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Water repellency and infiltration of biological soil crusts on an arid and a temperate dunes

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Biological soil crusts (BSCs) play an important role in many ecosystems and in all climates. We studies hydrological properties of BSCs under arid and temperate climates. The arid study site was located near Nizzana, in the northwestern Negev, Israel and the temperate site was near Lieberose, Brandenburg, Germany. BSCs were sampled at each site near the dune crest, at the center of the dune slope and at the dune base. Using principal component analysis (PCA), we studied the relationships between hydraulic properties and the molecular structure of organic matter using repellency indices, microinfiltrometry, and 13C-CP/MAS-NMR. The soil texture was finer and water holding capacities (WHCs) were higher in Nizzana, whereas surface wettability was reduced in Lieberose. At both sites, BSCs caused extra WHC compared to the mineral substrate. Infiltration after wetting along both catenas generally reached a maximum after 10 min and decreased after 30 min. Carbohydrates were the dominating components in all of the BSCs studied, where the relative peak areas of carbohydrate-derived structures (60–110 ppm) amounted to 28–46% and to 10–14% of total C-peak areas, respectively. PCA revealed that the WHC of the substrate was closely related to the amount of silt and clay, whereas the BSC induced extra WHC was closely related to carbohydrates. It was further found that water repellency was positively related to carbohydrate C, but negatively related to alkyl C. Infiltration kinetics was attributed to polysaccharide hydration and swelling. Our findings support the hypothesis that hydraulic properties of BSCs are determined by extracellular polymeric substances (EPS) and soil texture. Hydraulic properties in BSCs result from the combination of chemical properties related to C compounds mainly dominated by carbohydrates and physical surface properties related to texture, porosity and water holding capacity.

References

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