INFLUENCE OF CLIMATE CHANGE CONDITIONS (ELEVATED CO_2 and TEMPERATURE) ON THE GRAPE COMPOSITION OF FIVE TEMPRANILLO (Vitis vinifera L.) SOMATIC VARIANTS

Authors:Marta ARRIZABALAGA-ARRIAZU[1,2,3], Fermín MORALES[4,5], Juan José IRIGOYEN[1], Inmaculada PASCUAL[1], Ghislaine HILBERT[3]

[1]*Universidad de Navarra. Faculty of Sciences. Plant Stress Physiology group, Associated Unit to CSIC (EEAD, Zaragoza, and ICVV, Logroño). Irunlarrea, 1. 31008, Pamplona, Spain.*
[2] *Université de Bordeaux, Institut des Sciences de la Vigne et du Vin. Unité Mixte de Recherche, 1287 Ecophysiologie et génomique fonctionelle de la vigne. 33883, Villenave d'Ornon, France.*
[3] *UMR Ecophysiologie et Génomique Fonctionnelle de la Vigne, Bordeaux Sciences Agro, INRA, Université de Bordeaux, ISVV, 210 Chemin de Leysotte 33882 Villenave d'Ornon, France.*
[4] *Instituto de Agrobiotecnología (IdAB), CSIC-Gobierno de Navarra, Avenida De Pamplona 123, 31192 Mutilva Baja, Spain.*
[5] *Estación Experimental de Aula Dei (EEAD). CSIC. Department of Plant Nutrition. Apdo. 13034, 50080 Zaragoza, Spain.*

*Corresponding author: *marrizabalagaa@alumni.unav.es*

Abstract:

Context and purpose of the study - The current levels of greenhouse gas emissions are expecting to provoke a change on the environmental conditions which, among others, will include a rise of global mean surface temperature and an increment of atmospheric CO_2 levels (IPCC, 2014), known as climate change. The response of grapevine (*Vitis vinifera* L.), one of the most important crops in Europe, from both a cultural and economic point of view, is not completely understood yet and the studies considering the interaction between factors are scarce. Besides, the potential variety of responses among somatic variants needs to be studied in order to be exploited in the avoidance of undesired traits linked to climate change (Carbonell-Bejerano et al., 2015).

Material and methods - The objective was to determine the impact of an increment of atmospheric CO_2 and temperature (both acting independently and combined) on the grape composition of five somatic variants of Tempranillo (CL306, T3, RJ43, 1084 and VN31). Fruit-bearing cuttings were grown from fruit-set to maturity (around 22ºBrix) in temperature gradient greenhouses under two temperature regimes (ambient temperature and ambient temperature + 4ºC) in combination with two CO_2 levels (400 ppm and 700 ppm).

Results - The evolution of sugars (glucose and fructose) and malic acid, as well as the final levels of anthocyanins and the relation of anthocyanins and sugars indicate that grape ripening will be affected by climate change in different manner among somatic variants. High temperatures increased the degradation of malic acid and raised the accumulation of sugars, meanwhile CO_2 levels also promoted the degradation of malic acid especially at maturity. Somatic variants showed differences in the anthocyanin levels at maturity. Total anthocyanins were not dramatically affected by the temperature and CO_2 levels assayed. The CL306 and T3 somatic variants were identified as potential candidates for the adaptation of cv. Tempranillo to climate change.

Keywords: Grapevine, Climate Change, Tempranillo, Sugars, Malic acid, Anthocyanins.

1. Introduction

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Marta Arrizabalaga-Arriazu[1,2,3], Fermín Morales[4,5], Juan José Irigoyen[1], Inmaculada Pascual[1], Ghislaine Hilbert[3]

[1] Universidad de Navarra. Faculty of Sciences. Plant Stress Physiology group, Associated Unit to CSIC (EEAD, Zaragoza, and ICVV, Logroño). Irunlarrea, 1. 31008, Pamplona, Spain.
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[5] Estación Experimental de Aula Dei (EEAD). CSIC. Department of Plant Nutrition. Apdo. 13034, 50080 Zaragoza, Spain.

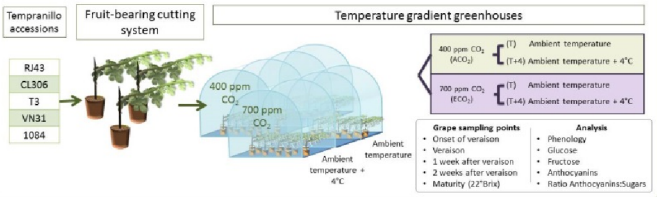
INTRODUCTION & AIM

The current emissions rates of greenhouse gases are expecting to provoke a change on the environmental conditions which, among others, will include a rise of global mean surface temperature and an increment of atmospheric CO_2 levels, known as climate change [1]. The response of grapevine (*Vitis vinifera* L.), one of the most important crops in Europe, both from a cultural and economic point of view, is not completely understood yet and the studies considering the interaction between factors are scarce. Besides, the potential variety of responses among somatic variants needs to be explored in order avoid or minimize the undesired traits in wine production linked to climate change [2].

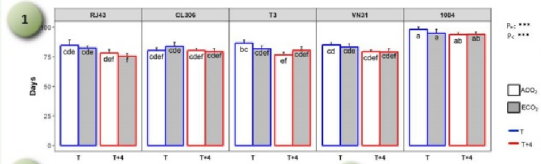
The **objective** was to determine the impact of an **increment** of atmospheric CO_2 **and temperature** (both acting independently and combined) on the grape composition of **five somatic variants** of **Tempranillo** (RJ43, CL306, T3, VN31 and 1084), facilitating the selection of future cultures.

METHODOLOGY

Fruit-bearing cuttings were grown from fruit-set to maturity (around 22°Brix) in temperature gradient greenhouses under two temperature regimes (ambient temperature and ambient temperature + 4°C) in combination with two CO_2 levels (400 and 700 ppm).

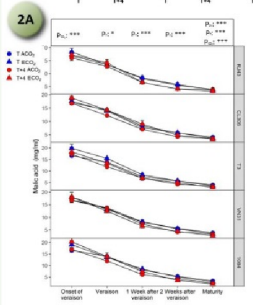


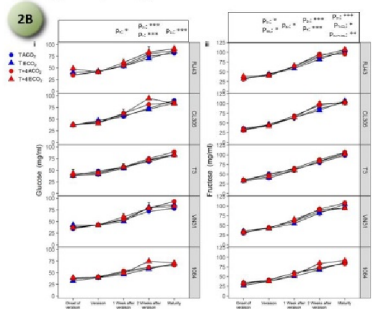
RESULTS

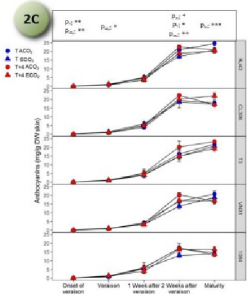


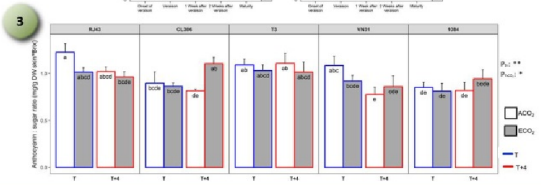
1. Elapsed time between fruit-set and maturity (around 22°Brix) (Values are means ± SE, n=4-8)
2. A. Evolution of malic acid concentration (values are means ± SE, n=4)
   B. Evolution of (i) glucose and (ii) fructose concentrations (values are means ± SE, n=4).
   C. Evolution of total concentration of anthocyanins in dry skin (values are means ± SE, n=4).
3. Anthocyanin and sugar ratio at maturity (values are means ± SE, n=3-4).

*Statistical analysis performed with R (3.5.1), using a three-way ANOVA and Fisher's least significant difference (LSD) as a post-hoc test. Probability (P) values for the effect of the main factors and their interactions are expressed as: *<0.05, **<0.01 and ***<0.001. Means with letters in common are not significantly different (P<0.05) according to LSD test.*









CONCLUSIONS

- **Somatic variants** showed differences in the phenological development (delayed maturity of 1084) and in the concentration of malic acid, sugars and anthocyanins at maturity.
- **T+4** hastened the ripening process, inducing a faster sugar (glucose and fructose) accumulation and increasing the degradation of malic acid from veraison onwards. Levels of anthocyanins two weeks after veraison were also increased by T+4.
- **ECO_2** levels also promoted the degradation of malic acid, especially at maturity, while they increased the concentration of anthocyanins at veraison, reducing them two weeks later. At maturity, however, differences in anthocyanin concentration between plants grown under different CO_2 levels disappeared.
- The anthocyanins:sugars ratio differed among somatic variants. The effect of temperature on this ratio was dependent on the CO_2 level. Whereas T+4 tended to reduce the ratio under ACO_2 conditions, under ECO_2 T+4 tended to increase the ratio in CL306 and 1084.
- The RJ43 accession, one of the somatic variants of Tempranillo more widely cultivated, seemed to be the most affected by climate change (combination of T+4 and ECO_2) in terms of phenology and anthocyanins:sugars ratio. In contrast, **T3 and CL306 stood as interesting somatic variants** to have into account in the future, as their phenological development was less affected by climate change conditions and they maintained a good anthocyanins:sugars balance under T+4 and ECO_2 conditions.

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