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Combining MRI techniques and modelling for characterizing root hydraulic properties of a white lupine plant

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Despite its importance for understanding transpiration regulation and soil water fluxes, characterizing the distribution of root water uptake and its evolution over time is still challenging. Measurements of root hydraulic properties are feasible with standard techniques (root pressure probe, pressure chamber, high pressure flow meter...) but these methods are destructive and time consuming. Moreover, the evolution of root properties with time is hardly achievable. In this study, we combined experiment and modelling to characterize in situ plant root hydraulic properties.

We monitored for seven days the leaching of a tracer through a column with a growing root system of a white lupine plant. After six days, the irrigation of the tracer was stopped to enhance the tracer accumulation around roots. We used Magnetic Resonance Imaging (MRI) to get daily three-dimensional root architecture and solute distribution. Then, the plant-soil system was modelled with R-SWMS (Javaux et al, 2008), a 3D model that provides water and tracer dynamics in the soil-plant system. An optimisation was performed to retrieve the root hydraulic parameters during the solute accumulation stage.

R-SWMS was proven to be a convenient tool for modelling 3D tracer dynamic in a planted soil column. Furthermore, data obtained by MRI (i.e. the 3D solute accumulation around roots) was shown to be informative enough to optimize root hydraulic properties and their evolution over time.

In conclusion, the combination of experiment and modelling seems to be needed and useful for characterizing root hydraulic properties in 3D systems.