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How root exudates affect hydraulic dynamics in microaggregates

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Recently, many studies have shown that root exudates strongly alter hydraulic properties of soil. When dry, mucilage can make soil particles water repellent, but when in contact with water it starts swelling and is capable of holding large amounts of water. It was found that the quantitative impact strongly depends on plant species and soil type: in fine soils, a large amount of mucilage is required to make its large surface water repellent. However, little amount of mucilage is sufficient to increase water content at low water potentials. While soils of various particle sizes have been studied, it is still unknown how root exudates alter hydraulic dynamics in micro-aggregated soils.
Aim of our study is to quantify the effect of mucilage on soil hydraulic properties in microaggregates: we mixed soil samples collected in Southern Amazonia that consist mainly of microaggregates at various concentrations of root exudates and performed experiments (i) to determine the critical concentration of root mucilage at which the soil turns water repellent, (ii) to measure the saturated hydraulic conductivity as function of mucilage, and (iii) to determine water retention curves as function of mucilage concentration. We used mucilage extracted from chia seeds as a model of root exudates. The critical concentration at percolation threshold (i) was determined visually in capillary rise experiments; hydraulic conductivities (ii) were measured using the falling head method and the water retention curves (iii) were obtained using the pressure plate technique.
Our experiments show that to a certain extend the effect of mucilage on hydraulic dynamics resembles rather the dynamics in a sandy soil than those in a clay soil. Together with further studies, our experiments help to improve our knowledge about hydraulic dynamics in the root zone of microaggregated soil. Since N2O fluxes are strongly linked to hydraulic dynamics, our findings might eventually also help to better understand N2O fluxes in the Southern Amazonia.