



Long-term drought resilience of 13 traditional red grapevine cultivars from a semi-arid region

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INTRODUCTION

The future of viticulture is seriously threatened by climate change and its evolution in the coming years. Water availability is a shortage of water is threatening the yield and quality of vine growing worldwide. In semi-arid climate regions, such as Castilla-La Mancha (Spain), vineyard profitability is highly dependent on water availability. In conditions of water scarcity, the sustainability of the wine sector in the medium and long-term may be compromised. The selection of drought-adapted cultivars can be decisive in ensuring the sustainability of vineyards and the quality of yields.

In the present study, 13 Spanish red cultivars authorized for cultivation in Castilla-La Mancha region were monitored for three years (2018-2020) under drought conditions in a multivarietal vineyard. Vine responses were evaluated mainly based on agronomic indicators, including yield, must quality and vegetative development. As indicators of WUE and transpiration, we used $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$, respectively.

RESULTS AND DISCUSSION

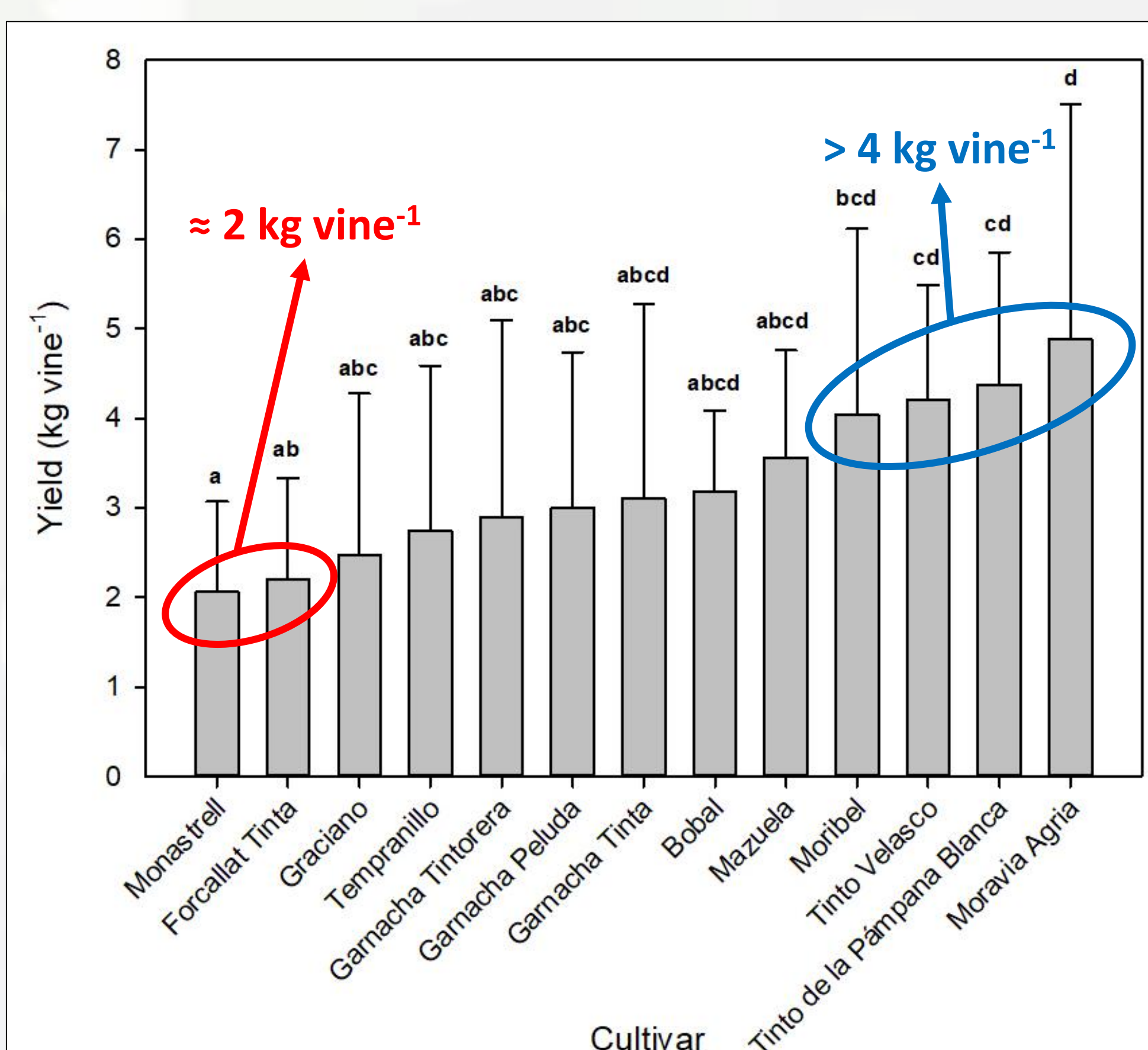


Figure 1. Mean yield in different varieties ($n = 15$). Different letters indicate statistical differences among varieties by S-N-K test (ANOVA, $p < 0.001$)

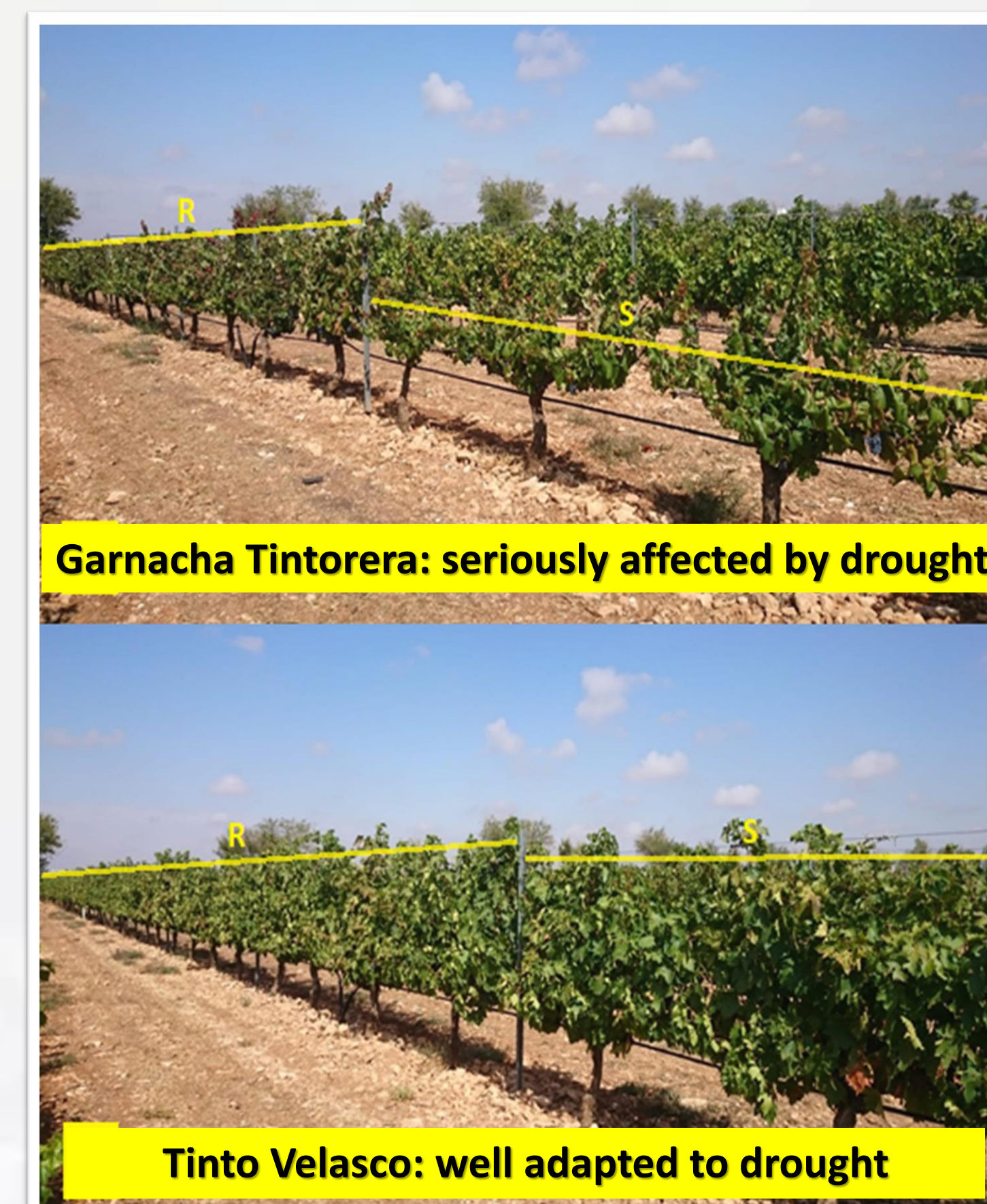
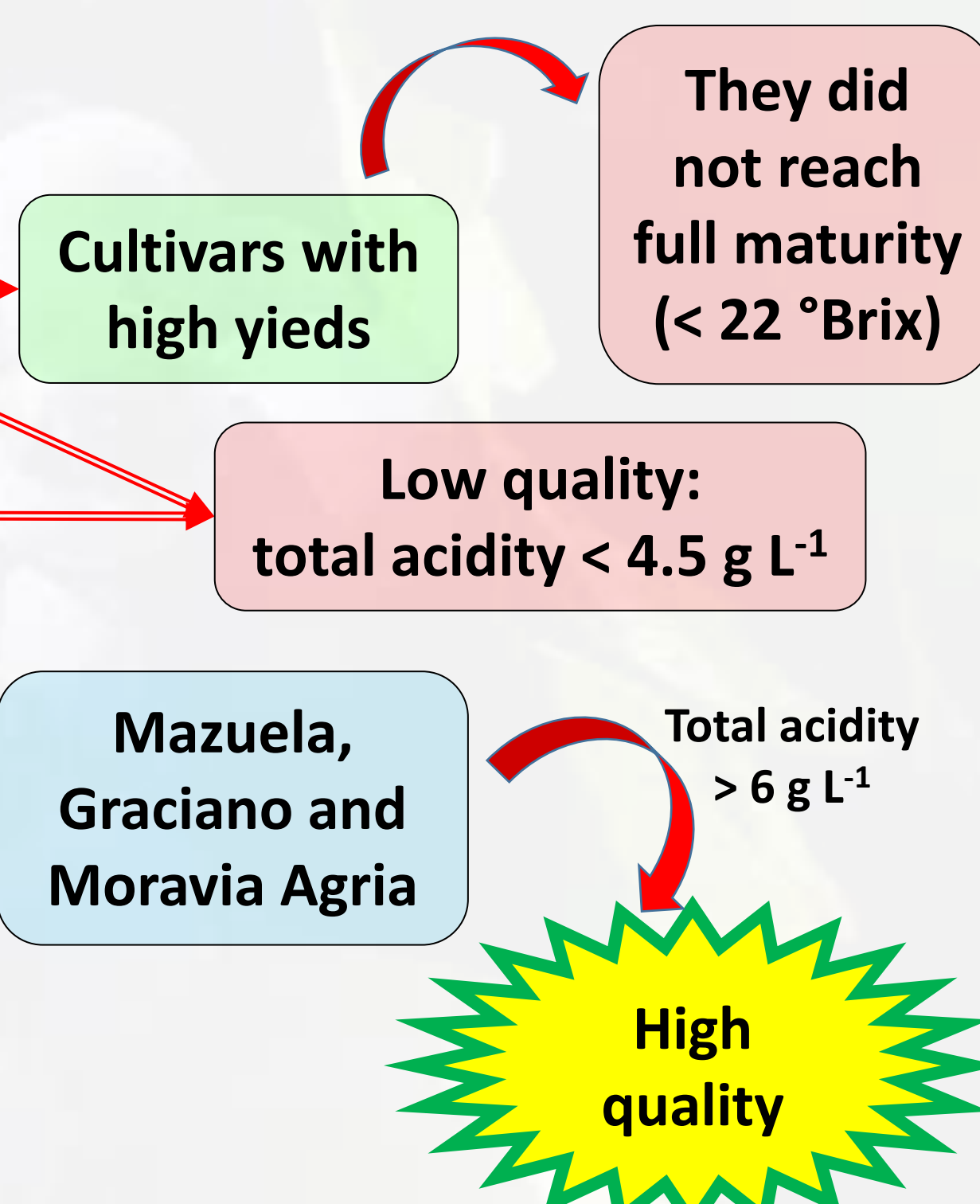


Figure 2. Different behaviour of varieties under drought conditions. Vines grown under drought (S) and irrigated (R) conditions. Yellow lines represent canopy height at veraison.

Table 1. Must quality parameters ($n = 15$)

Cultivar	Total soluble solids (°Brix)	Total acidity (g L ⁻¹)	pH
Moravia Agria	20.27 a	6.58 f	3.12 ab
Garnacha Tintorera	20.83 ab	4.29 b	3.34 cd
Tinto de la Pámpana Blanca	21.09 abc	4.88 bc	3.26 bcd
Tinto Velasco	21.65 bcd	4.85 bc	3.37 cd
Forcallat Tinta	22.11 cde	3.57 a	3.43 cd
Tempranillo	22.39 cdef	4.21 b	3.45 d
Mazuela	22.71 defg	6.09 ef	3.26 bcd
Monastrell	22.92 defg	4.81 bc	3.37 cd
Garnacha Tinta	23.53 efg	4.83 bc	3.26 bcd
Moribel	23.55 efg	5.54 cde	3.31 cd
Bobal	23.74 fg	5.80 de	3.36 cd
Garnacha Peluda	24.12 g	5.30 cd	3.23 bc
Graciano	26.32 h	6.52 f	3.06 a

Different letters in the same column denote statistically significant differences among cultivars (ANOVA, S-N-K test, $p < 0.001$).



Mean VDP of the week immediately before harvest explained up to 74% of the variability of $\delta^{18}\text{O}$ in musts

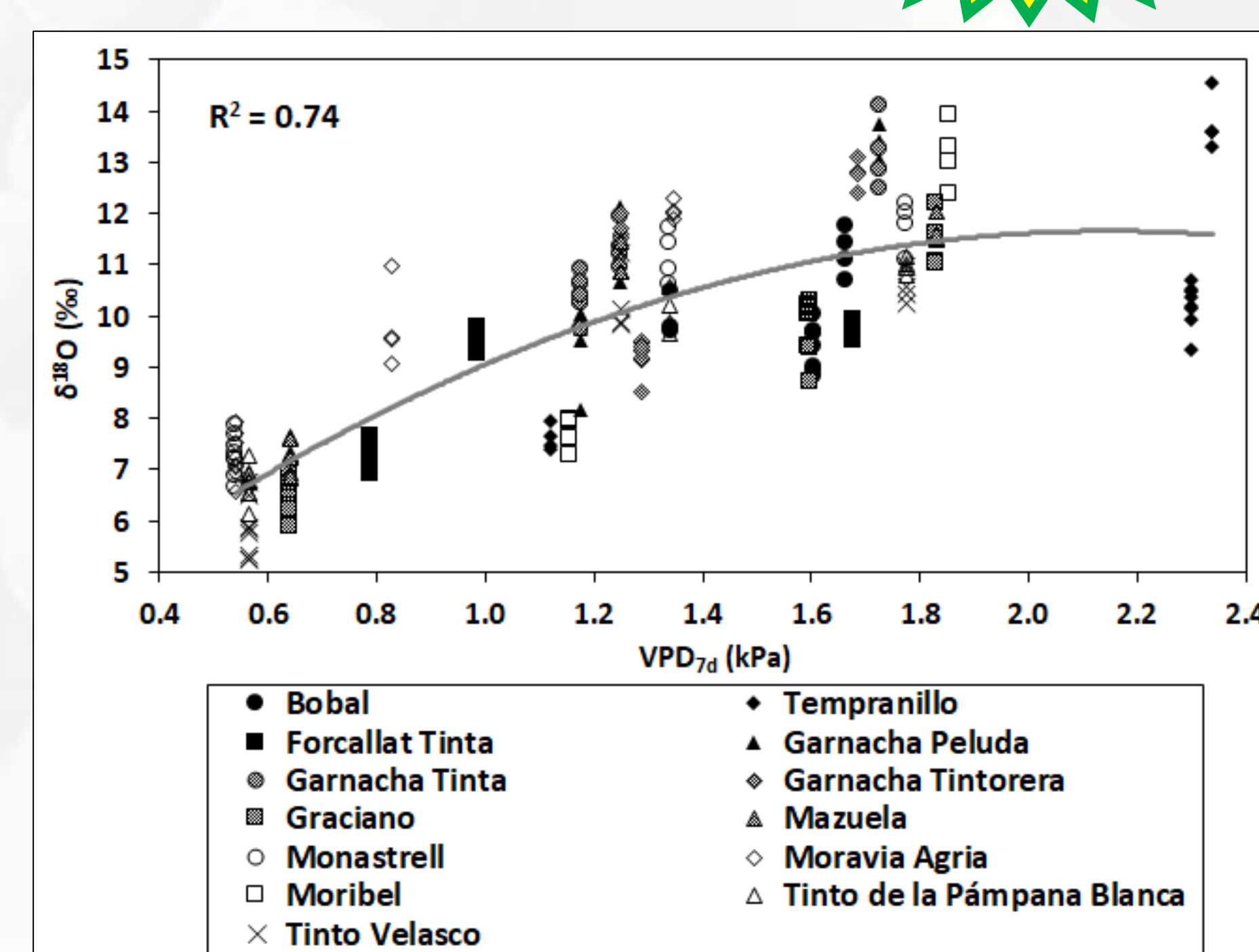
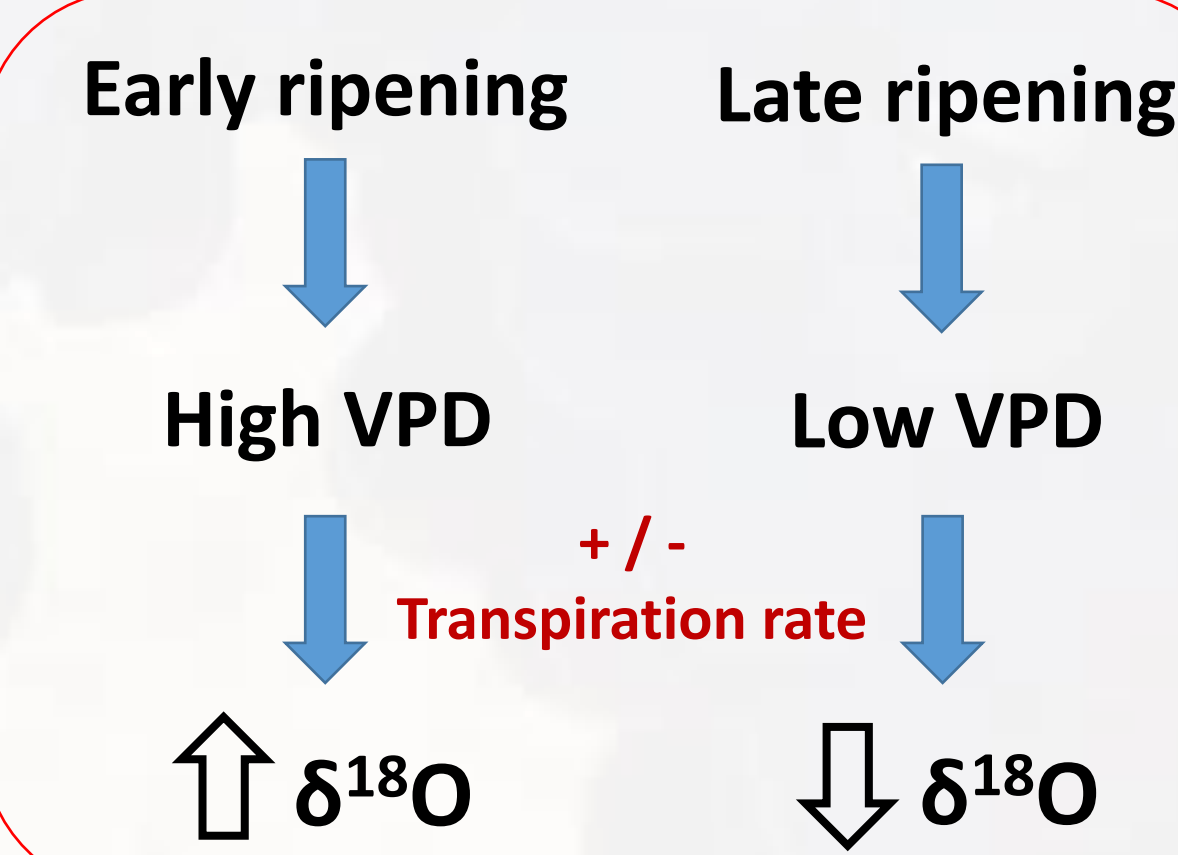
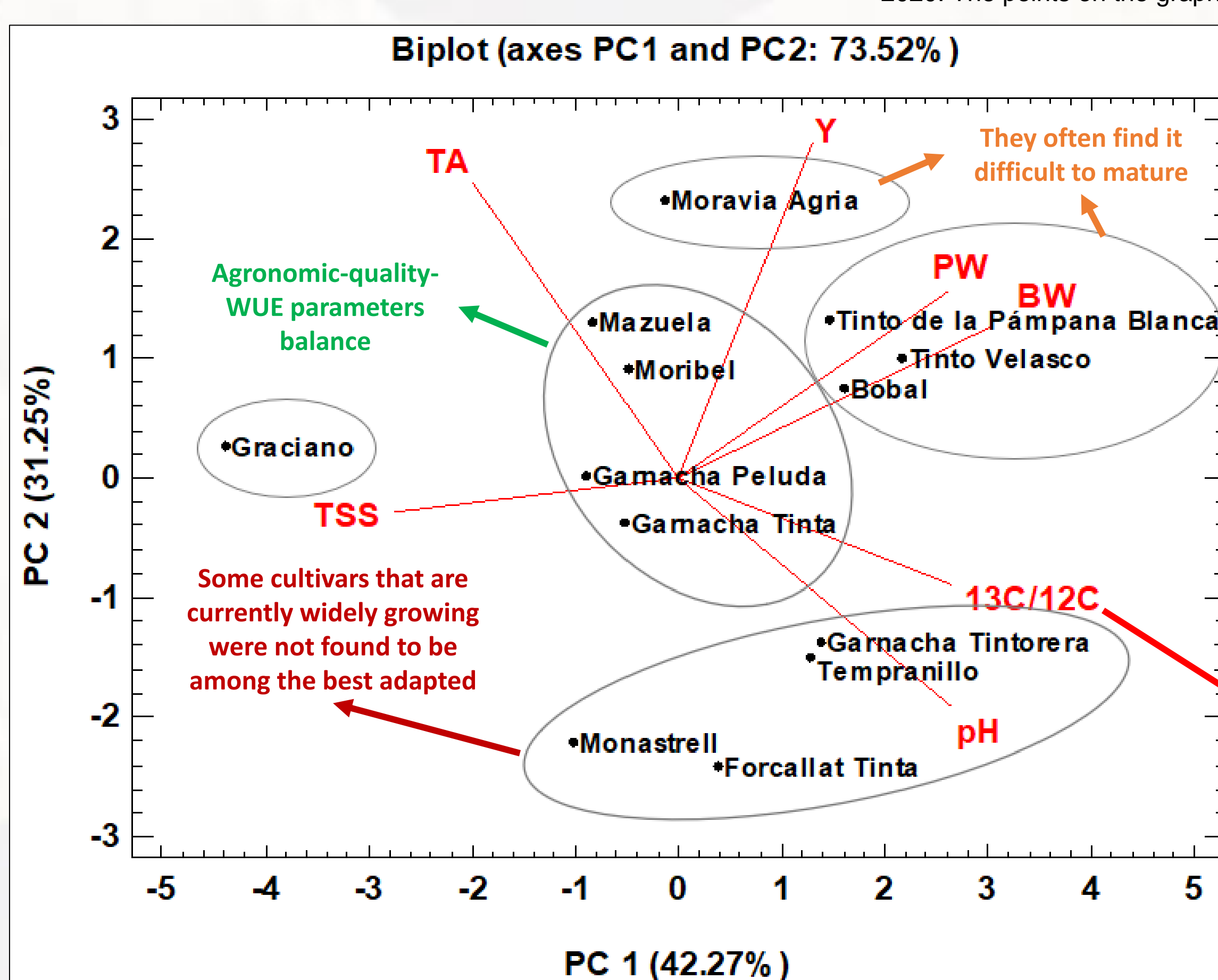


Figure 3. Relationship between $\delta^{18}\text{O}$ and VPD_{7d} for 13 red cultivars from 2018 to 2020. The points on the graph represent the $\delta^{18}\text{O}$ and VPD_{7d} of the individual vines.



A PCA analysis was performed with the main variables measured to better understand the effects of drought on the cultivars

Five well-defined drought response groups were identified

All cultivars had mean values > -24 ‰

Severe stress

Figure 4. PCA implemented with the mean values of the main variables measured in the study. TSS: total soluble solids, TA: total acidity, Y: yield, PW: pruning weight, BW: berry weight, 13C/12C: $\delta^{13}\text{C}$; pH: pH.

MATERIALS AND METHODS



EXPERIMENTAL SITE

- Experimental vineyard at IRIAF (Tomelloso, Spain)
- Continental semiarid mediterranean climate
- Petrocalcic calcixerept soil with 30 cm depth



VARIETIES

- Water regime: 30 mm/season
- Study: 22 vines
- Sampling: 5 vines/season
- Yield components analyzed:
 - Yield
 - Berry weight
 - Pruning weight



MUSTS

- Quality parameters:
 - Total soluble solids
 - Total acidity
 - pH
- Physiological parameters:
 - $\delta^{13}\text{C}$
 - $\delta^{18}\text{O}$

CONCLUSIONS

This study has allowed us to verify the variability that exists between cultivars in terms drought response. Among the cultivars best adapted in terms of drought were Garnacha Peluda, Garnacha Tinta, Mazuela and Moribel, which showed the best balance between all the parameters analyzed. Among the worst adapted cultivars were Forcallat Tinta, Garnacha Tintorera, Monastrell and Tempranillo, which, although they were efficient in their use of water, their agronomic parameters were unbalanced and the musts showed low quality. In the next future, in order to maintain adequate yields and quality, it is likely to increase the cultivation of some of the cultivars highlighted in this study for their good behavior under drought conditions.