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CANOPY MICROCLIMATE AND VINEYARD VARIABILITY IN VINEYARDS OF THE LODI REGION OF CALIFORNIA, USA

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Abstract

Aim: The aim of this project was to evaluate the microclimatic effects on objective measures of fruit quality within different vigour classes of multiple vineyards and to compare the results across the Lodi region of California, USA.

Methods and Results: In May 2019, small temperature sensors were installed in the fruit zones of 10 vineyards in the Lodi region of California. To assess differences in canopy temperature between high and low vigour areas, three sensors were installed in each vineyard, two in the fruit zone (high and low vigor) and one above the canopy (ambient control). Photosynthetically active radiation in the fruit zone was measured at veraison and harvest on 15 vines surrounding each sensor and compared with the temperature data. At harvest, two randomly selected clusters were collected from each of the 15 data vines, combined into one composite sample per temperature sensor, and analysed for individual objective measures of grape quality. Results showed large differences in fruit composition between vigour zones. Daytime temperatures were higher in low vigour zones and canopy light measurements were correlated with anthocyanins ($R^2 = 0.59$), polymeric tannins ($R^2 = 0.55$), malic acid ($R^2 = 0.48$), and linalool ($R^2 = 0.76$).

Conclusions: The results showed large differences in fruit quality within vineyards which implies delivery of heterogenous fruit to wineries. Excessive differences in fruit quality could be ameliorated with appropriate canopy management tools geared towards increasing vineyard uniformity.

Significance and Impact of the Study: Delivery of reliable fruit to wineries by vineyard managers and consistent wines by winemakers is challenging when harvesting large vineyards into single programs. These risks are highlighted by the above results which also provide further evidence for the need of differential management solutions in wine grape production.

Keywords: Canopy microclimate, objective measures of fruit quality, vineyard variability

Canopy microclimate and fruit quality variability in vineyards of the Lodi region of California, USA

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Aim: The aim of this project was to evaluate the microclimatic effects on objective measures of fruit quality within different vigour classes of multiple vineyards and to compare the results across the Lodi region of California, USA.

Methods: In May 2019, small temperature sensors recording hourly were installed in the fruit zones of nine vineyards in the Lodi region of California. Sensor locations were selected by classifying early season Sentinel-2 multispectral imagery into high and low vigour zones. To assess differences in canopy temperature between high and low vigour areas (Figure 1), three sensors were installed in each vineyard, two in the fruit zone (high and low vigour) and one above the canopy (ambient control). Photosynthetically active radiation in the fruit zone was measured at veraison and harvest on 15 vines surrounding each sensor and compared with the temperature data. At harvest, two randomly selected clusters were collected from each of the 15 data vines, combined into one composite sample per temperature sensor, and analysed for individual objective measures of grape quality. Additionally, commercial samples were included in the analysis as they were geolocated and based on an algorithm (Meyers and Vanden Heuvel, 2014) to identify optimum sample locations based on normalised difference vegetation index.

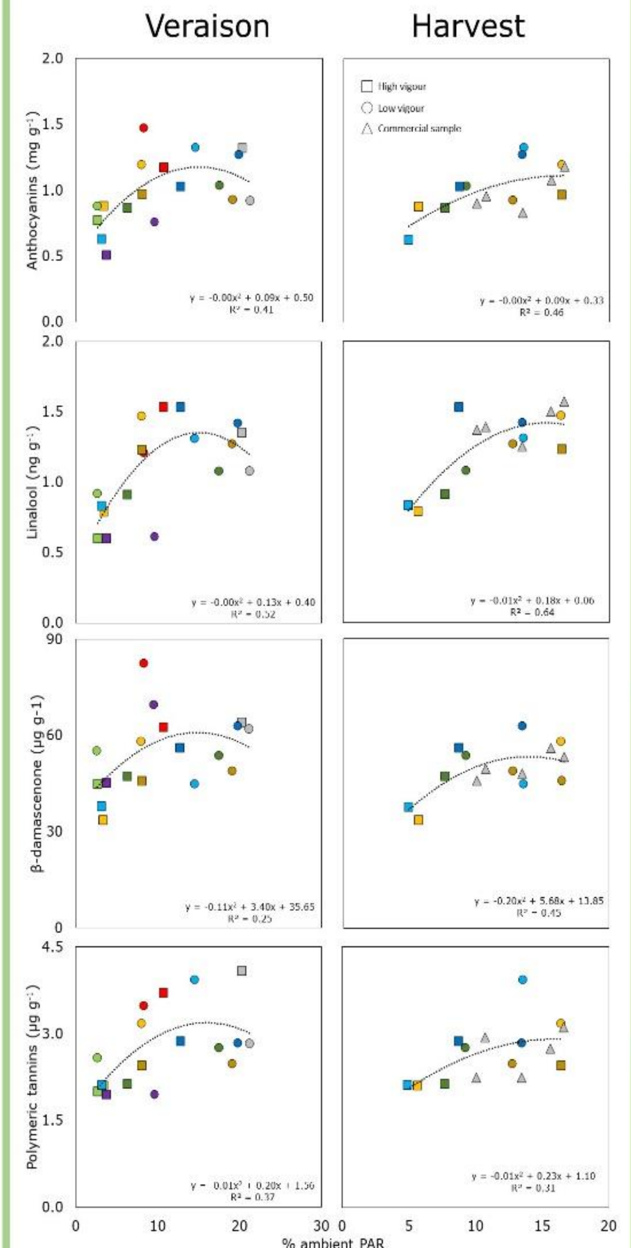
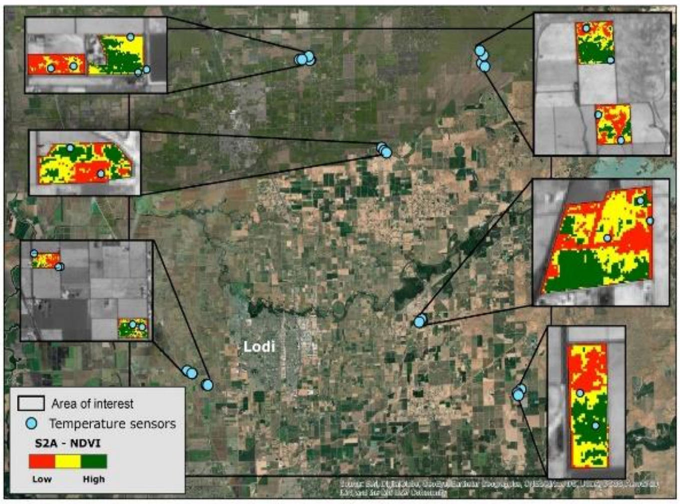


Figure 2. Comparisons between photosynthetically active radiation (PAR) and fruit chemistry. High and low vigour zones within a block are represented with the same colour.



Temperature sensor locations

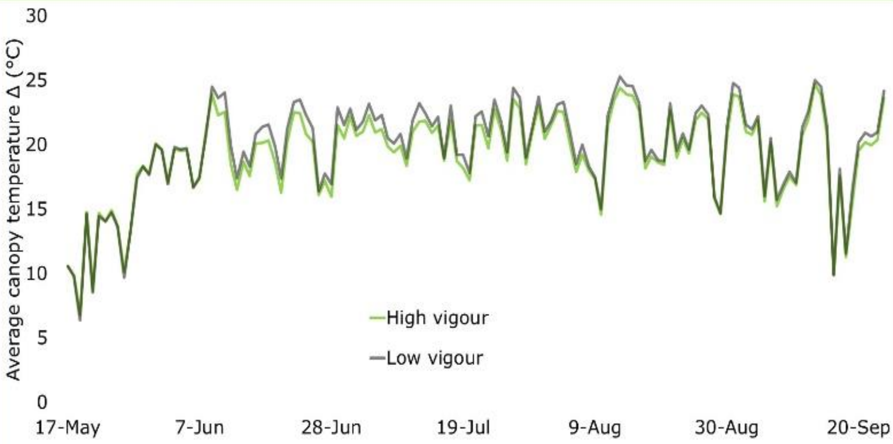


Figure 1. Average canopy temperature Δ (max – min) across all nine vineyards for both high and low vigour classes.

Table 1. Pearson correlations between temperature and fruit composition. Bold indicates $P < 0.05$.

Temperature	*Anthocyanins*	*β-damascenone*	*Polymeric tannins*	*Linalool*
May minimum	0.20	0.38	0.28	0.06
May average	0.01	-0.33	-0.01	0.03
May maximum	0.12	-0.15	0.07	0.14
May delta	**-0.56**	-0.39	**-0.57**	-0.40
June minimum	0.05	0.23	0.11	-0.12
June average	**0.67**	0.33	**0.51**	**0.67**
June maximum	0.44	0.13	0.36	**0.57**
June delta	0.21	0.40	0.07	0.28
July minimum	0.30	0.22	0.32	0.13
July average	0.49	0.37	0.42	0.49
July maximum	**0.54**	0.34	0.44	**0.56**
July delta	0.26	0.43	0.21	0.29
August minimum	0.18	0.16	0.21	-0.01
August average	0.32	0.09	0.28	0.35
August maximum	0.26	0.06	0.25	0.27
August delta	0.12	0.12	0.08	0.18
September minimum	0.14	0.22	0.10	-0.01
September average	0.25	0.00	0.28	0.33
September maximum	0.23	0.03	0.25	0.38
September delta	0.10	0.02	0.10	0.16

Table 2. Anthocyanin prediction using linear regression

Coefficients:	Estimates	Std Error	t value	Pr(>|t|)
(Intercept)	5.8799	1.7861	3.29	0.030 *
May ΔT	-0.1781	0.0401	-4.44	0.011 *
Jun Average T	-0.1664	0.0860	-1.94	0.125
Veraison PAR	0.0208	0.0072	2.89	0.045 *
Harvest PAR	0.0570	0.0148	3.84	0.019

* $P < 0.05$

Residual standard error: 0.0678 on 4 degrees of freedom

Multiple R-squared: 0.935 Adjusted R-squared: 0.869

F-statistic: 14.26 on 4 and 4 DF, p-value: 0.0123

Canopy shading

Sensor placement

Measuring PAR

Conclusions: The results showed differences in fruit quality between vigour zones (Figure 2). The correlation matrix in Table 1 shows significant variability in early to mid season temperatures and the variability in fruit zone light environment affected colour, aroma, and mouthfeel compounds related to Cabernet Sauvignon wine quality (Cleary et al, 2015).

Significance and impact of the study: The combination of early season image classification with measurements of temperature and fruit zone light environment are potentially capable of predicting fruit colour (Table 2). This method could be used as a cost-effective strategy to replace destructive sampling. Understanding how differences in canopy microclimate within vineyards affect fruit composition can aid vineyard managers and winemakers in optimizing streaming processes to wineries.

For more information

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