

Precision tools for monitoring experimental irrigation treatments in California vineyards

Previtali, P.¹, Mezger, J.¹, Aboutaleb, M.¹, *Sams, B.¹, Sanchez, L.¹, and Dokoozlian, N.¹

¹*Winegrowing Research, E&J Gallo Winery, Modesto, CA 95358*

*Corresponding and presenting author

Abstract

Precision farming techniques, such as zonal management and variable rate nutrient delivery, have been used to manage spatial variability in many crops. Wine grapes, and most permanent crops, have been slower than row crops or agronomic crops to take advantage of these techniques, though there are barriers to implementing these methods when compared to agronomic crops. The objective of this project is to show how a suite of monitoring and management tools can be used to evaluate the performance of an irrigation trial in a commercial vineyard. In this study, a conventional drip irrigation system was modified to differentially deliver water to each of four treatments, with the overall goal of evaluating the differences between vines watered using a concept called partial root zone drying (PRD). PRD occurs when only one side of a vine is allowed access to water, while the other side is not, causing the vine to experience water stress and producing more abscisic acid, resulting in a theoretical increase in water use efficiency. Two partial rootzone drying treatments were implemented with a subsurface irrigation line running in the interrow space between each row, allowing water only to one side of the vine or the other. Other treatments included a subsurface control and a standard above ground drip control. High-resolution imagery (<20 cm) was collected at weekly intervals throughout the growing seasons of 2021 and 2022, monthly in 2023. Ground measurements were collected in both seasons including plant physiology, yield components, and fruit composition. In 2023, a yield monitor-equipped machine harvester collected yield across the entire vineyard and allowed a comparison between large spatial datasets when coupled with the high-resolution imagery. Results showed that these tools can be useful to evaluate large trials where ground data may be difficult to collect at high volumes.

Mapping of fractional cover (FC)

FC (Figure 1A) is a measure that derives a percentage of canopy cover by vines in a given area. Typically, this is accomplished through calculating NDVI and thresholding the NDVI so that only pixels that are actual canopy are recorded. However, we used MCARI (Equation 1) to threshold the canopy, and calculated FC according to Equation 2. This decision was made because we found that red edge indices teased out the effects of cover crop more efficiently than those without. Starting from vine density measures, we created a grid that approximates the FC of each vine in a 60-vine treatment (Figure 1B). This allowed us to create a distribution of FC over a single treatment (Figure 1C), adding a dimension of variability of treatment effects.

$$\text{(Eq 1)} \quad MCARI = ((RedEdge - Red) - 0.2 * (RedEdge - Green)) * \left(\frac{RedEdge}{Red}\right)$$

$$\text{(Eq 2)} \quad FC = \frac{MCARI > 0.3}{Total\ Pixels}$$

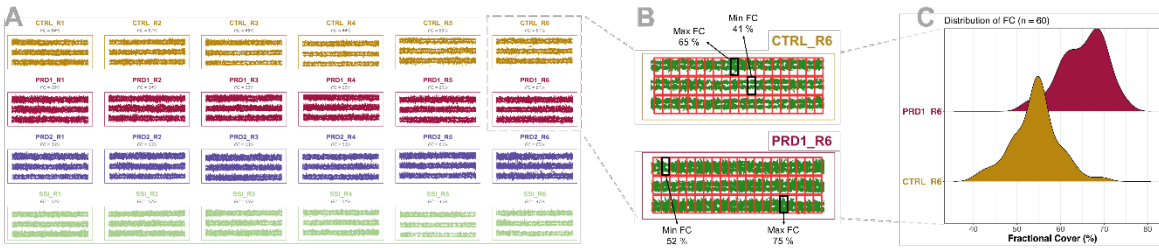


Figure 1. Fractional cover (FC) of vines submitted to differential irrigation treatments. A) Maps of FC by treatment and replicate (n = 6), corresponding to 3 rows of 20 vines. The average FC is reported directly on top of each map. B) Creation of grids to approximate “single-vine” FC. Examples for two treatments are provided and minimum and maximum FC values are marked in black. C) Distribution of FC values (n = 60) extracted from the previous step. Abbreviations: CTRL, control; SSI, subsurface irrigation; PRD1, partial rootzone drying (alternated); PRD2, partial rootzone drying (one side).

Comparison to low- and high-vigor areas

The experimental treatments were then compared to the highest, median, and lowest vigor areas in the rest of the vineyard (approx. 100 acres), selected using NDVI imagery. The MCARI (Figure 2A) and FC (Figure 2B) in the PRD treatments exceeded even the highest vigor areas in the rest of the block.

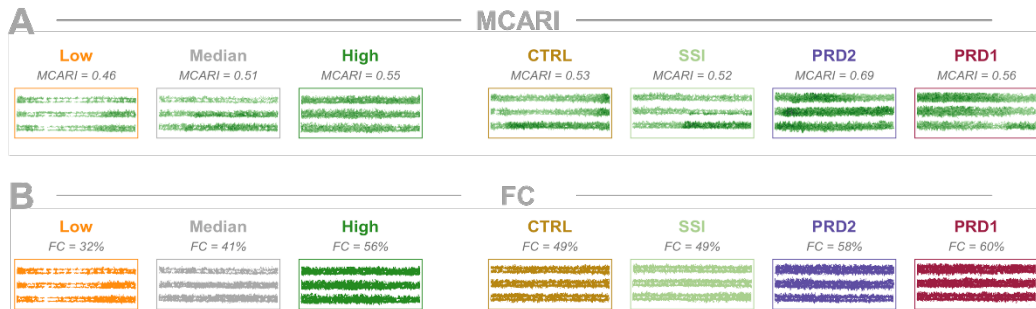


Figure 2. Comparison of MCARI (A) and FC (B) in Partial Rootzone Drying treatments showing the highest, lowest, and median vigor in a 100-acre vineyard.

Relationship between yield and FC

We also looked at downscaled yield numbers collected using a yield monitor mounted on a mechanical harvester. Yield data correlated with the FC values seen in the treatments.

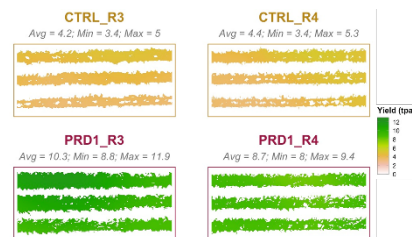


Figure 3. Yield comparison between the PRD treatment and the control.