Supplemental Material

Water retention of maize mucilage amended glass beads – Neutron radiography

The effect of maize mucilage (Zea mays) on water retention was tested by mixing hydrated mucilage at concentrations of 15 and 30 mg g\(^{-1}\) [mg of dry mucilage per g of hydrated mucilage] with glass beads of 0.1-0.2 mm in diameter (SWARCO VESTGLAS GmbH, Recklinghausen, Germany) to achieve mucilage content of 4, respectively 8 mg g\(^{-1}\). Mixtures were then packed beside water saturated glass beads in containers with inner dimensions of 0.8 ×0.5×0.3 cm (L×H×W). Mucilage amended glass beads were packed to one side of the container over a length of 0.25 cm in contact with their non-amended counterparts. By evaporation a range of water contents in different samples was achieved and then the containers were sealed with aluminium tape. After 2 days of equilibration at room temperature, the water content in the mucilage affected and unaffected part of the containers was measured using neutron radiography. Measurements were performed at the ICON beam line at the Paul Scherrer Institute, Villigen, Switzerland. The details on neutron radiography technique and image processing can be found elsewhere (Carminati et al., 2010). Results are shown in Fig. S1.
Fig. S1: Increase in water retention of mucilage amended glass beads. For mucilage content of 4 (blue dashed line) and 8 (red dashed line) mg g\(^{-1}\) glass beads hold approximately 25, respectively 125% more water at same negative water potential (deviation from 1:1 regression; black dashed line).

**Imaging of EPS and mucilage in soils**

All images shown were taken from samples prepared according to the procedure described in the Material & Methods section.

Fig. S2 shows an exemplary cross section and its segmented counterpart. Dry mucilage structures appeared comparable in their spatial extent as those obtained from samples at a mucilage content of 8 mg g\(^{-1}\). Dry mucilage bridged several large pores and formed a continuous structure spanning throughout the pore space. Note that due to their small thickness, mucilage structures appear disconnected across the contact region between particles although they are most likely not. Discontinuity arises from the fact that the resolution of the acquired images is limited while the spatial distance decreases towards the contact region of particles.

Fig. S3 shows an exemplary cross section through a dried sample of dine sand amended with mucilage at 8 mg g\(^{-1}\). As shown for glass beads, structures were continuous surfaces reaching across multiple pores.
Fig. S2 Example of mucilage structures formed by mucilage in glass beads. (a) Cross-section through a synchrotron-based X-ray tomogram of dry maize mucilage (Zea mays) structures in glass beads (bright circles) (mucilage content 4 mg g$^{-1}$; glass bead diameter 0.1 – 0.2 mm); (b) 3D segmentation of dry mucilage structures (red) showing interconnected surfaces of approximately 1 µm thickness within the pore space of glass beads (blue).

Fig. S3 Example of mucilage structures in fine sand. Two-dimensional dry mucilage (Zea mays, mucilage content 8 mg g$^{-1}$) structures (red arrows) in sand (particle diameter 0.125 – 0.2 mm) imaged with synchrotron-based X-ray tomographic microscopy.
Fig. S4 shows a light microscopy image of dry mucilage structures in fine sand. Samples were prepared according to the description given in the main text. Mucilage shaped the soil pore space by adhering to small particles during drying.

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**Fig. S4 Example of mucilage structures in fine sand.** Light microscope image of dry mucilage (*Slavia hispanica; mucilage content 4 mg g⁻¹*) structures (red arrows) in fine sand.

Fig. S5 shows example cross sections of the pore space of soil biocrust collected in Moab, Utah (Couradeau et al., 2018) observed with synchrotron based X-ray tomography. Shape of EPS-based structures connecting adjacent particles is similar to the ones observed in mucilage amended sand (Fig. S3) and glass beads (Fig. 2 and Fig. 2S).
Fig. S5 Examples EPS-based structures in biocrust. Two-dimensional EPS-based structures joining quartz grains in intact biocrusts imaged with synchrotron-based X-ray tomographic microscopy (Couradeau et al., 2018). High EPS content resulted in the formation of characteristic structures (red arrows) comparable to those formed by maize mucilage.