Effects of climate change scenarios on red and white Tempranillo grapevine (Vitis vinifera L.). Plant growth and grapes respond to a combination of elevated CO2, temperature and dr...
Introduction

Carbon dioxide (CO₂) is the most important anthropogenic greenhouse gas. Its atmospheric concentration has increased from 280 in the pre-industrial era to ca. 389-400 μmol mol⁻¹ air (ppm) and is expected to rise to ca. 700 ppm at the end of this century. An increasing drought in the agricultural areas and rising temperature (between 1.8 and 4.0 °C by the year 2100) are also indirect effects of the increased CO₂ concentration (IPCC, 2007).

Grapevine growth is sensitive to direct environmental factors including water availability, temperature and CO₂. A general response to elevated CO₂ is an increased grapevine growth rate and yield (Bowes, 1993; Rogers et al., 1994; Bindi et al., 1996).

Nevertheless, the global effects of elevated CO₂, and its interaction with drought and elevated temperature, on red and white Tempranillo, which are important in the Spanish wine sector, still need further investigation.

Material and Methods

Grapevine fruit-bearing cuttings were exposed to ambient (ca. 400 ppm) or elevated CO₂ (ca. 700 ppm), combined with ambient (T) or elevated temperature (T + 4°C) and two water regimes (optimum irrigation or cyclic drought) from fruit set to maturity in four temperature gradient greenhouses (Figure 1). Sampling was made at five phenological stages: (I) One week before verasion (equivalent to ca. 60 days after flowering), (II) Mid-veraison, (III) One week after mid-veraison, (IV) Two weeks after mid-veraison and (V) Maturity (21-23 °Brix) (Figure 2).

Results and Conclusions

Results showed that the red Tempranillo produces more leaf area and yield (berry bunch weight) than the white one (Figures 5 and 6). The increased growth and production of the red variety had as a consequence a higher water consumption and soil water depletion (Figure 3). Drought decreased leaf area in both varieties of all treatments (Figure 6). Leaf water content (expressed either per leaf area or per leaf dry weight) showed generally no remarkable differences in both varieties in any of the treatments. Only in the first sampling, some differences were observed; the elevated CO₂ well-irrigated ambient temperature treatment in both varieties had the highest leaf water contents (Figure 4). Elevated temperature reduced leaf area growth in both varieties of all treatments. Elevated CO₂ however tended to increase leaf area in all treatments (Figure 6). In summary, results indicate that climate change (elevated CO₂, elevated temperature and drought) affects red and white Tempranillo growth and yield.

References


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