Open Conference on Grapevine Physiology and Biotechnology
LOGROÑO - LA RIOJA
7-11 July 2024

Towards a better understanding of the root system diversity and plasticity in young grafted vines using 2D imaging and 3D modelling tools.

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Abstract

Three-dimensional functional-structural root architecture models, which decompose the root system architecture (RSA) into elementary developmental processes such as root emission, axial growth, branching patterns and tropism have become useful tools for (i) reconstructing *in silico* the spatial and temporal dynamics of root systems in a soil volume, (ii) analyzing their genotypic diversity and plasticity to the environment, and (iii) overcoming the bottleneck associated with their visualization and measurement *in situ*. Here, we present an original work on RSA phenotyping and modelling in grapevine. First, we developed 2D image-based analysis pipelines to quantify morphological and architectural traits in young grafts. Second, we parametrized and validated the 3D root model Archisimple on two rootstock genotypes (RGM, 1103P) grafted with *V. vinifera* Cabernet-Sauvignon and grown in different controlled conditions (rhizotrons, pots, tubes). Finally, we experimentally studied the sensitivity of RSA to initial carbon availability using hardwood cuttings of different lengths (8, 20, 30 and 50 cm). Results showed that the number of adventitious roots and their emergence rate were affected by changes in cutting length, whereas RSA traits related to elongation and branching remained relatively stable. Simulated root systems differed between rootstocks, with RGM having more shallow roots and less deep root length density than 1103P. This study highlighted how a modelling approach provides a deeper understanding of the genetic, environmental, and endogenous factors that determine rooting ability and early development of RSA. This knowledge can be applied in nurseries, for example, to improve the successful establishment of grafted vines after planting.

Keywords: root system architecture, functional-structural root architecture model, root phenotyping, rootstock