Solar radiation exclusion reduced evapotranspiration and improved skin flavonoid content of wine grape

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Introduction

Climatic conditions are expected to increase temperature and water deficits in viticulture regions by the mid-21st century, impacting grapevine physiology and production sustainability. With increasing temperature and solar radiation, vine water demand may increase to replace increased evaporative water losses. Grape clusters are also at risk of overexposure under current viticultural practices. Overexposure of grape clusters can lead to decreased flavonoid concentrations at harvest due to both decreased biosynthesis and increased degradation, ultimately impacting wine quality (Torres et al.2021). Photoselective overhead shade films (D1, D3, D4, D5) with varying degrees of solar spectra exclusion were installed and compared to an uncovered control (Co) to evaluate the vulnerability of 'Cabernet Sauvignon' grape berries to solar radiation overexposure and optimize the use of shade films for berry development.

Objective

Optimize the use of overhead shade films for a better understanding of the mode of action on leaf and fruit physiology to optimize application, identify its beneficial effects and report any deleterious effects on berry and wine chemistry.

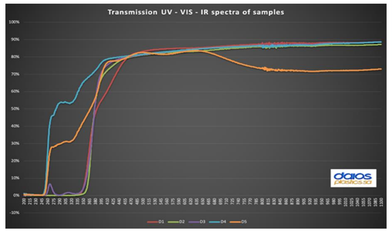
Materials & Methods

Experiment:

- Randomized complete block design, 4 replicates in Oakville, CA
- Untreated Control, D1, D3, D4, D5 films applied in 2019- retained **whole year**

Data collection:

- **Primary metabolism:**
  - Solar radiation at cluster level
  - Components of yield
  - ETa
- **Secondary metabolism:**
  - Anthocyanins
  - Flavonols



Results

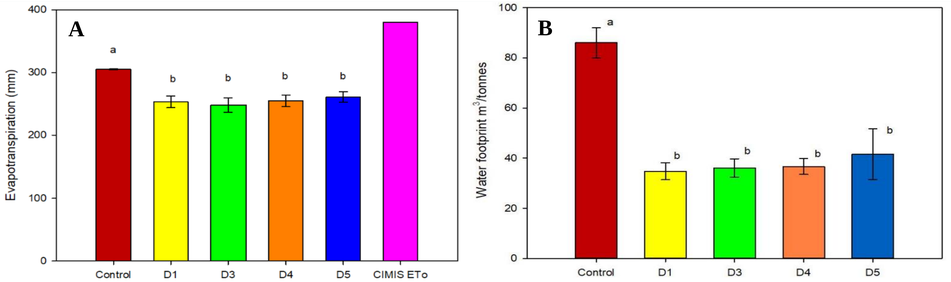


Figure 1. Evapotranspiration (mm; A) and vine water footprint (m^3/tonnes; B) in four shaded treatments and control

Table 1. Yield Components for Shaded Treatments and Control in a 'Cabernet Sauvignon' vineyard in Oakville, CA, USA [a, b]

Treatment	Yield (kg /vine)	Skin weight (g)	Berry weight (g)	Pruning weight (kg/vine)
Control	5.10 ± 0.32	0.070 ± 0.01	0.894 ± 0.02	0.84 ± 0.09
D1	5.78 ± 0.52	0.054 ± 0.00	0.972 ± 0.05	1.1 ± 0.11
D3	5.60 ± 0.57	0.074 ± 0.01	0.919 ± 0.02	1.1 ± 0.05
D4	5.44 ± 0.41	0.065 ± 0.01	0.871 ± 0.01	0.94 ± 0.05
D5	5.34 ± 0.87	0.071 ± 0.00	0.901 ± 0.05	0.99 ± 0.16
p value	n.s.	n.s.	n.s.	n.s.

[a] Values in each column are reported as mean ± one standard error

[b] n.s. indicates a *p* value ≥ 0.05

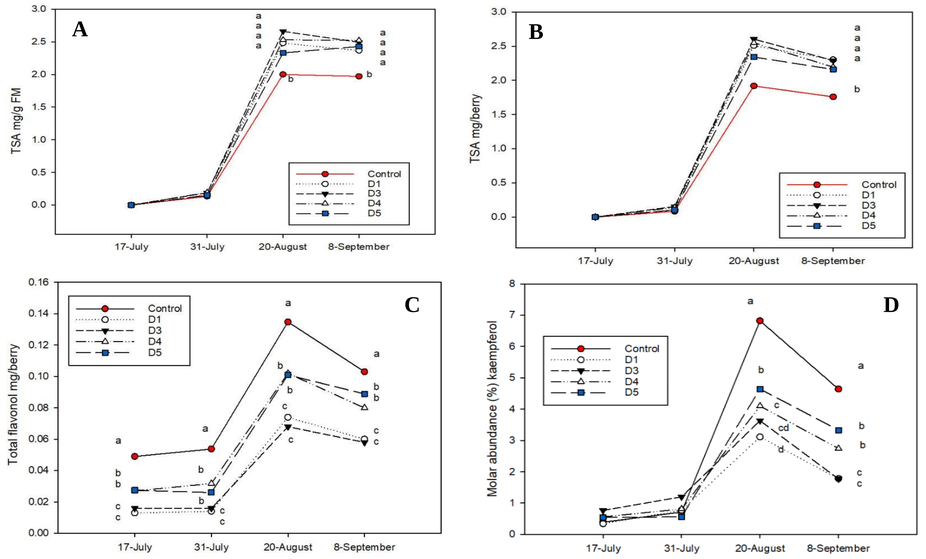


Figure 2. Total skin anthocyanins (mg/g fresh mass; A), total skin anthocyanins (mg/berry; B), total flavonol (mg/berry; C) and molar abundance of kaempferol (%; D) in four shaded treatments and the control from veraison to harvest.

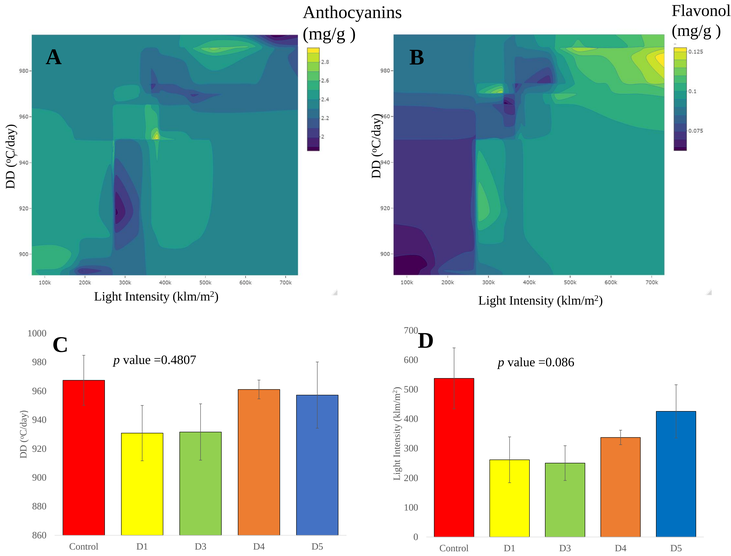


Figure 3. Response of total anthocyanins (A) and total flavonols (B) to cumulative degree days (DD) and the sum of the mean daily light intensity (Light Intensity) from July 7, 2020, to harvest. Cumulative degree-days (DD) (C) and sum of mean daily light intensity (Light Intensity) (D) received by berries collected from vines subjected to shaded treatments and the control at harvest.

Conclusions & Future Study

- Shade films reduced evapotranspiration compared to the uncovered control and lessened vine water footprint.
- Shade films effectively reduced anthocyanin degradation due to overexposure, resulting in higher anthocyanin concentrations at harvest compared to the uncovered control.
- D5 produced fruit with the highest flavonol concentration while also remaining beneath the 7% kaempferol overexposure threshold (Martínez-Lüscher et al. 2019). This is likely due to near infrared light exclusion.
- The continuation of this study will investigate the compounded water deficit from year to year as winter rainfall is excluded from shaded vines.

References

Martínez-Lüscher, J., L. Brillante, and S. K. Kurtural. 2019. Flavonol profile is a reliable indicator to assess canopy architecture and the exposure of red wine grapes to solar radiation. Front. Plant Sci. 10:1-15. doi:10.3389/fpls.2019.00010.

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Acknowledgements

Daios Plastics, Jim's Supply, Drake Enterprises