Geophysical Research Abstracts
Vol. 20, EGU2018-8410, 2018
EGU General Assembly 2018

Root induced compaction alleviation by root hairs – visualization with synchrotron imaging

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Keywords: non-invasive imaging, rhizosphere, root hairs, soil structure, root exudates

From two separate synchrotron experiments using different initial soil conditions, we visualized the impact of roots and root hairs on the formation of soil structure at the root-soil interface. Roots compact soil when they grow, but we hypothesise that a combined action of exudates and water uptake by roots causes restructuring that alleviates compaction. Both experiments grew barley seedlings that were either a mutant with greatly reduced root hair growth, or its wildtype parent. These were grown for X days in specially constructed chambers where roots could be trained into packed 4 mm diameter soil columns that were used for high resolution imaging to 1.6 um. The soil used was a sandy loam textured Dystric Cambisol.
In the first experiment the soil was sieved to < 1 mm. The results showed that root hairs may play an important role in rhizosphere structure formation by alleviating the compression that is induced by growing roots. Root induced compression was evidenced by decreased air-filled pore space between 0.1 and 0.8 mm from the root surface. However, at the root-soil interface, the pore space increased for the root hair bearing barley genotype, but not for the barley mutants with no root hairs.
In a similar experiment, conducted with the same soil sieved to <250 um, both genotypes showed increased porosity at the root soil interface, with no significant differences between the genotypes. Pore size distribution was narrower at the root-soil interface and became wider with distance from the root due to the decreased volume of large pores near the root surface.
Increased porosity near the root is discussed as an effect of the geometry of soil particles at the root surface. A model is proposed that describes the variation in porosity around roots, taking into account both root induced compression and the simplified geometry of solid mineral particles at the root surface.