RESPONSE OF ALBARIÑO TO LOCAL ENVIRONMENTAL CONDITIONS IN URUGUAY

Mercedes FOURMENT[1*], Ramiro TACHINI[1], Pablo GONZALEZ-BARROS[1], Paulina SIRI[1], Valérie BONNARDOT[2] Hervé QUENOL[2], Milka FERRER[1]

[1]*Facultad de Agronomía, Universidad de la República, Av. E. Garzón 780, CP 11400 Montevideo, Uruguay.*
[2]*Laboratoire LETG-Rennes UMR 6554 CNRS, Université de Rennes II, Place du Recteur Henri Le Moal, 35043, Rennes, France.*

*Corresponding author: *mfourment@fagro.edu.uy*

Abstract:

Context and purpose of the study

Albariño is a white cultivar that has been recently promoted in Uruguay due to its ability to maintain high berry quality even in adverse climate conditions during ripening. This study aims to assess the effect of different topographic conditions on Albariño agronomic behavior and oenological potential.

Material and methods

Ten Albariño plots located at different aspects of exposure, altitude and slope were selected in the emerging wine-growing region of Eastern Uruguay. To assess spatial temperature variability due to the topography conditions, a temperature sensor was installed in each plot. Bioindicators for grapevine were calculated, and relationships between site topography and plant responses (yield components and berry composition) were analyzed using climatic and agronomic data recorded over three seasons (2019, 2020, and 2021).

Results

In the plots of Albariño under study, we found that the interactions between topography and berry metabolites varied through the seasons. The slope was the topography factor which showed a more substantial impact on local temperature and berry metabolites. Plots on steeper slopes (8.8 to 11.6º) favored grapes with a higher acid content (more than 0.43 gH_2SO_4 per liter), while plots at lower elevations provided berries with higher amounts of secondary metabolites (more than 1.6 units of phenol richness). No significant statistical relationships were found between yield, local climate, and topography. This cultivar showed less differences in berry composition associated with temporal and spatial climate variability due to topography than other cultivars like Tannat (red cultivar).

Keywords: Grape composition, Albariño, Meso-climate, Topography, Uruguay.

1. Introduction

Albariño is a white cultivar that has been recently promoted in Uruguay due to its ability to maintain high berry quality even in adverse climate conditions during ripening. This is important, considering that one of the impacts of climate change in the region is the increase in rainfall during the summer and autumn when the grapes ripen and are harvested. The area planted has increased by 24% in the last five years, making up 1.6% of the country's vineyards (INAVI, 2023). However, the cultivar's adaptation to the environmental conditions in Uruguay is not well understood. Thus, this study aims to assess the effect of different topographic conditions on Albariño agronomic behavior and oenological potential in the emerging Atlantic wine region in Uruguay in order to contribute to develop knowledge on this cultivar.

2. Material and methods

Study region and climate network in vineyards plots

The study was developed in a commercial vineyard in an emerging wine region on the Atlantic side of southeastern Uruguay (Garzón, located in the Maldonado Department) (Figure 1). The climate of the region was classified as temperate, with temperate nights and moderated drought, according to the "Multicriteria Climatic Classification" method for vineyards (Ferrer, 2007). The grape ripening period in southeastern Uruguay is characterized by temperate maximum temperatures and a growing season average temperature of 18.9°C (Fourment et al., 2020).

Ten Albariño plots located at different aspects of exposure, altitude and slope were selected in a commercial vineyard (Bodega Garzon) (Table 1). The plots were similar in terms of vineyards age (10 years old) and viticultural management and practices (VSP system and Guyot pruning system). For each plot, two groups of 7 vines were randomly selected (each group in different row).

Table 1. Geography features for the ten Albariño plots (Altitude, Slope and Aspect) and their categories.

Plot	Altitude (m)	Slope (º)	Aspect (º)	Altitude Category	Aspect Category	Slope Category
1	135	9.4	110	High	E	3
2	140	11.2	187	High	S	3
3	108	9.3	43	Medium	N	3
4	92	11	122	Low	E	3
5	92	11.6	160	Low	S	3
6	110	7.5	323	Medium	N	2
7	77	5.7	345	Low	N	1
8	106	5.5	135	Medium	S	1
9	96	7.9	128	Medium	E	2
10	88	4.4	172	Low	S	1

To assess spatial temperature variability due to the topography conditions, a temperature sensor (Tinytag Data Loggers, Gemini, UK) was installed in each plot (on the vineyard trellis post). Hourly temperature data (º C) was recorded by the sensors, placed inside a radiation shield. Bioindicators for grapevine were calculated as Cool Night Index (Tonietto and Carbonneau, 2004), Huglin Index (Huglin, 1978), Thermal Amplitude during summer (Daily difference between Maximal temperature and Minimal temperature from January to 15th March) and Average growing season temperature (Daily mean temperature from 1st September to 15th March). We analyzed the relationships between site topography and plant responses (yield components and berry composition) using climatic and agronomic data recorded over three seasons (2019, 2020, and 2021).

Grapevine measurements

Yield components – For each plot, fourteen plants were selected and measured: number of clusters per plant, number of clusters per bud, number of clusters on bud position and grape weight per plant. Additionally, we assessed the rot intensity within the harvested clusters by counting and weighing the affected clusters per plant.

Berry composition - Following Carbonneau et al.'s (1991) recommendations, we collected weekly berry samples of Albariño grapes from veraison to harvest, resulting in four samples per growing season. In each plot, we collected two double samples of 250 berries, selecting portions of clusters (consisting of 5 to 7 grapes) from various positions and exposures. To analyze the grape berry composition, we measured sugar concentration (g/L) by refractometry, titratable acidity (g H_2SO_4/l) by tritation, pH by potentiometry in the must resulting from the collected samples, following the O.I.V. protocol (1990). To analyze phenolic potential, such as phenolic richness of grapes, the Glories and Agustin (1993) protocol was followed. All the measurements of phenolic potentials were carried out by duplication with a Shimadzu UV-1240 Mini spectrophotometer (Shimadzu, Japan). Those variables were important to provide enology valorization of grape and improve vinification management (González-Néves et al., 2010).

Statistical analysis – A Principal Components Analysis was conducted to determine statistical relationships between relief factors (the aspect of exposure, altitude, and slope) and seasons. Additionally, an analysis of repeated measures over time using a heterogeneous variance structure was performed to evaluate the performance of berry composition traits such as pH, acidity, and sugar content. For that propouse, R and SAS Software were used.

3. Results and discussion

3.1. *Spatial variability of temperature and its relation to topography*

Within the analysed temperature indices over the three growing seasons, the CNI index only showed significant statistical differences between plots (Table 2). However, correlations were founded when we analyzed differences in temperature grouping plots by altitude, slope, or aspect.

Table 2. Mean values of temperature of the growing season (T avg), Thermal amplitude (TA), Cool Night Index (CNI) and Huglin Index (HI) from each plot, for the three studied growing seasons.

Plot	Altitude Category	Aspect Category	Slope Category	T avg	TA	CNI	IH
1	High	E	3	19.2	11.9	16.7	2774
2	High	S	3	19.3	11.7	16.6	2771
3	Medium	N	3	19.3	12.1	16.7	2843
4	Low	E	3	19.3	12.8	16.3	2840
5	Low	S	3	19.3	13.1	16.2	2877
6	Medium	N	2	19.4	12.5	16.6	2856
7	Low	N	1	19.1	13.7	15.4	2826
8	Medium	S	1	19.2	12.0	16.5	2786
9	Medium	E	2	19.2	12.2	16.4	2810
10	Low	S	1	19.0	12.7	15.8	2755
Average				19.2	12.5	16.3	2814

Altitude was the main feature that statistically differentiated the temperature of the different plots. The effect was observed on thermal amplitude (F value 3.92; p 0.03) and the Cool Night Index (F value 26.57; p <0.0001). Plots situated at the highest altitude (140 masl) reached 11.8 of TA, while plots situated mid-slope and at lower altitude (70 masl) reached the highest values (12.3 and 11.3, respectively). During summer, plots at lower positions showed the lowest CNI (15.94º minimal temperature in February) while the other plots (at medium and higher positions) showed CNI up to 16.57 ºC. The main factor conditioning this result was the proximity of the ocean and the slope exposure facing sea breeze air circulations.

Aspect did not show statistical differences in temperature between plots, while slope showed significance only in minimum temperatures (CNI). Plots on slopes under 5.7º showed the minimum values of CNI compared to those at slopes up to 6º (15.91 and 16.51 ºC respectively).

***3.2.** Albariño behaviour and its relation to meso-climate and topography*

In the evaluated plots of Albariño, we found that the interactions between topography and berry metabolites varied through the seasons. The slope was the topography factor which showed a more substantial impact on local temperature and berry metabolites. Plots on steeper slopes (8.8 to 11.6º) favored grapes with a higher acid content (more than 0.43 gH2SO4 per liter), while plots at lower elevations provided berries with higher amounts of secondary metabolites (more than 1.6 units of phenol richness).

When we modeled the evolution of berry metabolites, we observed statistical significance in berries from plots at different altitudes only for one season. No significant statistical relationships were found between yield, local climate, and topography.

4. Conclusions

This cultivar showed less differences in berry composition associated with temporal and spatial climate variability than other cultivars like Tannat (red cultivar). Albariño is a cultivar that, while preserving its typicity, seems to adapt to different seasonal and local conditions. This may be due to the cultivation and development of Albariño in the region.

5. Acknowledgments

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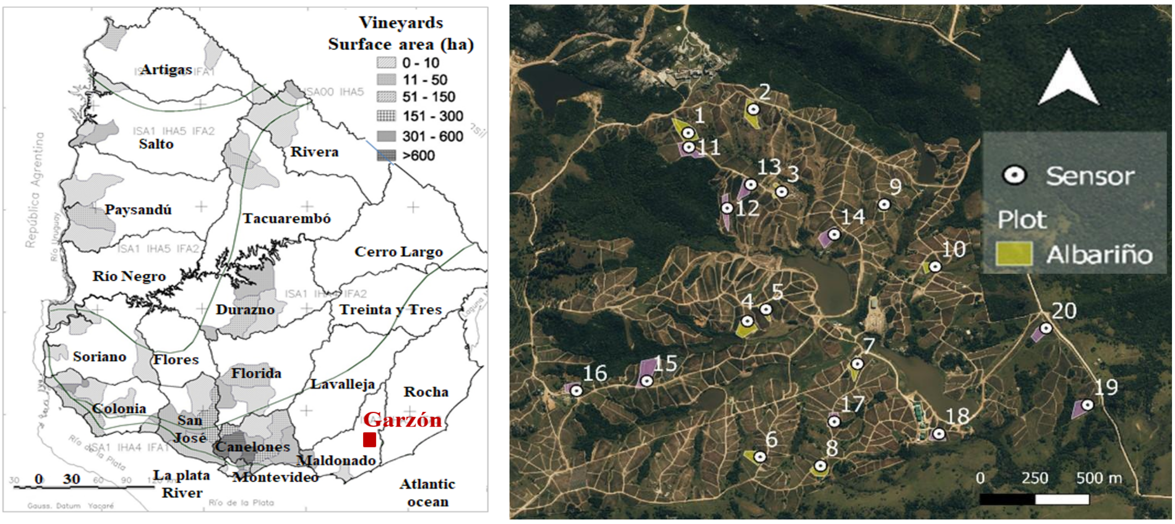

Figure 1. Surface under vineyards in Uruguay with the location of the site (Garzón, Maldonado Department) in red **(left)**, the network of 10 Albariño plots (in yellow), in the commercial vineyard under different geographic features **(right)**.

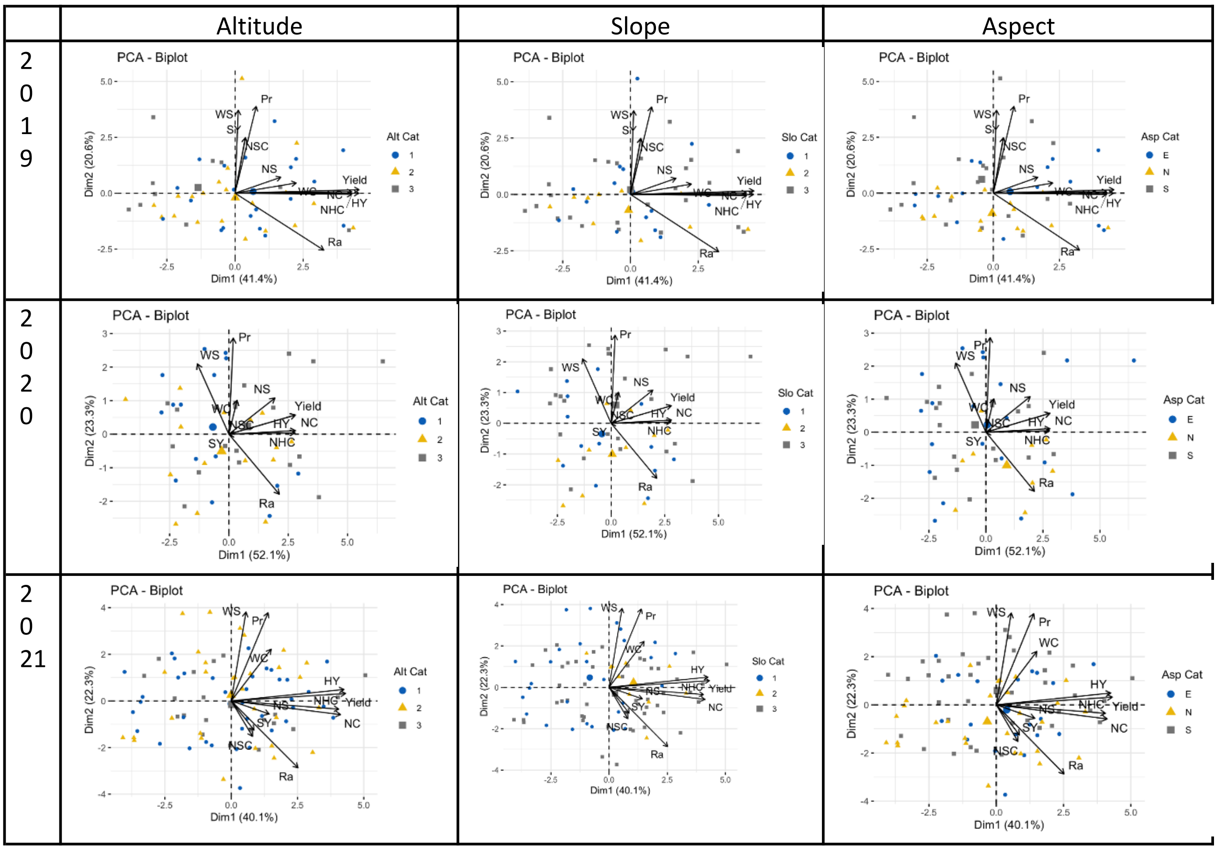

Figure 2: Principal Component Analysis (PCA) between the different topograhpy situations (Altitude, slope and aspect) and the yield components of each Albariño plot (Number of clusters, Clusters' weight, Yield) through the three studied years (WS= Shoot weight in winter; WC= Cluster weight; Pr= Pruning weight; NS= Number of rot clusters; HY= Healthy yield; NC= Number of cluster; SY= Rot Yield; Ra= Ravaz Index)

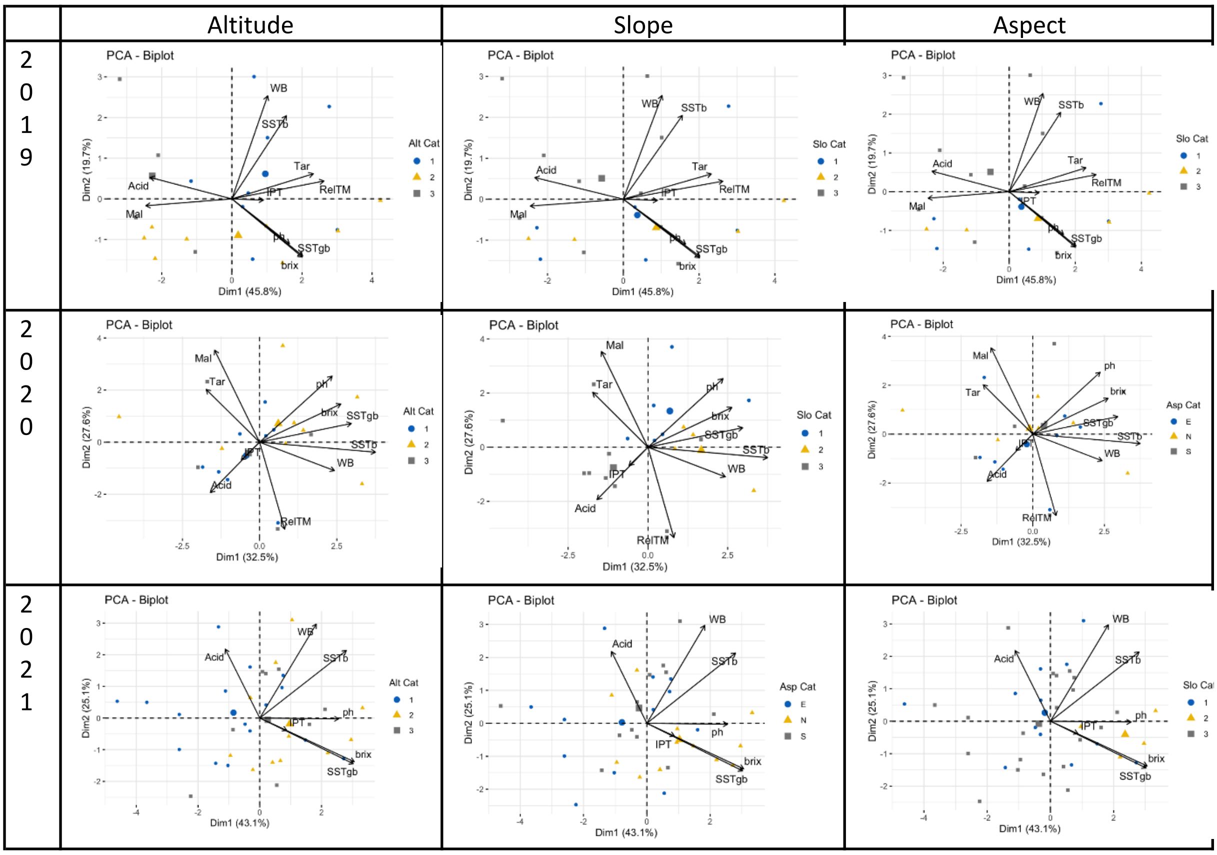

Figure 3: Principal Component Analysis (PCA) between the different topograhpy situations (Altitude, slope and aspect) and the Albariño berry composition (Acidity, pH, Total sugars, Sugars per gram, Phenol Richness) through the three studied years (WB= Berry weight; SSTb= Soluble solids per berry; IPT= Total Phenol Index; SSTgb= Soluble solids per grame of berry).