
The Root Water Uptake strategy of a combination of contrasted root wheat phenotypes: insights from an isotopic analysis

Samuel Le Gall*¹, Dagmar Van Dusschoten², Moritz Harings¹, Adrian Lattacher³, Mona Giraud¹, Holger Pagel³, Christian Poll³, Ellen Kandler³, Guillaume Lobet¹, Andrea Schnepf¹, Harry Vereecken¹, Mathieu Javaux⁴, and Youri Rothfuss¹

¹Institute of Bio- and Geosciences, IBG-3 Agrosphere, Forschungszentrum Jülich GmbH, Jülich, 52425, Germany – Allemagne

²Institute of Bio- and Geosciences, IBG-2 Plant Sciences, Forschungszentrum Jülich GmbH, Jülich, 52425, Germany – Allemagne

³Institute of Soil Science and Land Evaluation, Soil Biology Department, University of Hohenheim, Hohenheim, 70599, Germany – Allemagne

⁴Earth and Life Institute, Environmental Sciences (ELIE), Université catholique de Louvain (UC Louvain), Louvain-la-Neuve, 1348, Belgium – Belgique

Résumé

The use of intraspecific diversity in wheat co-culture (growing different phenotypes in the same field) is a well-known agro-ecological practice for improving yield stability and even yield levels. However, we lack elements from a water cycle point of view to understand how the root water uptake (RWU) strategies of contrasting root systems interact to improve co-crop performance.

In a control environment, we ran experiments on soil columns (silty-clay) (diam=11cm, height=80cm) each planted with two wheat phenotypes ("shallow-rooted" vs "deep-rooted") until ear emergence. Six different modalities were tested, i.e., 3 crop types (2 shallow-rooted individuals / 2 deep-rooted individuals / combination of 1 shallow-rooted individual and 1 deep-rooted individual) x 2 treatments (well-watered conditions or water stress). We repeated the experiment to test all the different modalities mentioned above in triplicate. Profiles of root water uptake (RWU) relative fractions were statistically evaluated (with a Bayesian mixture model) at cm to dm vertical resolution from soil water and transpiration flux isotope data non-destructively using gas-permeable membranes and gas chambers coupled to a laser spectrometer. Plants were also monitored physiologically during the experiment (e.g., leaf area, chlorophyll content) and destructively (e.g., above-ground and below-ground biomass, root area, stomatal density).

Our experimentation allowed us to test the following hypotheses: 1- In a water deficit situation, the general adaptation of the RWU strategy consists in increasing uptake in the deep, water-rich horizons; 2- The root traits of our phenotypes orient their RWU strategies; 3- The co-culture of these two phenotypes reinforces the individual RWU strategies of the two phenotypes for a better complementarity access to the water.

*Intervenant

Mots-Clés: Root Water Uptake, water stable isotopes, Wheat