A COMPREHENSIVE ECOLOGICAL STUDY OF GRAPEVINE SENSITIVITY TO TEMPERATURE; HOW TERROIR WILL SHIFT UNDER CLIMATE CHANGE

Authors:Molly CLEMENS[1], Andrew WALKER[2], Elizabeth WOLKOVICH[3]

[1] *University of California Davis and San Diego State University Joint Doctoral Program in Ecology**

[2] *University of California Davis Department of Viticulture and Enology*

[3] *University of British Columbia Department of Conservation and Forestry*

*corresponding author mclemens@ucdavis.edu

Abstract:

Fossil fuel combustion continues to drive increases in atmospheric carbon dioxide, consequently elevating the global annual mean temperature and specifically increasing the growing season temperatures in many of the world's most important wine growing regions (IPCC 2014; Jones et al 2005). Grapes are sensitive to changes in growing season temperatures, and past models have shown a direct link between warming temperatures and earlier harvest dates (Cook and Wolkovich 2016). Globally, there have been shifts of 1-2 weeks for wine growing regions (Wolkovich et al 2017 and references within). The phenological shifts resulting from growing season temperature increases are documented internationally, and models predicting phenology using temperature are becoming more precise (Parker et al 2011). The intraspecific variation in heat thresholds for grapevines impacts adaptation capacity (Parker et al 2011, Zapata et al 2017). Predicting phenology and the impact of temperature helps growers select later ripening varieties and clones most suitable for their location (Parker et al 2011). A broader understanding of variety sensitivity to climate change can inform planting and breeding decisions. Accurate estimations of ripening through phenological models can also guide viticultural decisions, especially under changing climate conditions (Zapata et al 2017). Models of warming indicate that increases in temperature are not uniform globally, and that warming has increased in the winegrowing areas of California and Western Europe more than South America and Australia during the past 50 years (Jones 2013). Even with our current understanding of varieties' climate niches, only a few existing cultivars are late ripening enough to avoid the warming predicted to occur during maturation in future climate scenarios (Parker et al 2013, García de Cortázar-Atauri et al 2017).

Materials and Methods - This study builds on previous research by tracking over 130 varieties in a common garden over five years and models the response of the varieties through three main phenological stages: budburst, flowering, and veraison in a common garden, which allows for a more specific ecological study of each variety's response to climate. We also compare traditional *Vitis vinifera* species with hybrids grown at the University of California, Davis, originally cultivated by Harold Olmo. We present sensitivity as the days shifted (standard error in days) over five years in response to temperature, and we include recommendations for future planting under several climate change scenarios.

Results -Our results suggest that future breeding and planting programs choose varieties with lower sensitivity to temperature changes, with later ripening patterns and high heat tolerance, such as hybrids cultivated by Harold Olmo, Italian, and French varieties. Future research will target potential varieties for successful marketing in California under future climate conditions, and potentially elucidate physiological drivers of phenological variation that have been artificially selected through grapevine cultivation. These physiological traits could be useful for adapting plant material to new regions and new climates.

Keywords: climate change, phenology, warming, grapevine

1. Introduction

Climate Change Shifts Terroir

Molly Clemens, Andrew Walker, Elizabeth Wolkovich
UC Davis and San Diego State University
Joint Doctoral Program in Ecology

Abstract

The phenological shifts resulting from growing season temperature increases are documented internationally, and models predicting phenology using temperature are becoming more precise (Parker et al 2011). The intraspecific variation in heat thresholds for grapevines impacts adaptation capacity (Parker et al 2011, Zapata et al 2017). A broader understanding of variety sensitivity to climate change can inform planting and breeding decisions. Accurate estimations of ripening through phenological models can also guide viticultural decisions, especially under changing climate conditions (Zapata et al 2017). Even with our current understanding of varieties' climate niches, only a few existing cultivars are late ripening enough to avoid the warming predicted to occur during maturation in future climate scenarios (Parker et al 2013, García de Cortázar-Atauri et al 2017).


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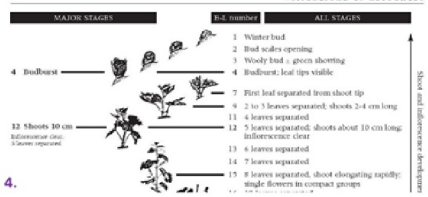

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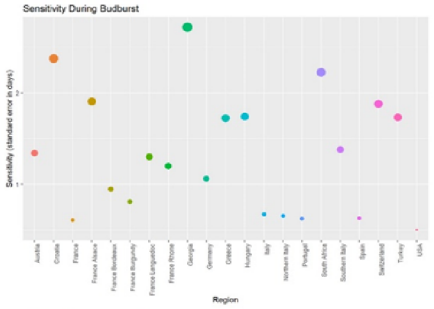
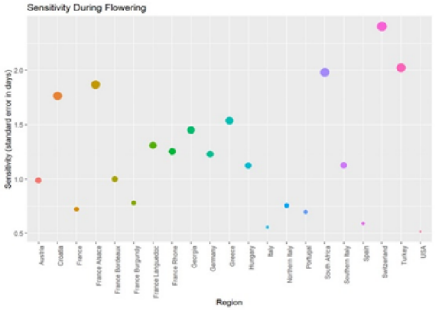
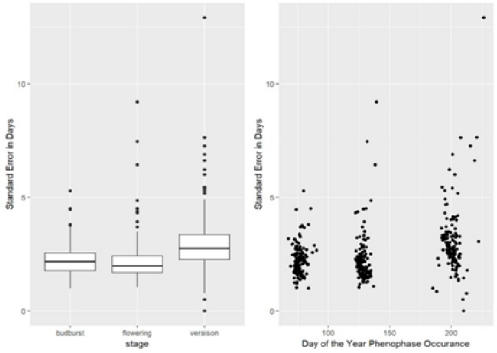




Results

Our results suggest that future breeding and planting programs choose hybrid varieties with lower sensitivity to temperature changes, with later ripening patterns and high heat tolerance. Future research will target potential varieties for successful marketing in California under future climate conditions, and potentially elucidate physiological drivers of phenological variation. These physiological traits could be useful for adapting plant material to new regions and new climates.



Methods

Major phenology stages monitored:
1. Budburst 2. Flowering 3. Veraison

Phenological data has been collected from UC Davis starting in 2014, continued through 2018 using 137 varieties of *Vitis vinifera*. Recorded according to EL stage (**4.**)

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