Genotypic variability in root architectural traits and putative implications for plant water uptake in grafted grapevine.

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Background and objectives

- Root System Architecture (RSA) is important for soil exploration and edaphic resources acquisition by the plant, and thus contributes largely to its productivity and adaptation to environmental stresses, particularly soil water deficit (Archer et al. 2018)
- In grafted grapevine, while the degree of drought tolerance induced by the rootstock has been well documented in the vineyard (Smart et al. 2006), information about the underlying physiological processes, particularly at the root level, is scarce (Ollat et al. 2017), due to the inherent difficulties in observing large root system in situ (Krzyzaniak et al. 2021).
- The objectives of this study were to determine genetic differences in the RSA traits and their relationships to water uptake in two young *Vitis* rootstocks genotypes differing in their adaptation to drought.

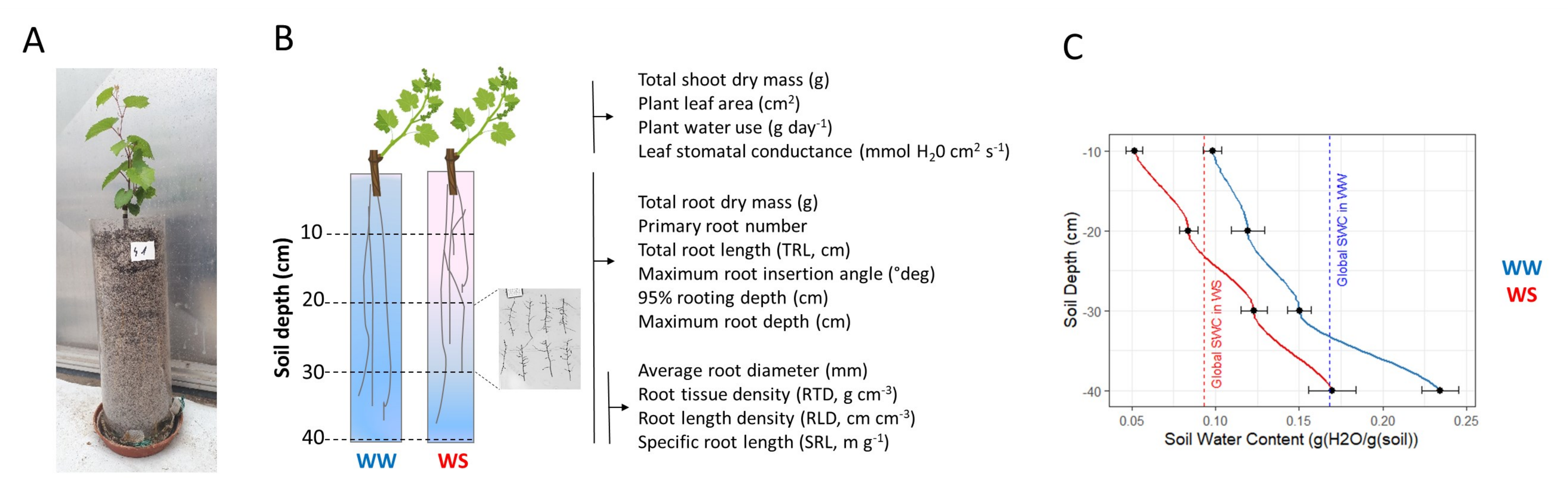

Figure 1 : Illustrations of the experimental design, **(A)** Potted plant after 30d of growth under control condition, **(B)** Shoot and root phenotypic traits measured on each plant, **(C)** vertical profile of soil water content in control (**WW**) and water stressed (**WS**) pots.

Experimental pipeline

1. *Vitis vinifera* cv Riesling scions were grafted on 2 rootstock genotypes : 140 Ruggeri (**140Ru**) considered as tolerant to water stress and Riparia Gloire de Montpellier (**RGM**) considered as sensitive to water stress.
2. Plants were grown in 40 transparent tubes (40cm high) for 4 weeks : 1 week of acclimatization and 3 weeks under two soil water regimes (**WW** : irrigation to 90% of field capacity, **WS** : no irrigation until reaching 50% of field capacity).
3. The amount of transpired water was measured gravimetrically twice a week.
4. For each tube, root traits were analyzed after 30d in 4 soil layers by digital imaging using a 2D flatbed scanner and Rhizovision software. ***(Fig 1)***

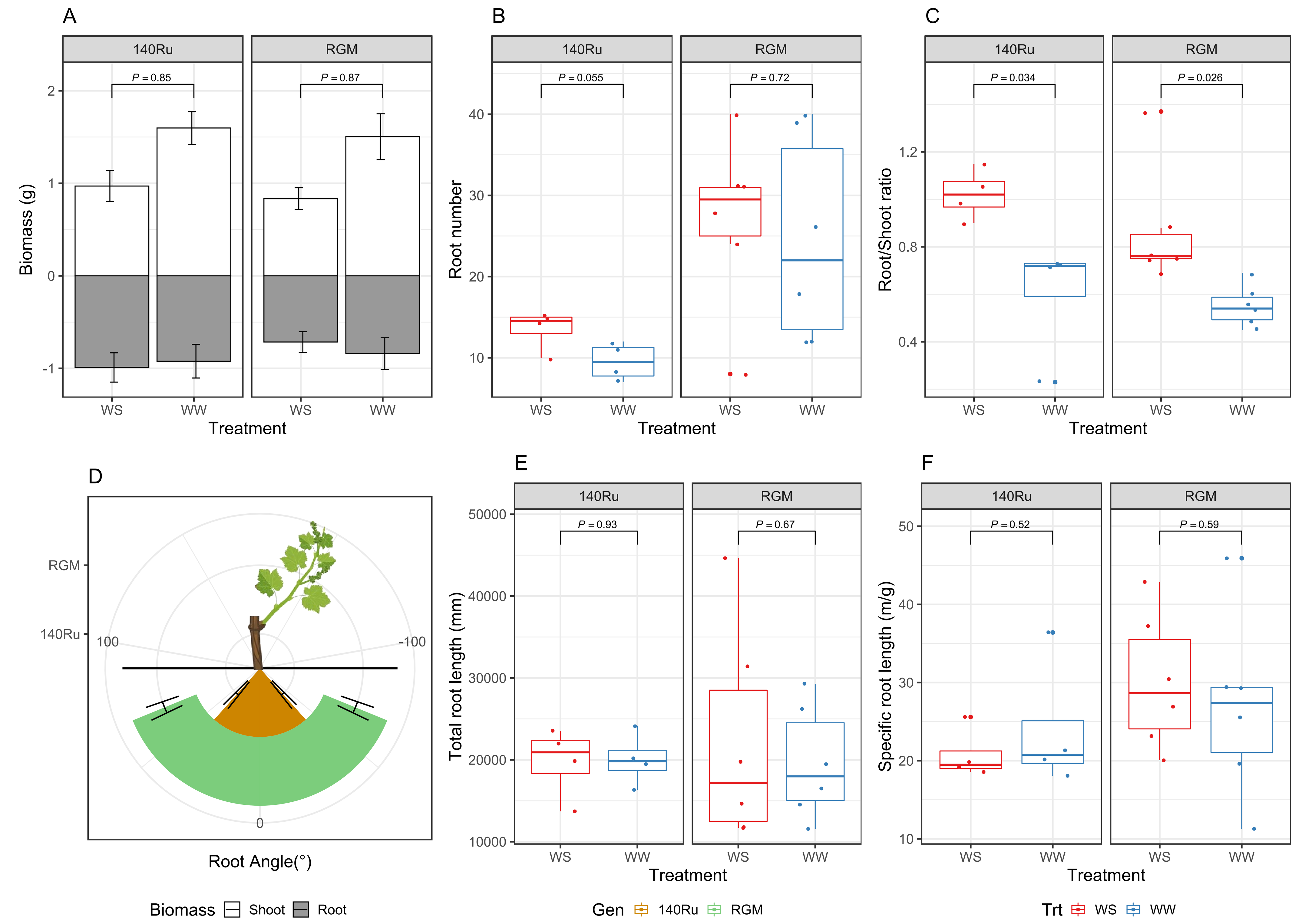

***Figure 2*:** Phenotypic traits after 30d of growth for the 2 rootstock under 2 water regimes, **(A)** plant dry mass allocation, **(B)** total primary root number, **(C)** root/shoot ratio, **(d)** maximum root insertion angle, **(e)** total root length, **(f)** specific root length.

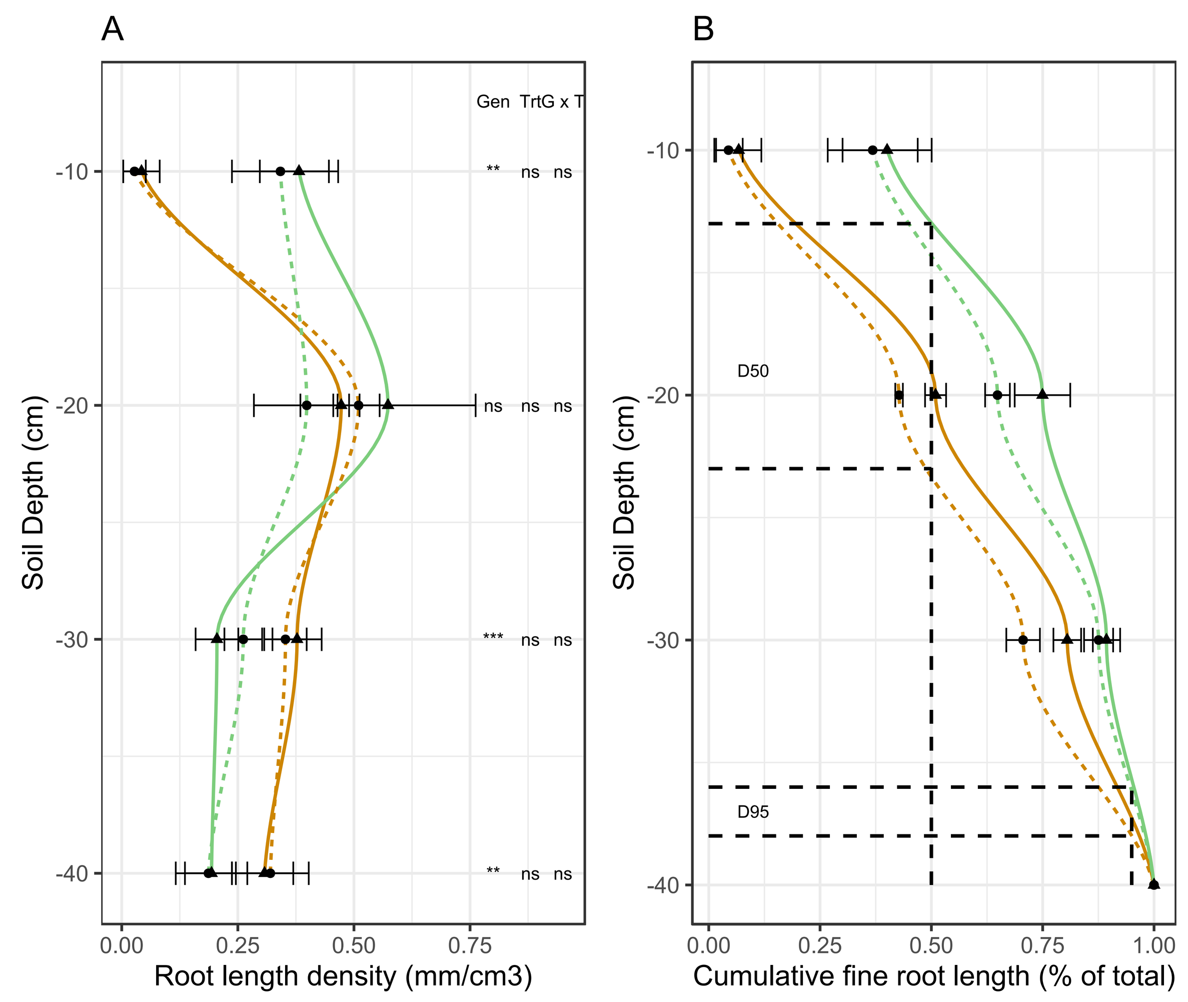

Figure 3 : Vertical distribution of 2 root traits after 30d of growth, **(a)** root length density, **(b)** cumulative root length of fine roots (diameter <1mm) (WW --- ; WS - - -)

Keys results & take-home message

- Root phenotyping after 30d revealed substantial variation in RSA traits between rootstock genotypes, despite similar total root mass (**Fig 2A**).
- 140Ru showed higher root length density in the deep layer (**Fig 3A**), while RGM was characterised by shallow-angled root system development (**Fig 2D**) with more basal roots (**Fig 2B**) and a larger proportion ine fine roots in the upper half of the tube (**Fig 3B**).
- Water deficit affected canopy size and shoot mass (**Fig 2AC**) to a greater extent than root development and architectural-related traits for both 140Ru and RGM (**Fig 2ED**); no difference in vertical distribution of RSA traits were observed between WW and WS (**Fig 3AB**), probably due to the low intensity or the short period of stress.
- The deeper root system of 140Ru as compared to RGM correlated with greater daily water use (**Fig 4**).

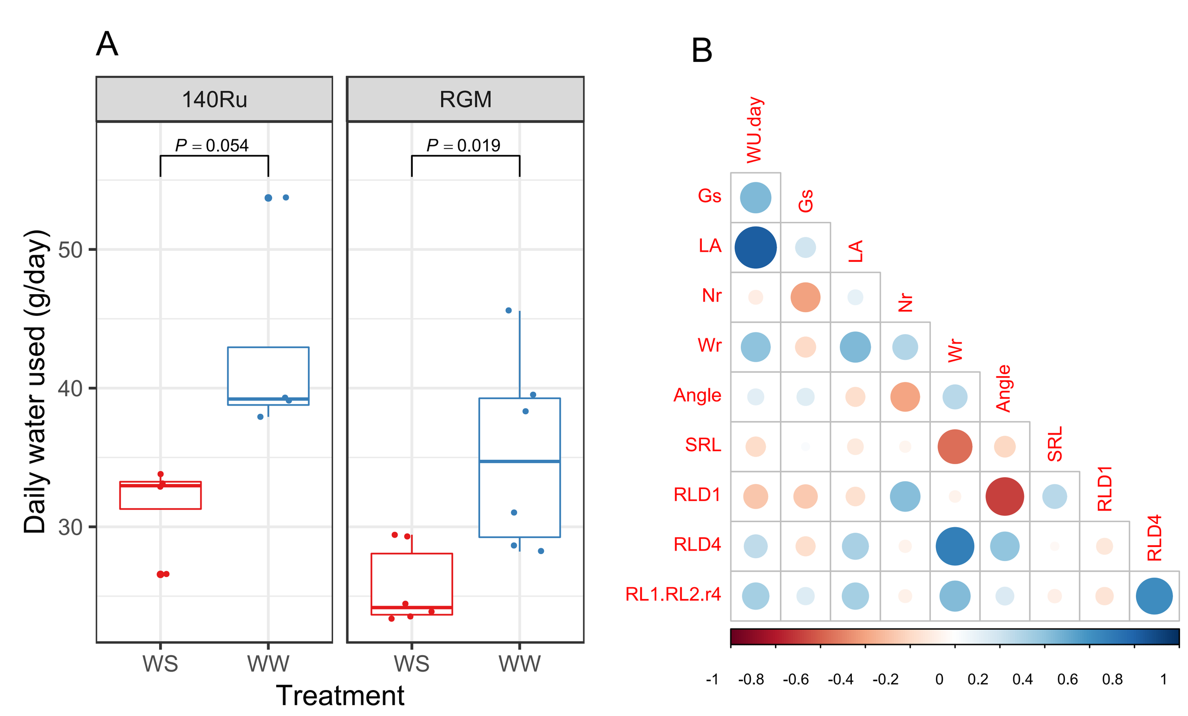

Figure 4 : Relationships between plant water used and phenotypic traits after 30d of growth for the 2 rootstock under 2 water regimes.

References

Archer et Saayman 2018, in Vine roots.

Krzyzaniak et al. 2021, Front. Plant Sci.

Ollat et al. 2017, Act. Hort.

Smart et al. 2006, Am. J. Enol. Vitic.

Our results highlight that grapevine rootstocks have constitutively distinct RSA phenotypes and that, in the context of climate change, those that develop an extensive root network at depth may provide a desirable advantage to the plant in coping with reduced water resources.