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Assessment of the sensitivity of a low-field NMR sensor by characterizing root water status of an herbaceous plant under drought conditions

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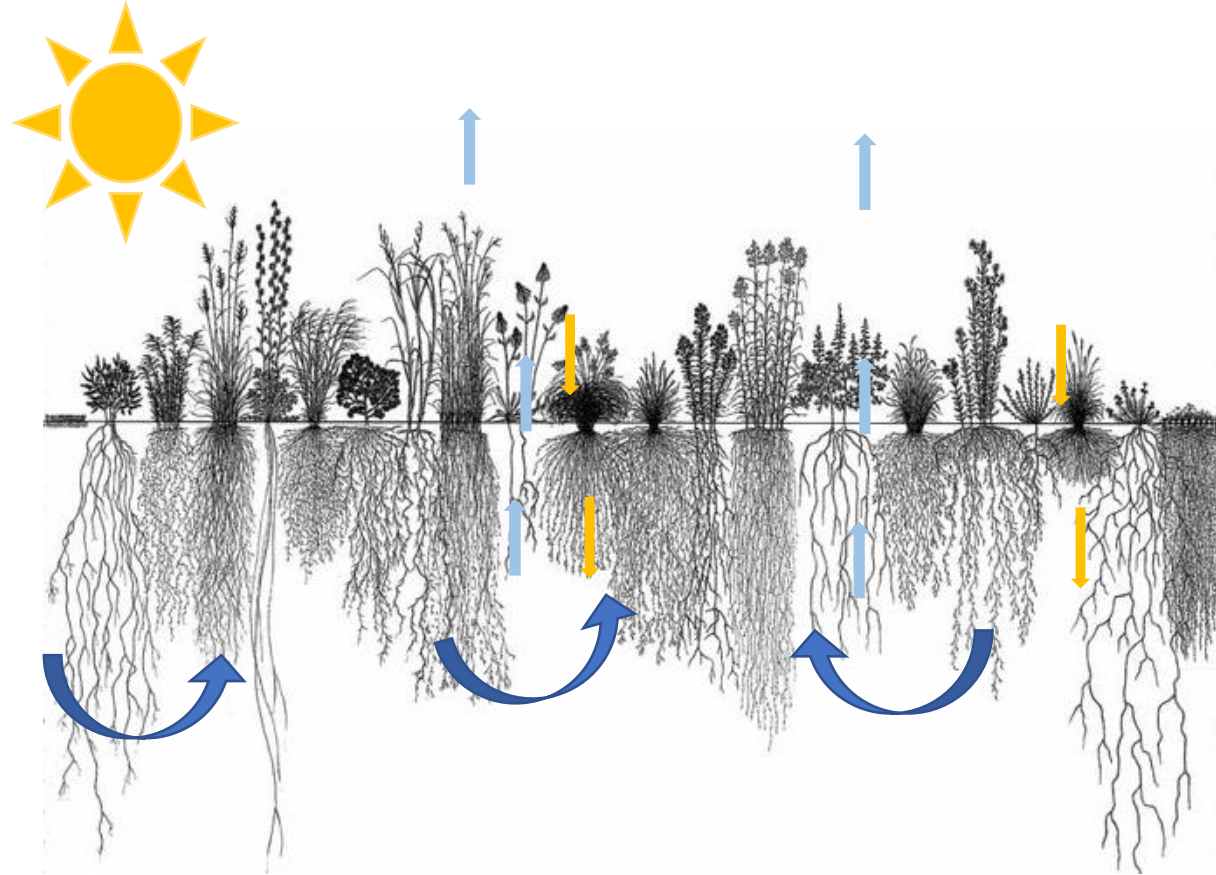
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Assessment of the sensitivity of a low-field NMR sensor by characterizing root water status of an herbaceous plant under drought conditions

Magali Nuixé, Amidou Sissou Traoré, Jean-Marie Bonny, Guilhem Pages and Catherine Picon-Cochard

Context and aim of the study



Grasslands enable carbon sequestration especially in the underground biomass (*IPCC, 2001*)

This process depends on the water availability and on plant water status

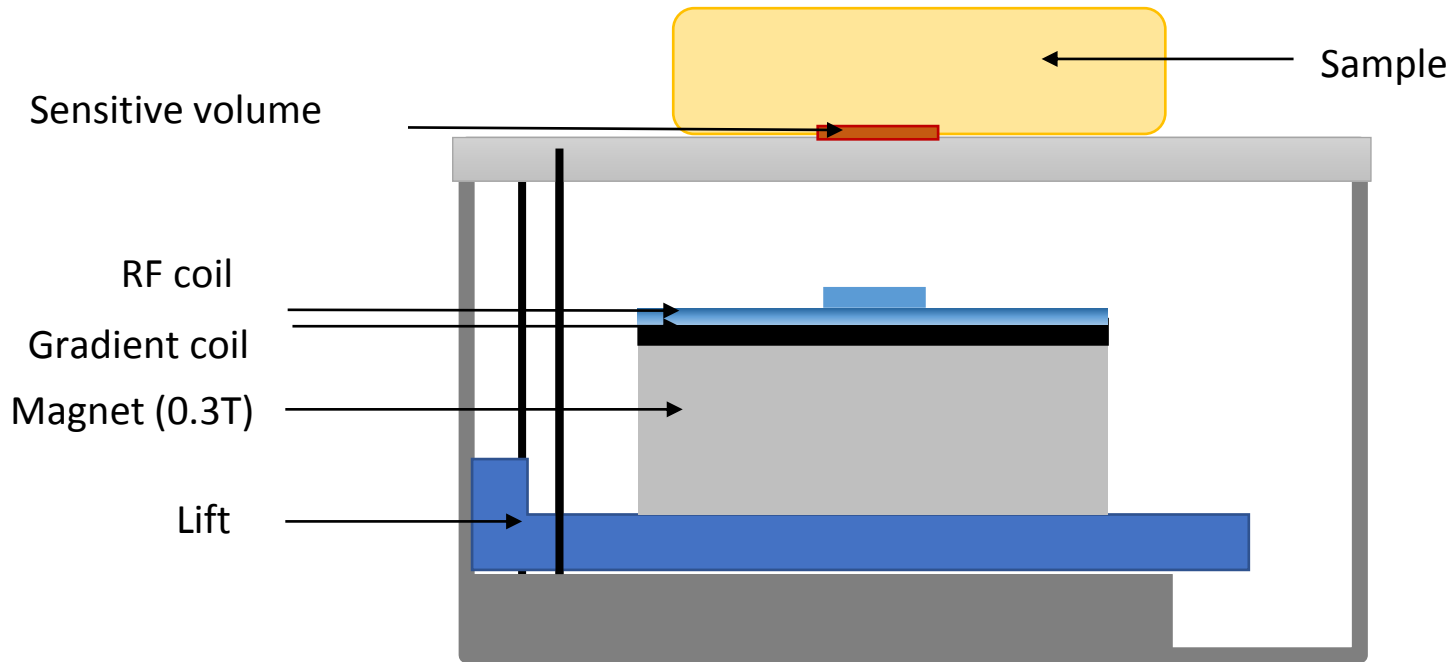
⇒ Interest to develop apparatuses to study plant water status *in situ*

⇒ NMR and especially low field NMR is an interesting tool to achieve this goal

Context and aim of the study

NMR MOUSE (Mobile Universal Surface Explorer) *Eidmann et al. 1996*

B_0 gradient : depth localization



After demonstrating the feasibility of low field NMR to study root water status in herbaceous plants (*Nuix et al. 2021*), we want **to determine the sensor sensitivity**



Material and Methods

A *Rumex acetosa* was cultivated in a rhizotron and positioned in a climatic chamber

(Day : 21°C, lights on from 08:00 to 22:00;
Night : 18°C, lights off from 22:00 to 08:00)



Example of the rhizotron model

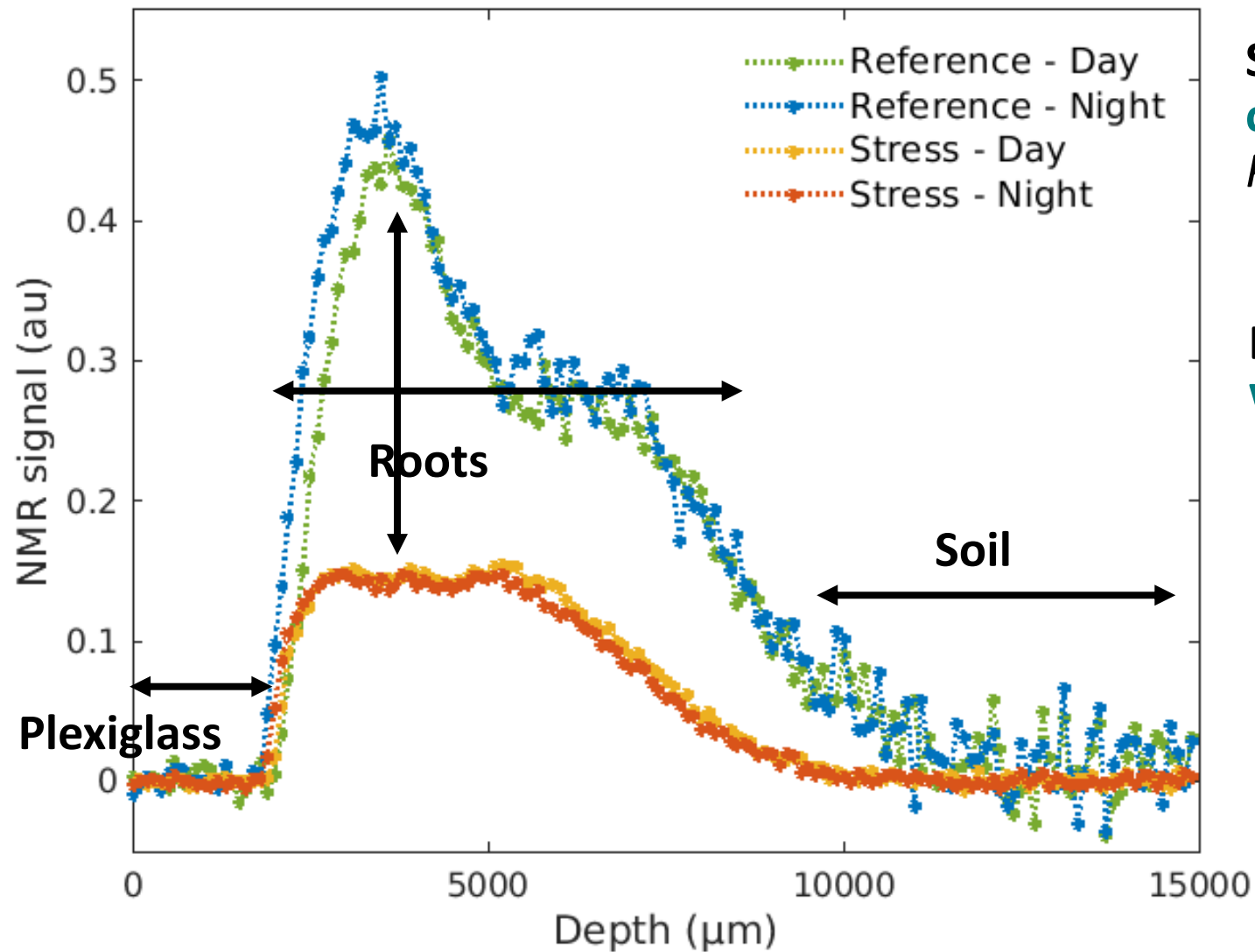
Plant was submitted to 3 hydric conditions :

- Reference conditions (250mL of water twice per day)
- Drought conditions (after 3 weeks without irrigation)
- Rehydration conditions (200mL of water three times per day during 3 days)

Acquisition of

- NMR profiles** (CPMG, TE 116 μ s, TR 3s, 256 echoes)
- T₂** (mono-exponential fit on the filtered averaged profile decay)
- Ecophysiological measurements**

Results – Profiles

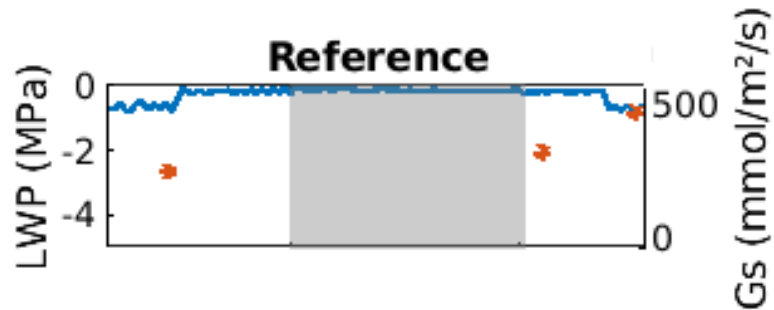


Soil/roots difference due to the **water content** but also to T_2 (Bagnall et al. 2020, Pohlmeier et al. 2010)

Day/Night difference due to the **increase of water mobility**

Reference to stress conditions characterized by a decrease of **65.2%** of root NMR area

Results – Profiles



Reference state :

Visualization of **variation of root and soil NMR signals** according to the ecophysiological measurements

⇒ Variation due to the transpiratory flux

⇒ In agreement with our previous study

Stress conditions :

No longer variation of root and soil NMR signals

⇒ In agreement with ecophysiological measurements

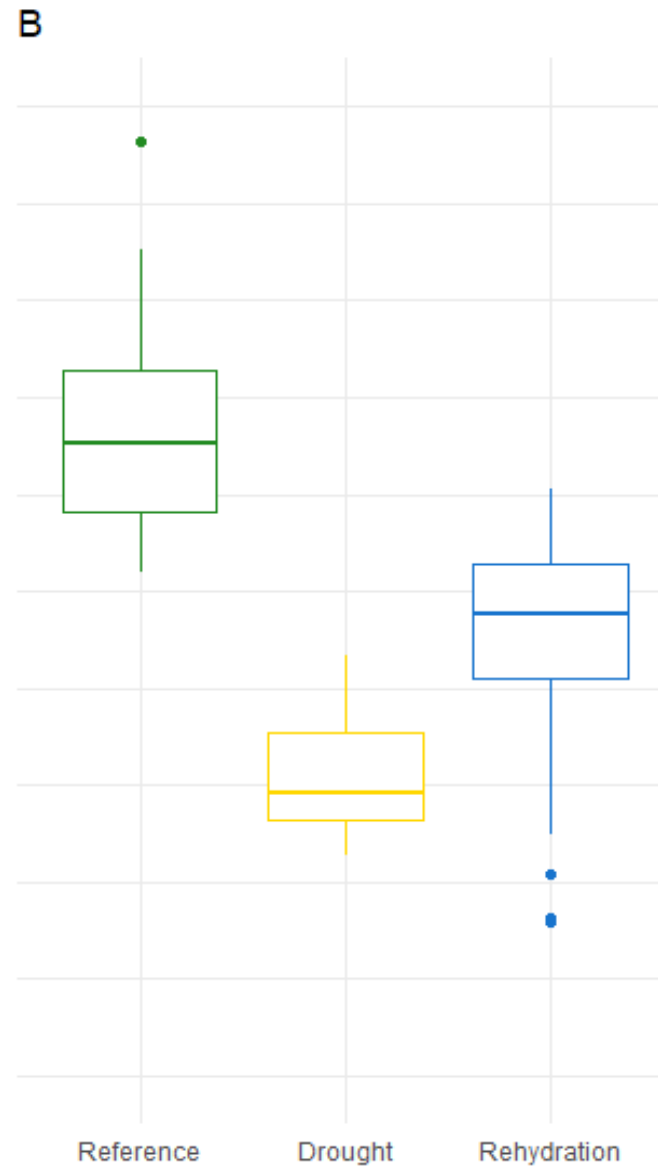
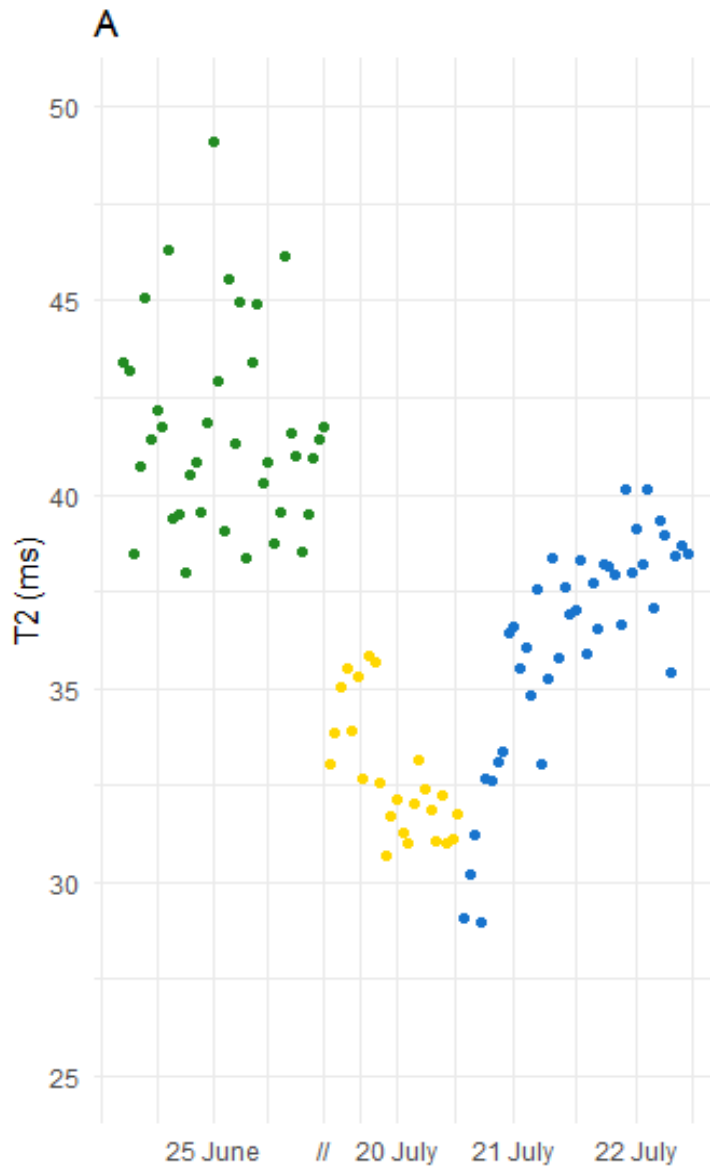
Decrease by:

- 93.4% for Gs

- 53.8% for SWC

⇒ No transpiration

Results – T_2



The 3 conditions are clearly different:

□ $T_{2\text{ref}} > T_{2\text{drought or rehydr.}}$

Stress :

Shorter T_2 = Water less mobilizable

Greetings



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