Contribution ID: **559** Type: **Oral Presentation**

The impact of drought-induced root and root hair shrinkage on root-soil contact

Monday, 31 May 2021 18:45 (15 minutes)

Increasing the contact area between roots and soil, root hairs are hypothesized to be a key plant strategy facilitating nutrient and root water uptake. Although future agriculture will have to deal with an increasing water and nutrient deficiency, there is still a lack of knowledge regarding root responses to soil drying. In particular, the effect of drought stress on root-soil contact remains unknown. Hence, the objective of our study was to determine morphological responses of roots and root hairs to soil drying in situ.

For this purpose, we have grown maize plants (Zea mays L.) in 3D-printed seedling holder microcosms. After a growing period of 8 days, plants were harvested and scanned using a synchrotron radiation CT in order to visualize root compartments as well as the elongated root hairs. The obtained images served as a basis for both image analysis and numerical modelling.
The results revealed that not only roots but also root hairs lose turgidity under dry soil conditions. Root hair shrinkage occurs at high soil water potentials and leads to a severe reduction of both the surface area and the soil contact area of roots. It represents the first step in a sequence of responses to progressive soil drying, followed by the formation of cortical lacunae and root shrinkage. The latter results in air filled gaps at the root-soil interface and thus in a further loss of contact to the soil. Only minor cavitation within the xylem was observed at the corresponding soil water potentials meaning that xylem embolism occurs at even lower potentials.
The data suggest that there is a tremendous loss of root-soil contact and consequently of hydraulic conductivity at the root-soil interface before xylem cavitates and reduces water as well as nutrient fluxes in the axial root direction. Although it is not yet clear if shrunk root hairs are inactive in nutrient and water uptake, their enormous shrinkage due to soil drying might limit rhizosphere processes.
Additionally, we estimated the importance of root hairs on root water uptake by means of image-based simulation of water flow through soil and roots, explicitly accounting for pore scale features such as: root hairs, root-soil matrix contact and air-filled gaps at the root-soil interface and within the root tissue.

Time Block Preference

Time Block B (14:00-17:00 CET)

References

Acceptance of Terms and Conditions

Click here to agree

Newsletter

I do not want to receive the InterPore newsletter

Student Poster Award

Primary author: Mr DUDDEK, Patrick (ETH Zurich, Physics of Soils and Terrestrial Ecosystems)

Co-authors: Dr AHMED, Mutez (University of Bayreuth, Soil Physics); Dr KOEBERNICK, Nicolai (Martin Luther University Halle-Wittenberg, Soil Science and Soil Protection); Ms OHMANN, Luise (Helmholtz Centre for Environmental Research –UFZ); Mr LOVRIC, Goran (Swiss Light Source, Paul Scherrer Institute); Prof. CARMINATI, Andrea (ETH Zurich, Physics of Soils and Terrestrial Ecosystems)

Presenter: Mr DUDDEK, Patrick (ETH Zurich, Physics of Soils and Terrestrial Ecosystems)

Session Classification: MS2

Track Classification: (MS2) Porous Media for a Green World: Water & Agriculture