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Comparison of MRI techniques and modelling with R-SWMS for determining solute distribution patterns and root water uptake of a white lupine plant (Lupinus Albus L.).

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Measuring water extraction by plant would allow us to better understand root water uptake processes and how soil and plant properties affect them. Yet, direct measurement of root water uptake is still challenging and determining its distribution requires coupling experimentation and modelling. In this study, we investigated how the 3D monitoring of a tracer movement in a sand container with a lupine plant could inform us about root water uptake process.

A sand column (10 cm height, 5 cm inner diameter) planted with an 18-day-old white lupine was subject to a tracer experiment with a chemically inert tracer (1 mmol/L Gd-DTPA2-) applied for 6 days. Then the tracer and water fluxes were stopped. The plume was monitored in 3-D for 7 days by Magnetic Resonance Imaging (Haber-Pohlmeier et al, unp). In addition the breakthrough curve at the outlet was also measured.
We used a biophysical 3-D soil-plant model: R-SWMS (Javaux et al, 2008) to extract information from this experiment.

First, we ran a virtual experiment to check the assumption that Gd concentration increase around roots is proportional to the extracted soil water during the same period. We also investigated whether this type of experiment helps discriminate different root hydraulic properties with a sensitivity analysis.

Then, we compared the experimental and simulated Gd concentration patterns. A preliminary (qualitative) assessment showed that measured Gd distribution patterns were better represented by the model at day 7, where the main driver of the concentration distribution was root and not soil heterogeneity (which is not taken into account in the model).
The main spatial and temporal features of the transport where adequately reproduced by the model in particular during the last day. The distribution of the tracer was shown to be sensitive to the root hydraulic properties.

To conclude, information about root water uptake distributions and so about root hydraulic properties could be deduced from Gd concentration maps.

Keywords: R-SWMS; Modelling; MRI; Root Water Uptake; Gadolinium