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Real-time spatial analysis of root water uptake in rhizotrons

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Nowadays, drought is a major constraint on crop production and becomes increasingly prevalent. The availability of water for plants defines constraints for stomatal conductance (which affects photosynthesis and yield) and is critical at several sensitive phenological stages, such as flowering and grain filling (some may have irreversible effects). It is therefore important to improve the capacity of plants to use and uptake water in various environmental conditions.

The availability of water is defined by (i) soil exploration (root architecture), (ii) conductivity of individual root segments and (iii) quantity and capacity of bulk-to-rhizosphere water flow. These factors must be considered simultaneously if we aim at tailoring root architecture to improve water stress tolerance.

We propose a combination of tools based on thin 2D rhizotrons that allows both root architecture and soil water content to be monitored. This experimental platform is combined with two models. One generates a 3D root system with hydraulic conductivities of individual roots as a function of age, type… The second model (R-SWMS) simulates root water uptake and soil water transfer, based on 3D root and soil hydraulic properties.

This platform is used to study how various aspects of root systems dynamics (such as regulation by aquaporins or ABA, root architecture) interfere with root water uptake using a quantitative approach.