

Drought lessons: long-term effects of climate, soil characteristics, and deficit irrigation on yield and quality under high atmospheric demand in the Douro Region

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Abstract:

Context and purpose of the study – Global warming is one of the biggest environmental, social and economic threats in several viticultural regions. In the Douro Valley, changes are expected in the coming years, namely an increase in temperature and a decrease in precipitation. These changes are likely to have consequences for the production and quality of wine.

The aim of this study was to explore the effects of soil characteristics combined with deficit irrigation strategies, managed throughout ETC references and predawn leaf water potential thresholds, covering physiology, yield, and qualitative attributes of the Touriga Nacional variety in years of mild to severe water and heat stress.

Material and methods – The study was conducted over eight years (2015 to 2022) in a commercial vineyard located at Quinta do Ataíde (Symington Family Estates) planted in 2011 at 170 meters elevation, growing under two regimes: non-irrigated (NI) and deficit irrigation strategy (DI - 30% ETC) evaluated weekly by Ψ_{pd} . Irrigation start at Ψ_{pd} (-0,35 to -0,40) and finish on average one week before harvest. The site has an annual rainfall below 500 mm, with high atmospheric demand. Climate data was collected from a weather station, located on site. Berry ripening was tracked weekly for fruit analysis. To this work only use the data sampled each year, six weeks after veraison. At harvest, yield, vigour and pruning weight per vine were determined from 90 vines by treatment. Each season at veraison the NDVI Index was accessed through drone images. The soils' physic-chemistry in the experimental blocs were analysed and grouped by SWHC. Delta C-13 analyses were also performed per treatment over a two-year period. This experimental parcel is located in one schist derived soil from a geological formation "Desejosa" with chlorite phyllites, with intercalations of metasilites and metagreywackes, that normally lead to soils with low water holding capacity. For complementary information, the parcel was split into three soil blocks with distinct SWHC and organic matter percentages (data not show).

Results – General results from the two irrigation strategies shows deficit irrigation to have a positive effect on yield per vine, preserving a desired yield compared to de NI, reflected mainly through an combination between a berry and cluster weight, and the fertility index through the years. No significant effect was observed in sugar and acidity through the years. Data shows a impact of the years of higher water and heat stress (2017 and 2022) in the NI treatments, and a decrease in fertility after 2020 (10 years after plantation), higher than expected to the variety, probably due to warmer conditions in bud fruitfulness, which lead to a reduction in yield in the following years. Examining the soil characteristics we get mixed results with the blocks with medium fertility and water storage, showing a better compromise between yield, quality, preservation of the vine reproductive structure, and optimized water stress confirmed by the Ψ_{pd} and $\delta^{13}C$.

Keywords: Climate, Soil, Deficit Irrigation, Touriga Nacional, Yield, Quality, Douro Region.