Combining *in vivo* and *in silico* experiments to unravel root water uptake dynamics

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Introduction

Water flow inside the soil-plant-atmosphere continuum is thought to be regulated by a handful of key hydraulic resistances: in the soil, across root tissues, inside the xylem and across leaf tissues and stomata.

Unfortunately, while some resistances can be easily measured, others remains challenging. In this study we used a combinaison of experimental and computing tools to decrypt the interplay between these resistances and their influence on the water uptake dynamics

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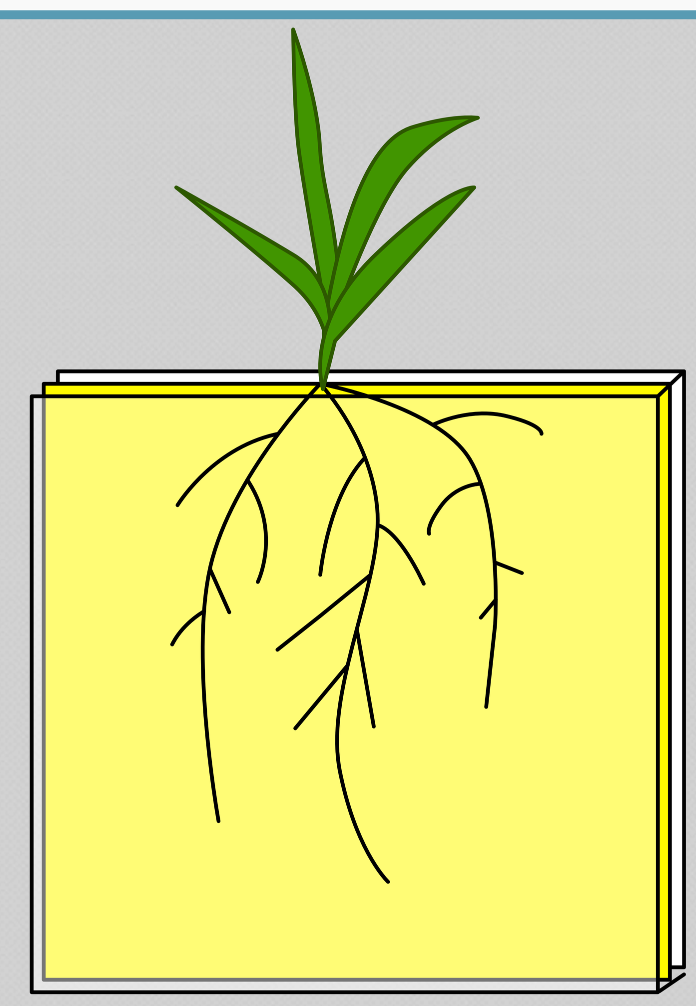


Plant growth

Maize plants were grown in 2D rhizotrons in order to monitor root architecture and soil water content variations (see below).

Maize plants were grown during 14 days in 2D rhizotrons (fig. 1) with a sufficient water supply. After this period and during three days, water supply was stopped to induce a drought episode.

At the end of the drought episode, root and shoot were scanned individually.

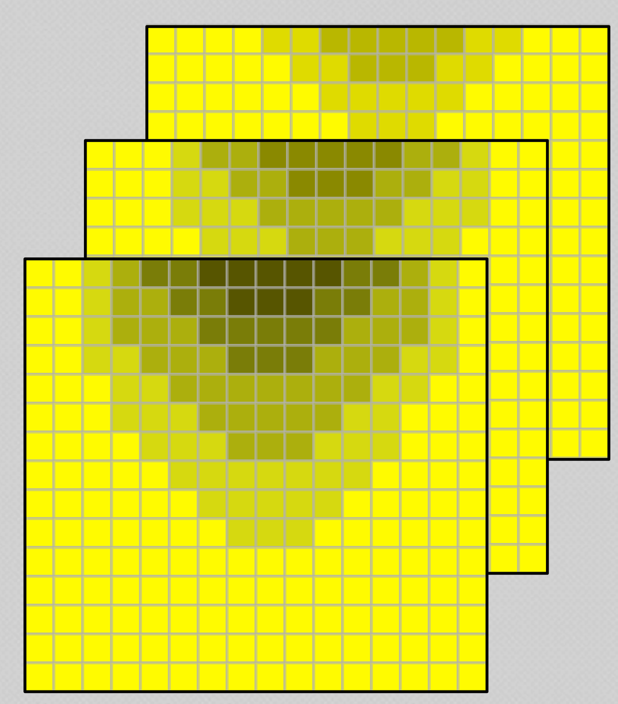
Soil water content

Variations in soil water content were observed using the light transmission imaging method [Garrigues *et al.* 2006].

The resulting images showed a downward progression of the uptake zone and a quick apparition of a dry zone near the plant collar (fig. 2).

See the Results

2



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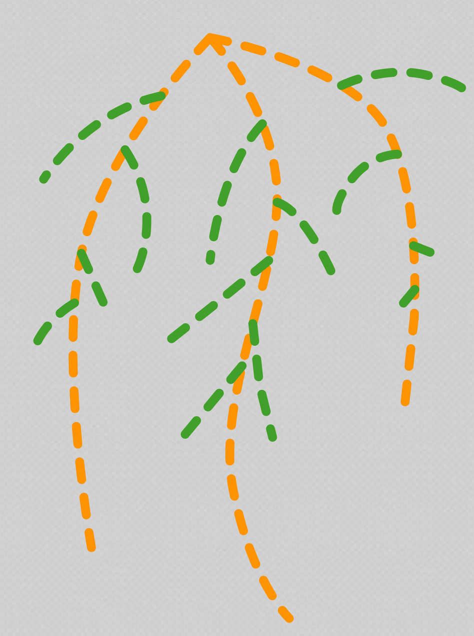

Root system

Root systems were divided in different root axes, which were scanned individually in order to avoid root overlap and crossing.

After the scanning process, roots were digitized using SmartRoot [Lobet *et al.* 2011] (fig. 3). Root segment localisation, morphology and topology were conserved and transformed into an R-SWMS input file.

Using models to help decrypt the water dynamics

R-SWMS is an HYDRUS-like model that expicitely simulates water flow in the soil-root system [Javaux *et al.* 2008].

Digitized root systems as well as rhizotron soil characteristics were used as an input file to run simulations in R-SWMS.

The expected correlation between soil water depletion (fig. 4) and local water uptake (fig. 5) was blurred by the soil redistribution capacity and the constrains imposed by root architecture.

As a consequence, the soil water content variations observed experimentally cannot be used as a proxy of local root water uptake.

This finding has practical implications for researchers as most of the techniques used to analyse water flows in the soil-root system rely on differences in soil water content.

See the Results

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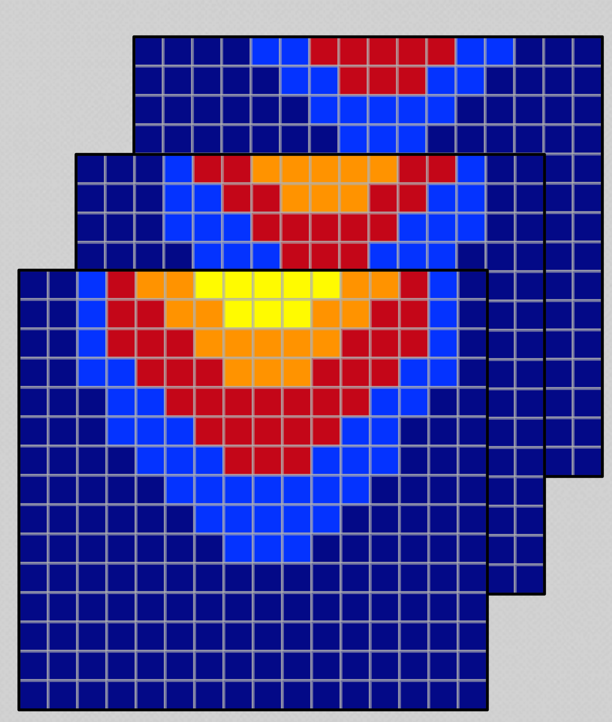

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Conclusion & perspectives

Our new analysis pipe clearly shows that the combined use of computer models and experimental data enables a better analysis of the water fluxes in the soil-plant system and can help researchers to decrypt the root water uptake dynamics.

Currently, this method is used to analyse differences observed in soil water content variations obtained under different treatments.

In the simulation presented here, we used empirical values for axial and radial conductivities [Doussan *et al.* 1998]. In the near futur, we plan to use inverse modelling in order to create more precise conductivity maps.

Doussan *et al.* [1998], Annals of Botany, 81, 213-223
Garriguès *et al.* [2006], Plant and Soil, 283, 83-98
Javaux *et al.* [2008], Vadoze Zone Journal, 7, 1079-1088
Lobet *et al.* [2011], Plant Physiology, 157, 29-39

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