Low-field mri: a useful tool to characterize water in intact plants

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LOW-FIELD MRI: A USEFUL TOOL TO CHARACTERIZE WATER IN INTACT PLANTS

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Grasslands and forests are the two main terrestrial ecosystems limiting the global warming thanks to their high capability to store carbon. Sap flows are playing a critical role by bringing the water and minerals used for transpiration and photosynthesis (xylem) and transporting the photosynthetic carbons (phloem) to the carbon sinks (e.g., wood, roots, soil). In the context of global warming, a fine understanding of these transport mechanisms is necessary. However, a sensor able to locally probe water content and its movement directly on the plants in their ecosystem (i.e., *in situ*) does not exist yet.

To measure non-invasively and in a given spatial volume water properties, MRI is the analytical tool of choice. However, such instrument cannot be moved and only laboratory experiments can be performed. Recently, portable MRI have been developed. To be able to move the MRI system, the magnetic field intensity is significantly decreased. Thanks to special design and tricks, few portable sensors can record the MRI signal in a slice having a thickness of few tenths of micrometers. After choosing one of these devices, the NMR-MOUSE,[1] we designed a vector allowing to move it and to position it directly against the plant in any positions.

Our objective is then to evaluate the capabilities of this MRI sensor to measure water both repartition and flow in plants inside their natural environment. Our first experiments on agroeco systems were performed on root systems of different grassland species grown as monocultures. We demonstrated that the MRI sensor was able to detect water content variation during the cycle day / night.[2] These circadian variations matched the reference methods used to obtain information on the water in roots: soil relative humidity and leaf water potential. By exploiting MRI information related to water movements, we were then able to explain the variation observed with the MRI sensor by the plant water demand due to transpiration. We evaluated the capability of our sensor to monitor water content during a hydric stress (Figure 1) as well as during the plant recovery after rehydration. The first results obtained on roots from different grassland species demonstrated the interest of this MRI sensor.

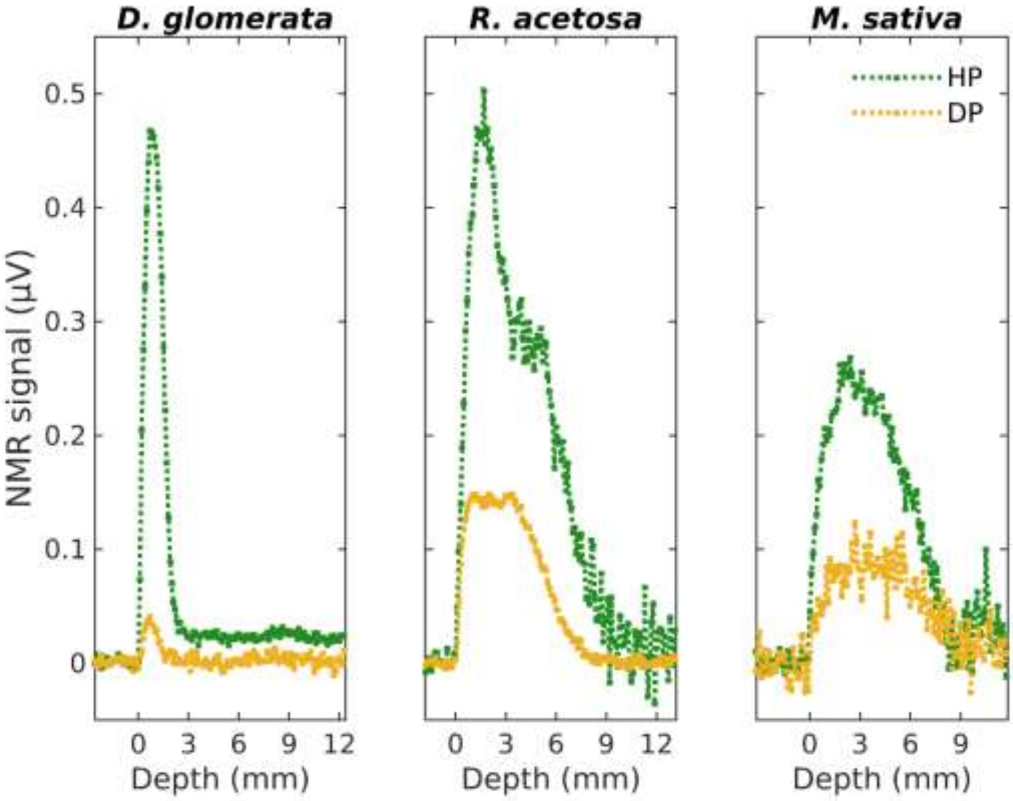

Figure 1 : Illustration of the MRI signal obtained under normal hydration conditions (green, HP= hydrated period) and at the end of the 3-weeks drought period (yellow, DP=drought period).

References
[1] Eidmann G., Savelsberg R., Blümer P. & Blümich B., *J. Magn. Reson. Ser A*, 122, 104, 1996
[2] Nuixe M., Traoré A., Blystone S., Bonny J.-M., Falcimagne R., Pagés G. & Picon-Cochard C., *Plants*, 10, 782, 2021