HEATWAVES IMPACTS ON GRAPEVINE PHYSIOLOGY, BERRY CHEMISTRY & WINE QUALITY

Authors: Elisabeth FORRESTEL[1*], Martina GALEANO[1], James CAMPBELL[1], Sophia BAGSHAW[2], Morgan FURZE[3], Luis SANCHEZ[4], Nick DOKOOZLIAN[4], Annegret CANTU[1], Andrew GAL[5], Mallika NOCCO[5], Andrew McELRONE[1,2]

[1] *Department of Viticulture and Enology, University of California Davis*
[2]*USDA-ARS, Davis, California*
[3]*Department of Botany and Plant Pathology, Purdue University*
[4] *E. & J. Gallo Winery, Modesto CA*
[5]*Department of Land Air & Water Resources, University of California Davis*
*Corresponding author:ejforrestel@ucdavis.edu

Abstract:

Context and purpose of the study – Climate change impacts on both yields and quality have increased over the past decades, with the effects of extreme climate events having the most dramatic and obvious impacts. Increasing length and intensity of heatwaves associated with increased water stress necessitates a reevaluation of climate change responses of grapevine and, ultimately, a reconsideration of vineyard management practices under future conditions. Here we summarize results from a three-year field trial manipulating irrigation prior to and during heatwave events to assess impacts of water application rates on vine health and physiology, berry chemistry, and wine quality. We also highlight potential mitigation strategies for extreme heat, both in terms of water application, as well as other cultural practices that could be widely applicable.

Material and methods – A three-year experimental study consisting of manipulating irrigation prior to and during heatwave events was conducted in a commercial vineyard of Cabernet Sauvignon on 1103P rootstock. To evaluate the use of irrigation applied prior to and during heat waves (HWs), and its effect on grapevine physiology and berry composition, we exposed *Vitis vinifera* cv. Cabernet Sauvignon vines in an established vineyard to three differential irrigation treatments. The baseline treatment was under water deficit (60% ET), while the 2x baseline ET and 3x baseline ET treatments had double and triple the irrigation of the baseline, respectively. Differential irrigation started one to two days prior to a HW and continued until the last day of the HW. Vine physiology, berry chemistry, transcriptomic data, yield and wine chemistry were collected for all seasons, and the carbohydrate status of the different vine organs were assessed at the end of the study.

Results – The amount of irrigation applied before and during heatwaves had significant effects on yield, primary and second chemistry, as well as sensory properties of the resulting wine. Throughout HWs there was a significant reduction in gas exchange, an increase in leaf temperature, and lower evaporative cooling in the baseline treatment, while no differences were observed between 2x and 3x treatments. However, after HWs the baseline treatment showed signs of recovery from physiological stress. Skin tannin and anthocyanin content, the onset of anthocyanin synthesis, pH, and acidity were affected negatively by underwatering (60% ET) or overwatering (3x). Additionally, the baseline treatment had the highest total soluble solids (TSS), and the lowest yield. There were no significant impacts on carbohydrate status of the vine after three years of treatment. Despite distinct weather patterns each year of the study, impacts were Our study highlights the detrimental effects of insufficient or excess water applications during heat waves on grapevine physiology, berry composition, and wine quality, and emphasizes the need for a broader understanding of how different mitigation strategies for extreme heat impact vines and wine.

Keywords: Grapevine health, heatwaves, climate change, irrigation, water stress, carbohydrate storage, berry chemistry, wine quality