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Sustaining wine identity through intra-varietal diversification

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To sustain local wine identity in uncertain climate outcomes, the study of intra-varietal diversity is important to reflect the adaptive potential of cultivated varieties. Findings highlight the strong phenotypic diversity of studied varieties and the importance of diversification to enhance climate change resilience. This study is the first step towards quantifying heat requirements of different clones and how they can provide adaptation solutions for winegrowers.

Introduction

Cultivated and shaped by human uses for many centuries, the grapevine has a rich genetic diversity with an estimated five to ten thousand varieties worldwide. Each variety has a climate suitability range, explaining the ecological fitness of varieties to a set of environmental conditions[1]. Climate change is questioning these climate niches[2]. Despite ongoing projects on genetic diversity among grapevine and rootstocks varieties for climate change adaptation, the study of intra-varietal diversity is equally important to reflect the adaptive potential of current cultivated varieties.

To sustain wine identity in uncertain climate outcomes, the aim of this ongoing study is to understand to what extent can intra-varietal diversity be a climate change adaptation solution. With a focus on early to moderate late ripening varieties, historical data was collected for agronomy observations of flowering and veraison for the studied clones (Table 1). Applying the GFV model[3], climate data were compiled to calculate heat units necessary for each individual clone to reach phenological stages. Climate change projections were then integrated to observe how the individual clones are adapting to continuous regional warming. The goal was to evaluate the ecological suitability of studied varieties when considering its genetic diversity.

TABLE 1. *Data description of the studied clones cultivated in the Loire Valley, Bordeaux and Alsace.*

Region	Variety	Population	Site	Years
Loire Valley	Chenin	187 accessions	Montreuil-Bellay	97-99
	Sauvignon blanc	113 accessions	Montreuil-Bellay	97-02
		150 accessions	Montreuil-Bellay	14-15
	Grolleau noir	207 accessions	Montreuil-Bellay	00-03
Bordeaux	Petit verdot	87 accessions	Mérignac	15-16
Alsace	Pinot	422 accessions	Bergheim	86-93
	Riesling	433 accessions	Rorschwihr	82-91

Results

Study results showed a strong phenotypic variability within the same variety and how they translate into distinct heat requirements. For example, Table 2 illustrate the calculations on historical data for Chenin and Sauvignon in the Loire Valley. Chenin clones with an early onset in flowering required 1301 heat units, compared to almost 1400 heat units for clones with a delayed phenology. These variations in phenology and heat requirements become more important over the growing season as shown for veraison. For instance, Sauvignon clones with an early onset in flowering required 2480 heat units, compared to 2736 heat units for clones with a delayed veraison timing. When considering the established heat requirements for flowering and veraison, these values are close to the behaviour of early ripening clones according to study findings, displaying the interest to better understand the genetic diversity within the same variety. Most clones were selected in the second half of the 20th century, when early phenology was considered being an asset to achieve full ripeness. As a result, there is room for selecting other clones better adapted to warmer climatic conditions.

TABLE 2. Average day of the year (DOY) and heat requirements for individual clones of Chenin and of Sauvignon blanc to reach the phenological stages of flowering and veraison.

Grapevine variety	Clone Range	Flowering DOY	Heat requirements for flowering	Veraison DOY	Heat requirements for veraison
Chenin blanc	Early	161	1301	228	2618
	Mean	164	1343	235	2771
	Late	168	1396	241	2895
Sauvignon blanc	Early	165	1352	225	2480
	Mean	167	1394	231	2660
	Late	169	1422	234	2736

The ecoclimatic modelling approach seeks to understand the adaptive potential of the intra-varietal diversity in a changing climate. Considering the example of Chenin clones to reach flowering, initial findings show that in the recent past, the flowering date was around 25 June with a range of 6 days between the earliest and latest clones. According to the emission scenarios, clones will advance between 7 and 8 days by 2050 with a range of 5 days between the earliest and latest clones. A more substantial shift in flowering timing is expected by 2100 under the 4.5 and 8.5 RCP climate scenarios where the range between the early and late developing clones remain 5 days. For the timing of veraison, similar results are obtained. Considering Chenin, initial findings show that in the recent past, the timing of veraison was around 8 September with a range of 15 days between the earliest and latest clones (Figure 1). According to the emission scenarios, clones will advance between 11 and 13 days by 2050 with a range of 13 days between the earliest and latest clones. By

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2100, veraison will advance by 22 days (RCP4.5) and by 32 days (RCP8.5) compared to 1971-2000. In both scenarios, the range between the early and late clones will be 11 days.

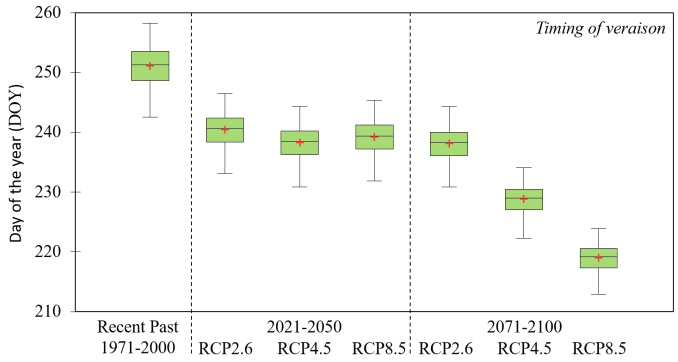


FIGURE 1. Box plots representing the temporal variability in veraison timing for Chenin blanc clones in the recent past and based on different climate scenarios for the near and far future. The range for box plots indicates the difference between the earliest and latest developing clone.

Conclusion

With the common objective to strengthen the resilience of the wine sector to climate change, the aim of this ongoing study was to understand to what extent can intra-varietal diversity be a climate change adaptation solution. Data was collected for flowering and veraison timing for the various clones of studied varieties. While model performances require improvements, this study is the first step towards quantifying heat requirements of different clones and how they can provide adaptation solutions for winegrowers to sustain local wine identity in a global changing climate. Findings highlight the strong phenotypic diversity and the importance of clonal diversification for climate change resilience. In addressing climate variability and change, promoting a limited proportion of mass and private clonal selections in vine propagation at local and community levels are equally important in addition to institutional clonal selections. These mass and private selections provide economic gains and the preservation of genetic diversity[4]. As the latter is an ongoing process through point mutations and epigenetic adaptations, perspective work is also to explore clonal data from a wide variety of geographic locations. This ongoing study is financed by the French National Research Agency (grant ANR-22-CE03-0003). ■

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