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Root system architecture with and without root hairs: Consequences for nutrient and water uptake efficiency and related spatio-temporal patterns

Eva Lippold[1], Maxime Phalempin[1], Steffen Schlüter[1], Robert Mikutta[2], and Doris Vetterlein[1]
[1]Department of Soil Physics, Helmholtz Center for Environmental Research – UFZ, Theodor-Lieser-Straße 4, 06120 Halle/Saale, Germany
[2]Bodenkunde und Bodenschutz / Soil Science and Soil Protection, Martin-Luther-Universität Halle-Wittenberg, Von-Seckendorff-Platz 3, 06120 Halle/Saale, Germany

Root hairs substantially contribute to the acquisition of nutrients and potentially also to water uptake. Hence, they might have a strong impact on plant growth under nutrient- or water-limited conditions. As little information presently exists about differences in matter uptake to plants either with or without root hairs, we hypothesize that the absence of root hairs will be compensated by an increase in root growth to overcome the hair-less handicap. Within the DFG-funded Priority Program 2089, we compare two different genotypes (i.e. *Zea mays* "Wild Type" and its corresponding hair-less mutant "*rth3*") grown in two different substrates (loam and sand) in column experiments. X-ray computed tomography (X-ray CT) was used to investigate the spatial-temporal change of root architecture during growth. Additionally, total root length was measured after destructive sampling at harvest with WinRhizo. Contrary to our expectation, the reduced root surface area available for water and nutrient uptake in case of the hair-less cultivar was not compensated by more intensive root growth. The substrate had a higher impact on root growth than the presence or absence of root-hairs. For shoot growth (shoot biomass), both factors (genotype, substrate) had a significant impact. As a consequence, nutrient uptake efficiency (uptake per unit root length) was clearly increased by the presence of root-hairs, irrespective of the substrate. Water uptake efficiency did not show any difference between genotypes under the well-watered conditions studied. In general, water uptake per unit root length was higher in sand compared to loam. Differences in nutrient uptake efficiency should be reflected in the extent of nutrient depletion gradients around roots. To address such biochemical gradients we develop a new subsampling scheme based on extraction of undisturbed subsamples. Subsamples will be imaged with micro X-ray fluorescence (μXRF) for elemental mapping. The 2D μXRF image will be registered into the 3D X-ray CT image to relate the extent of gradients to the age of the respective root segment.

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