Effects of temperature on gas exchange and berry composition in two grapevine varieties

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Introduction

Higher temperatures may accelerate phenology, increase sugar accumulation rate and decrease the phenols synthesis [1]. Photosynthesis increases with temperature until a maximum rate is reached and then it lowers [2,3]. Conversely, stomatal conductance response to temperature has been less predictable and contradictory results were reported [2,3,4]. Previous evidence suggest that temperature responses depend on the variety [5]. Nevertheless, the long-term responses have not been studied in this works.

Objective

The purpose of this study was to evaluate the effect of an increase in temperature during the growing season in gas exchanges, ripening and grape composition in two grapevine varieties with contrasting stomatal behavior.

Materials and methods

The experiment was conducted during the 2016-2017 season in a vineyard located in Mendoza, Argentina. Heated and not heated vines of Syrah and Grenache were compared. Heated vines were passively heated by installing an under-vine tent of polycarbonate from budburst to harvest (Figure 1). Leaf and air temperatures were measured at canopy level. Gas exchange was measured every 15 days, between 10:00 and 12:00 h and between 14:00 and 16:00 h. Berry weight, total soluble solids, pH and global polyphenols parameters were measured every 10 days from veraison to harvest. At harvest, individual anthocyanin, phenols, flavonoids and non-flavonoids compounds were identified and quantified by HPLC-DAD (data not shown).

Results

The heating system increased the temperature at canopy level during the season resulting in a higher degree-days accumulation over the season (1969.2°C in non-heated plants and 2173.5°C in heated plants, Figure 2). Stomatal conductance was higher in Syrah control plants during the morning (Figure 3A) and in Grenache heated plants during the afternoon (Figure 3B). Net photosynthesis (Figure 3C) and transpiration (Figure 3D) were higher only in Grenache heated plants in the afternoon. Regarding grape maturity, heated vines of both varieties presented higher soluble solids concentration (Figure 4A) and higher pH (Figure 4B) than those not heated.

Conclusion

These preliminary results suggest that the responses to an increase in ambient temperature depend on the variety. We found that Grenache (an isohydric variety) increased stomatal conductance, transpiration and carbon assimilation in response to an increase in temperature. By contrast, Syrah (a near-anisohydric variety) decreased stomatal conductance in response to temperature. In terms of maturity, the effects of temperature were similar in both varieties, resulting in higher soluble solids and higher pH.

Figure 1. Passive heating system consisted of under-vine tent of polycarbonate plaques, collocated from budburst to harvest. Mendoza, 2016-2017.

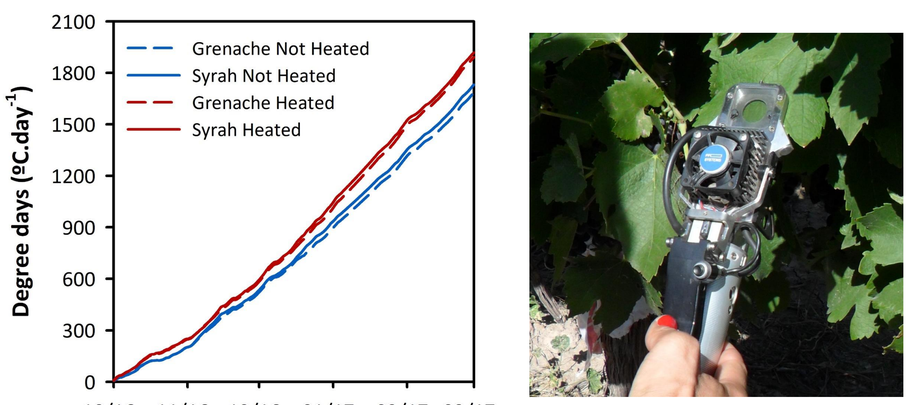

Figure 2. Degree-days accumulation calculated with air temperature measured at canopy level in Syrah and Grenache heated and not heated vines, grown in a vineyard in Mendoza, 2016-2017.

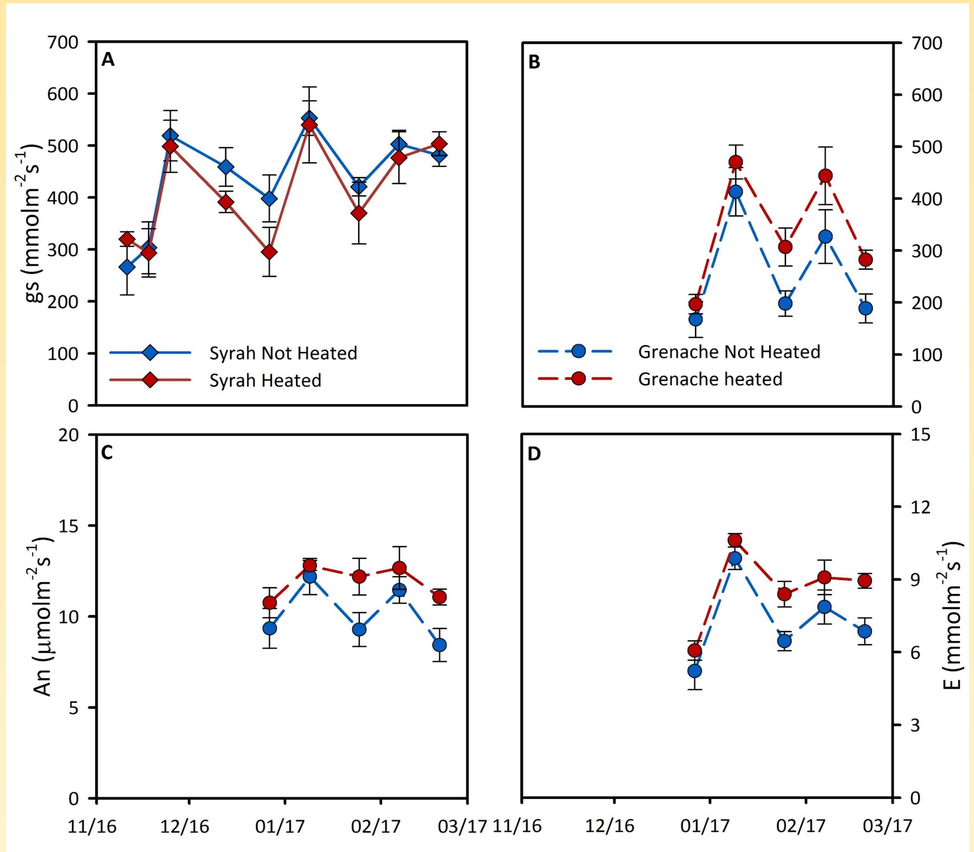

Figure 3. Evolution during the season of (A) stomatal conductance (gs) measured between 10:00 and 12:00 h in field-grown Syrah heated and not heated vines; (B) stomatal conductance, (C) net photosynthesis and (D) transpiration measured between 14:00 and 16:00 h in field-grown Grenache heated and non-heated plants. Data is the mean (n=8) ± standard error. Mendoza, 2016-2017.

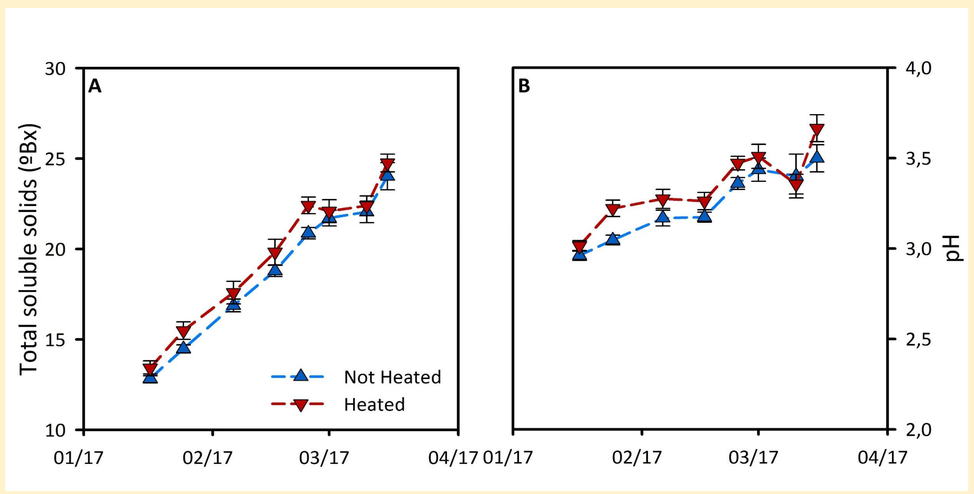

Figure 4. Evolution of (A) total soluble solids and (B) pH in field-grown Syrah and Grenache heated and not heated plants. Data is the mean (n=8) ± standard error. Mendoza, 2017.

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