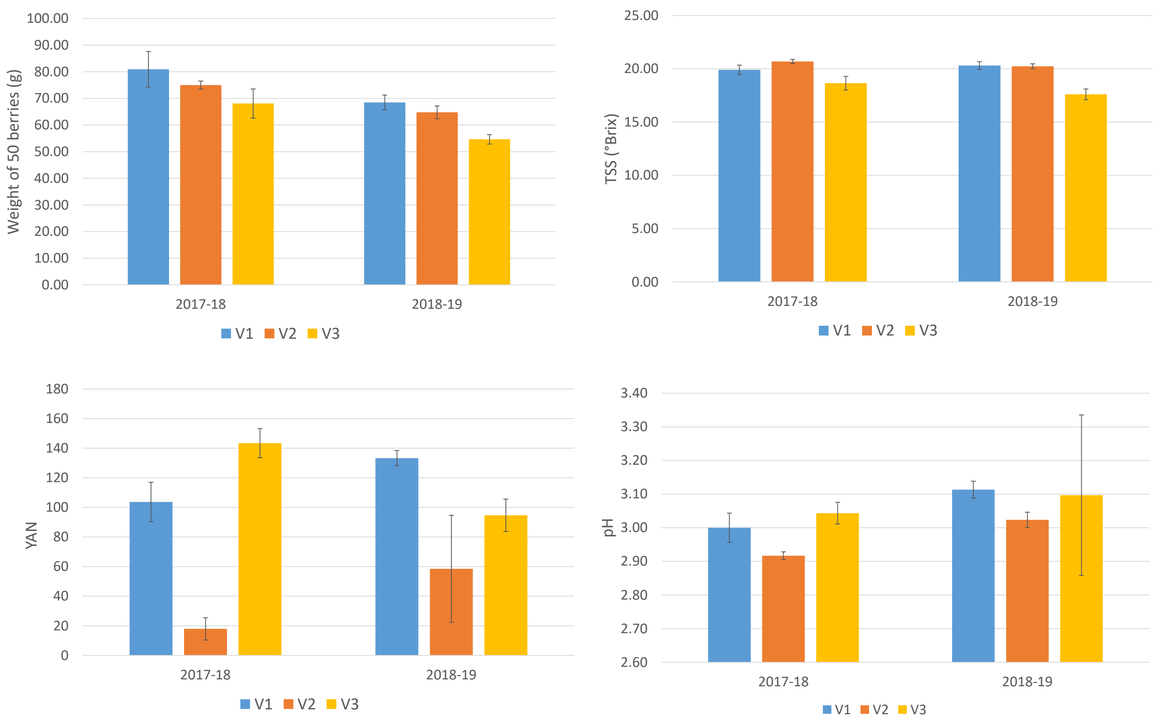

Figure 2 – Basic chemistry (berry weight, TSS, TA and YAN) of Riesling berries at harvest during the 2017-18 and 2018-19 vintages

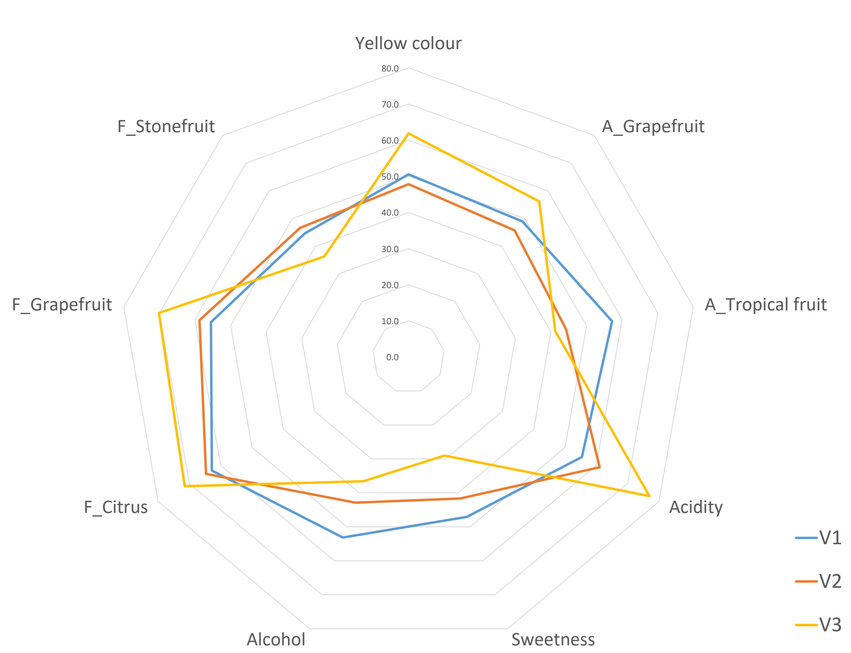

Figure 4 – Spider graph of significantly different (α = 0.05) sensory attributes for Riesling wines produced during 2018-19 season

- Sites selected had approximately 1 °C difference in average diurnal temperature permitting comparison of three different climate scenarios.
- Higher temperature resulted in larger berries with higher TSS and lower TA. Other factors such as soil composition and vine nutrition affected final YAN levels.
- Clear discrimination was observed between the different sites based exclusively on the volatile composition of grapes at harvest despite the pronounced vintage effect. Main compounds driving these differences along PC1 were 1-octanol, Z-2-hexenol and 1-heptanol (which were all higher in grapes from the 2019 vintage), and along PC2 were linalool, α-terpineol, *E*-2-hexenal, heptanal and hexanal (all higher in the cooler site) and furfural (higher in the warmer site).
- As temperature rose perception on acidity dropped together with citrus and grapefruit sensory attributes.

Conclusions

The temperature differentials of 1°C between sites resulted in Riesling grapes and wines with significantly different chemical and sensory composition. Grapes from the cooler site had overall lower TSS, acidity and weight, as well as higher levels of terpene compounds and aldehydes. The loss of desirable terpenes and aldehydes has been previously related to higher temperatures.

Each altitude and temperature range yielded wines with distinctly different styles with wines from the cooler V3 characterised by higher levels of citrus notes and an overall profile that was reminiscent of typical 'cool climate' Riesling.

As air temperatures continue to rise, knowledge of the impact of temperature increase on grape and wine quality will be a help inform adaptation strategies by the wine industry. Choosing vineyards at higher altitude may help mitigate the impact of climate change, although wine style change must also be considered.

Acknowledgments: This project was funded by the Faculty of Science, Charles Sturt University

References: Longo et al. (2018) Food Res. Int. 109, 561-571