Genotypic differences in early-stage root architectural traits and consequences for water uptake in three grapevine rootstocks differing in drought tolerance.

Mathieu LARREY[1*], Louis BLOIS[1,2], Jean-Pascal TANDONNET[1], Clément SAINT CAST[1], Marina DE MIGUEL VEGA[1], Elisa MARGUERIT[1] and Philippe VIVIN[1]

[1]*EGFV, Univ. Bordeaux, Bordeaux Sciences Agro, INRAE, ISVV, Villenave d'Ornon, France*
[2]*Department of Viticulture, Hochschule Geisenheim University, Germany*

*Corresponding author: mathieu.larrey@inrae.fr

Abstract:

Context and purpose of the study – Root architecture (RSA), the spatial-temporal arrangement of a root system in soil, is essential for edaphic resources acquisition by the plant, and thus contributes largely to its productivity and adaptation to environmental stresses, particularly soil water deficit. In grafted grapevine, while the degree of drought tolerance induced by the rootstock has been well documented in the vineyard, information about the underlying physiological processes, particularly at the root level, is scarce, due to the inherent difficulties in observing large root systems *in situ*. The aims of this study were (i) to determine the phenotypic differences in traits related to root distribution and morphology along the substrate profile in different *Vitis* rootstocks during early growth, (ii) to assess the plasticity of these traits to soil water deficit and (iii) to quantify their relationships with plant water uptake.

Material and methods – *Vitis vinifera* cv Riesling were grafted on three rootstocks genotypes : 140Ru and 110R considered as tolerant to water stress and RGM as sensitive. Plants were grown in a glasshouse for 4 weeks either in rhizotrons and in transparent tubes (40cm height) and submitted to two substrate water regimes (WW, irrigation to 90% of field capacity; WD, no irrigation until reaching 50% of field capacity). In the tube experiment, the amount of transpired water was measured gravimetrically three times a week. In both trials, RSA traits were analyzed by 2D digital imaging using SmartRoot and RhizoVision software.

Results – Root phenotyping after 30 days revealed similar total root biomass between RGM and 140Ru greater than 110R, but there are substantial variations in RSA morphological traits between rootstocks.The drought-sensitive RGM was characterized by shallow root system development, with more primary roots and a larger proportion of laterals roots in the upper half of the rhizotrons or tubes. In contrast, the drought-tolerant rootstocks 140Ru and 110R were characterized by fewer, more plunging roots and showed proportionately a higher root length density in the deep layer. Water deficit affected canopy size and shoot mass to a greater extent than root development and architectural-related traits for all three rootstocks ; suggesting vertical distribution of roots was more influenced by genotype than plasticity to the soil water regime, at least in our experimental conditions. The deeper root system of 140Ru compared to RGM correlated with greater daily water uptake and sustained stomata opening under water-limited conditions but had little effect on aboveground growth. 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.

Keywords: Root system architecture, Root traits, Water uptake, Drought tolerance, Genotypic diversity, Rootstock, Grapevine.