



Investigating the impact on water fluxes and physiological development of the combination of contrasted root wheat cultivars from isotopic analysis

Samuel le Gall¹, Dagmar van Duschoten², Adrian Lattacher³, Mona Giraud¹, Moritz Harings¹, Paulina Deseano Diaz¹, Ahmet Sircan³, Christian Poll³, Guillaume Lobet¹, Mathieu Javaux⁴, and Youri Rothfuss¹

¹Forschungszentrum, IBG3, Juelich, Germany (s.le.gall@fz-juelich.de)

²Forschungszentrum Juelich, IBG-2 Plant sciences, Germany

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

⁴Université Catholique de Louvain-la-Neuve, Belgium

Farmers are increasingly adopting practices that add more biodiversity to agro-ecosystems for improving crop yield level and stability. These practices include co-cropping, that is the cultivation of different phenotypes (or cultivars) in the same field. However, we are missing clear criteria for the selection of the cultivars as well as a quantified assessment of the effect of the combination on water use and partitioning.

In our study, we proposed to focus on the association of two wheat cultivars having contrasted root systems. We further aimed at evaluating the effect of such an association on water flow by monitoring root water uptake vertical patterns from isotopic analyses.

In a control environment, we ran experiments on soil columns (silty-clay) (diam=11cm, height=80cm) each planted with two wheat cultivars ("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 six times 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, root architecture by magnetic resonance imaging) and destructively (e.g., above-ground and below-ground biomass, root area, stomatal density).

We will present our observations on how the RWU profile are affected by soil water status, wheat phenotype and associated plant identity. Surprisingly, the deep-rooted phenotype individuals - which uptake more water than the shallow-rooted individuals at soil depth between 40cm and

80cm under water deficit condition - are also the most physiologically sensitive (reduction in leaf area, significant change in shoot/root biomass ratio) at the first reproductive stages. On the field scale, this could have later a negative impact on the yield of the deep-rooted phenotype monoculture, but this should be moderate in co-cropping situations, where the sensitivity of the whole is lower.