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Wurzel-Boden-Wechselwirkung und physikalische Prozesse in der Rhizosphäre

Autoren
P. Benard[1], M. Zarebanadkouki[1], C. Hedwig[1], M. Holz[1], M. Ahmed[1], A. Carminati[1]
[1]Georg-August-Universität Göttingen, Bodenhydrologie, Göttingen

Titel
Pore-scale distribution of mucilage affecting water repellency in the rhizosphere

Abstract
The hydraulic properties of the rhizosphere are altered by plants, fungi and microorganism. Plant roots release different compounds into the soil. One of these substances is mucilage, a gel which turns water repellent upon drying. We introduce a conceptual model of mucilage deposition during soil drying and its impact on the soil wettability. We hypothesized that as soil dries, water menisci recede and draw mucilage towards the contact region between particles where it is deposited. At high mucilage content, mucilage deposits expand into the open pore space and finally block water infiltration when a critical fraction of the pore space is occupied. To test this hypothesis, we mixed mucilage and particles of varying grain size, let them dry and measured the contact angle (CA) using the sessile drop method. Mucilage deposition was visualized by light microscopy imaging. Contact angle measurements showed a distinct threshold-like behavior with a sudden increase in apparent contact angle at high mucilage concentrations. Particle roughness induced a more uniform distribution of mucilage. The observed threshold corresponds to the concentration when mucilage deposition occupies a critical fraction of the pore space, as visualized with the microscope images. Particle roughness induced a more uniform distribution of mucilage. In conclusion, water repellency is critically affected by the distribution of mucilage on the pore-scale. This microscopic heterogeneity has to be taken into account in the description of macroscopic processes, like water infiltration or rewetting of water repellent soil.