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Liquid bridges at the root-soil interface

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The role of the root-soil interface on soil-plant water relations is unclear. Despite many experimental studies proved that the soil close to the root surface, the rhizosphere, has different properties compared to the adjacent bulk soil, the mechanisms underlying such differences are poorly understood and the implications for plant-water relations remain largely speculative.

The objective of this contribution is to discuss the key elements affecting water dynamics in the rhizosphere. Special attention is dedicated to the role of mucilage exuded by roots in shaping the hydraulic properties of the rhizosphere. We identified three key properties: 1) mucilage adsorbs water decreasing its water potential; 2) mucilage decreases the surface tension of the soil solution; 3) mucilage increases the viscosity of the soil solution. These three properties determine the retention and spatial configuration of the liquid phase in porous media. The increase in viscosity and the decrease in surface tension (quantified by the Ohnesorge number) allow the persistence of long liquid filaments even at very negative water potentials. At high mucilage concentrations these filaments form a network that creates an additional matric potential and maintains the continuity of the liquid phase during drying.

The biophysical interactions between mucilage and the pore space determine the physical properties of the rhizosphere. Mucilage forms a network that provides mechanical stability to soils upon drying and that maintains the continuity of the liquid phase across the soil-root interface. Such biophysical properties are functional to create an interconnected matrix that maintains the roots in contact with the soil, which is of particular importance when the soil is drying and the transpiration rate is high.