Editorial

Viticulture and Winemaking under Climate Change

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Abstract: The importance of viticulture and the winemaking socio-economic sector is acknowledged worldwide. The most renowned winemaking regions show very specific environmental characteristics, where climate usually plays a central role. Considering the strong influence of weather and climatic factors on grapevine yields and berry quality attributes, climate change may indeed significantly impact this crop. Recent-past trends already point to a pronounced increase in the growing season mean temperatures, as well as changes in the precipitation regimes, which has been influencing wine typicity across some of the most renowned winemaking regions worldwide. Moreover, several climate scenarios give evidence of enhanced stress conditions for grapevine growth until the end of the century. Although grapevines have a high resilience, the clear evidence for significant climate change in the upcoming decades urges adaptation and mitigation measures to be taken by the sector stakeholders. To provide hints on the abovementioned issues, we have edited a special issue entitled: “Viticulture and Winemaking under Climate Change”. Contributions from different fields were considered, including crop and climate modeling, and potential adaptation measures against these threats. The current special issue allows the expansion of the scientific knowledge of these particular fields of research, also providing a path for future research.

Keywords: viticulture; winemaking; climatic influence; climate change; adaptation measures

1. Introduction

Viticulture and winemaking are largely recognized worldwide, having a strong socio-economic role for many countries. Globally, in 2018, wine production was $292 \times 10^6$ hl, which has remained relatively unchanged over the last decades [1]. Geographically, the winemaking regions are widespread, but are usually located in temperate climatic regions. Europe incorporates the largest vineyard area in the world (~40%), despite losing some of its dominance to Asia, USA, and some southern hemisphere areas (Argentina, Australia, Chile, South Africa). The world’s top wine producing countries are France, Italy, and Spain, while it is worth noticing that China recorded the largest increases in production over the latest years.

Climate is an important forcing factor on grapevine (*Vitis vinifera* L.) physiological development [2], vegetative growth [3], phenology [4], production, and consequently on wine quality. Climatic factors also determine the geographical location of vineyards [5], and the variability in the weather parameters, such as air temperatures, precipitation, and solar radiation, leads to annual changes in productivity [6,7]. Weather extremes are also known to have detrimental impacts on grapevine productivity and quality, namely hail, late frost spells, and excessive rainfall [8].

Climate change is an anticipated challenge that winegrowers will have to deal with in the next decades. During the 20th century, significant changes in temperatures were found, including increases from 2 to 5 °C in Europe [9], which is home to world-renowned wine regions. Moreover, decreases in the precipitations over southern Europe [9] were also found. According to the latest report of the *International Panel on Climate Change* (IPCC), following different representative concentration pathways...
(RCP), global temperature is expected to rise between 1 °C (RCP2.6—least severe scenario) and 5 °C (RCP8.5—most severe scenario), over the 21st century [10].

2. Climate Change Impacts on Viticulture

Given the projected modification to climatic conditions, it is expected that climate change will generally have a negative impact on grapevines and wine production. Grapevines will be strongly affected by the higher temperatures during the growing season. As temperatures are a major driver of the grapevine development stages [11], significant warming is expected to lead to earlier phenological events. The advance of the flowering stage may also have a strong impact on management practices. Moreover, a warming during the maturation period will most likely change wine quality attributes and typicity. Extreme heat during this period may abruptly reduce vine metabolism, affecting wine quality attributes. Higher sugar and lower acidity levels should be expected, potentially increasing the risk of wine spoilage [12], threatening wine production and quality. Furthermore, extreme heat and water stress, under future climates, may threaten final yields and productivity [13].

Given the mentioned climate change impacts on this crop, it becomes imperative to plan and implement suitable adaptation measures. Short-term adaptation measures imply changes in management practices, such as the application of irrigation, improving water use efficiency, or providing protection against sunburns. Long-term adaptation measures include more adequate varietal selection and vineyard geographical changes. Sector growers and stakeholders should become aware of this problem in order to timely plan and adopt these measures in order to ensure the future sustainability of this important crop.

3. The Special Issue

The current special issue collects contributions from several papers from colleagues worldwide, reporting how the effects of climate change can affect grapevines and how to deal with these changes on a regional level. The special issue contains reviews and original research articles devoted to the problem of climate change impacts on viticulture and winemaking. One article provides a review of the updated impacts of climate change on grapevines [14]. Some research articles are more focused on climatic factors, such as the possible impacts of decadal-scale cold waves over Europe on viticulture [15], and the grapevine response to natural hail events [16]. Other studies apply crop modeling to better understand the impact of climate change on grapevines [4,17,18]. Furthermore, this special issue contains articles devoted to improving water use efficiency [19] and the effect of a natural anti-transpirant on grapevines [20]. Additionally, another study makes use of reflectance indices to assess vine water status [21]. Other articles are devoted to new and innovative management practices that could prove beneficial under future climates, such as the semi-minimal pruned hedge [22], the application of kaolin clay [23], or even the introduction of unmanned aerial vehicles in vineyards to assess climate change impacts [24]. There are studies devoted to understanding the adaptation potential of some grapevine varieties under the context of climate change [25–27], while another article studies the effect of future enhanced CO₂ levels on specific vine pests. Overall, the current special issue incorporates several areas of research related to climate change impact on viticulture and winemaking, allowing the expansion of current scientific knowledge on this issue.

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