AN INTRA-BLOCK STUDY OF BUNCH ZONE AIR TEMPERATURE AND ITS IMPACT ON BERRY AND WINE ATTRIBUTES

Authors:Olivier GEFFROY[1,2*], Fanny PREZMAN[2], Thierry DUFOURCQ[3], Jean-Philippe DENUX[1,4], Harold CLENET[1,4]

[1]*Université de Toulouse, INP-École d'Ingénieurs de Purpan, 75 voie du TOEC, 31 076 Toulouse Cedex 3, France*
[2]*IFV Sud-Ouest, V'innopôle, Brames Aigues, 81 310 Lisle Sur Tarn, France*
[3]*IFV Sud-Ouest, Domaine de Mons, 32 100 Caussens, France*
[4]*UMR 1201 DYNAFOR, INRA / Toulouse INP, 24 chemin de Borderouge 31326 Castanet Tolosan Cedex, France*

*Corresponding author: *olivier.geffroy@purpan.fr*

Abstract:

Context and purpose of the study – Temperature is a key environmental factor affecting grape primary and secondary metabolites. Even if several mesoscale studies have already been conducted on temperature especially within a Protected Designation of Origin area, few data are available at an intra-block scale. The present study aimed at i) assessing the variability in bunch zone air temperature within a single vineyard block and the temporal stability of temperature spatial patterns, ii) understanding temperature drivers and iii) identifying the impact of temperature on grape berry attributes.

Material and methods - The experiment was carried out on a 0.51 ha Guyot trained Syrah vineyard from the South West of France. Loggers displayed in solar radiation shields were positioned at 19 points in the vineyard to monitor air temperature within the bunch zone every ten minutes between veraison and harvest. At each logger, a sampling area of 21.5 m^2 was delimited to collect data on topography, soil stoniness, vine behavior and fruit characteristics at harvest. Rotundone, a sesquiterpene responsible for the black pepper typicality of Syrah wine which is known to be affected by berry temperature, was also determined in wine prepared by microvinification techniques (1-L Erlenmeyer). Data were spatialized using GIS tools and used to calculate several climatic indexes over the measuring period. Dh25, Dh30 and Dh35, the percentage of degree hours above 25°C, 30°C and 35°C respectively were also determined. The whole data set was treated through principal component analysis (PCA).

Results – Average temperature varied across points from 20.93°C to 21.62°C. The amplitude of variation was greater for cool night index and maximum air temperature which fluctuated from 12.49°C to 13.92°C and from 30.36°C to 33.28°C respectively. A relative stability in temperature spatial patterns was observed on the block over the maturation period. Surprisingly, the warmest area in the morning in the center of the block turned out to be the coolest part of the block during the afternoon and the night. Maximal air temperature and cool night index were best explained respectively by stem water potentials and the distance to the southern end of the vineyard which was characterized by a slightly higher elevation and a greater stoniness. Surprisingly rotundone was poorly correlated to Dh25 while Dh25 spatial pattern tends to visually overlay the anthocyanins map. Our results indicate that bunch zone air temperature can differ largely within a single vineyard block and suggest that variations in this environmental factor can affect berry and wine volatile compositions.

Keywords: temperature, intra-block, spatial pattern, temporal stability, fruit attributes.

1. Introduction

OLIVIER GEFFROY[1,2*], FANNY PREZMAN[2], THIERRY DUFOURCQ[3], JEAN-PHILIPPE DENUX[1,4], HAROLD CLENET[1,4]

[1]Université de Toulouse, INP-École d'ingénieurs de Purpan, 75 voie du TOEC, 31 076 Toulouse Cedex 3, France
[2]IFV Sud-Ouest, Vinopôle, Branes Aigues, 81 310 Lisle Sur Tarn, France
[3]IFV Sud-Ouest, Domaine de Mons, 33 100 Caussens, France
[4]UMR 1201 DYNAFOR, INRA / Toulouse INP, 24 chemin de Borderouge 31326 Castanet Tolosan Cedex, France
*Corresponding author: olivier.geffroy@purpan.fr

AN INTRA-BLOCK STUDY OF BUNCH ZONE AIR TEMPERATURE AND ITS IMPACT ON BERRY AND WINE ATTRIBUTES

Temperature is a key environmental factor affecting grape primary and secondary metabolites. Even if several mesoscale studies have already been conducted on temperature especially within a Protected Designation of Origin area, few data are available at an intra-block scale. The present study aimed at i) assessing the variability in bunch zone air temperature within a single vineyard block and the temporal stability of temperature spatial patterns, ii) understanding temperature drivers and iii) identifying the impact of temperature on grape berry attributes.

MATERIAL AND METHODS

- **Experimental site and loggers :** The experiment was carried out in 2016 on a 0.51 ha Guyot trained Syrah block from the South West of France. Loggers displayed in solar radiation shields (Figure 1) were positioned at 19 points to monitor air temperature within the bunch zone every ten minutes between veraison and harvest.
- **Sampling area and data collected :** Elevation, slope (%) were obtained through the RGE ALTI model from the French IGN. At each logger, a sampling area of 21.5 m² was delimited to collect data on vine behavior and fruit characteristics at harvest. Rotundone, a sesquiterpene responsible for the black pepper typicality of Syrah wine which is affected by berry temperature, was also determined in wine prepared by microvinification techniques (1).
- **Data treatment :** Data were spatialized using GIS tools and used to calculate several climatic indexes over the measuring period. Dh25, Dh30 and Dh35, the percentage of degree hours above 25°C, 30°C and 35°C respectively were also determined. The whole data set was treated through principal component analysis (PCA).

Figure 1 : solar radiation shield housing temperature logger

RESULTS AND DISCUSSION

Variation in temperature and temperature spatial patterns

Average temperature varied across points from 20.93°C to 21.62°C. The amplitude of variation was greater for cool night index and maximum air temperature which fluctuated from 12.49°C to 13.92°C and from 30.36°C to 33.28°C respectively. A relative stability in temperature spatial patterns was observed on the block between August 10 and September 29 (Figure 2). This indicates that the change in azimuth angle over this period of 50 days had a minor impact on the distribution of bunch zone temperature. Surprisingly, the warmest area in the morning located in the center of the block, turned out to be the coolest part of the block during the afternoon and the night. Soil stoniness did not allow to discriminate these two points which were characterized by some of the greatest leaf area and slope.

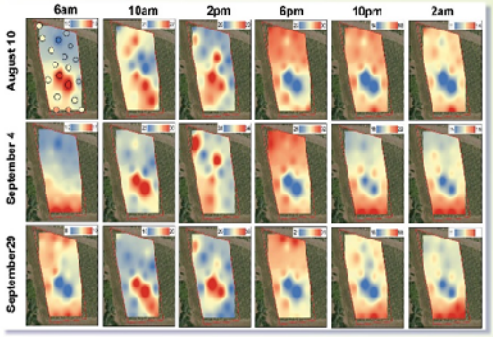

Figure 2 : temperature spatial patterns observed on the experimental plot at different times of the day and at 3 time points over the maturation period. Mid-veraison and harvest occured on August 9 and October 5 respectively.

Factors driving temperature

As it can be noticed on the PCA plot (Figure 3), maximal air temperature was explained by stem water potentials. Leaf temperature is known to increase with the increase in water stress (1) and we can assume that canopy temperature impacted bunch temperature during the warmest hours of the day. Cool night index was correlated to the distance to the southern end of the vineyard whose surface contained a larger quantity of white stones that kept the warmth and released it during the night. No clear relationship could be established between mean temperature and other variables.

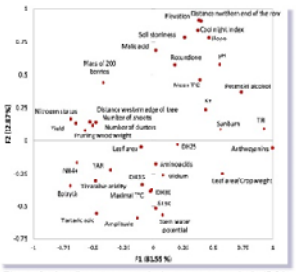

Figure 3 : Loadings for a principal component analysis (PCA) performed on the data collected on the experimental block

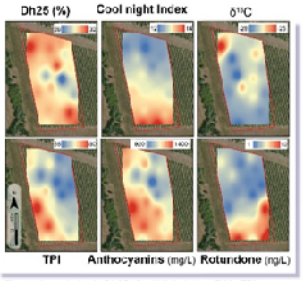

Figure 4 : variation in Dh25, Cool Night Index, δ¹³C, TPI anthocyanins and rotundone in the experimental block

Impact of temperature on grape secondary metabolites

The level of water deficit reflected by δ¹³C was rather homogenous on the plot (Figure 4). As grape secondary metabolites are mostly impacted by water constraint and temperature, temperature is expected to be the main driver of phenolic and aroma compounds biosynthesis. Indeed, Dh25 spatial pattern tends to visually overlay the anthocyanins map which is consistent with previous research showing an increase in anthocyanins levels with an increase in temperature up to the 35°C threshold (3). Temperature exceeding 25°C are known to negatively affect the rotundone concentration and unexpectedly no relationship could be established between Dh25 and rotundone. The best correlation was found between the pepper aroma and the Cool Night Index or percentage of stoniness. As recent findings indicate that UV rays may enhance rotundone synthesis (5), we can suppose that the light reflected by the white stones stimulated rotundone production in this part of the plot.

CONCLUSIONS

Our results indicate that bunch zone air temperature can differ largely within a single vineyard block and that temperature patterns are stable over the maturation period. They also suggest that variations in this environmental factor can affect berry and wine volatile compositions.

[1] Geffroy, O., Dufourcq, T., Carcenac, D., Siebert, T., Herderich, M., & Serrano, E. (2014). Aas: J Grape Wine Res, 20(3), 401-408.
[2] Jackson, R. D., Iczo, S. D., Reginato, R. J., & Pinter, P. J. (1981). Am J Enol Viticult, 17(4), 1130-1136.
[3] Mori, K., Goto-Yamamoto, N., Kitayama, M., & Hashizume, K. (2007). J Exp Bot, 58(6), 1935-1945.
[4] Zhang, P., Howell, K., Krstic, M., Herderich, M., Barlow, E. W. R., & Fuentes, S. (2015). PloS one, 10(7).
[5] Geffroy, O., Desoblas, J., Lavesseur-Genia, C., Debord, C., Denux J.-P. & Dufourcq, T. (2019). Oeno One, submitted

This study was carried with financial support from FranceAgriMer and the Occitanie Region