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Characterization of the polysaccharidic matrix of induced biocrusts in different soil types

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Cyanobacteria have been used as inoculants in dryland soils to promote biological soil crust (or biocrust) recovery and restore vital soil functions. Their viability obeys to their high resilience to stressful conditions and their reported beneficial effects on soil properties. Cyanobacteria from dry environments are characterized by a high capacity to synthesize large amounts of exopolysaccharides (EPS) that play a fundamental role in the survival of cyanobacteria in these extreme habitats and are responsible of many soil functions. Cyanobacterial EPS increase soil organic matter and nutrient content, thus improving soil fertility, and greatly enhance soil stability, thus conferring a high resistance to soils to erosive forces by water and wind. Cyanobacterial EPS are characterized by a different degree of condensation, molecular weight (MW) distribution and monosaccharidic composition, which condition the role of the cyanobacterial polysaccharidic matrix in the soil. A few studies have analyzed the MW distribution and chemical characteristics of the polysaccharidic matrix in natural and induced biocrusts, and most of them have been carried out on sandy soils. However, the characteristics of the cyanobacterial polysaccharidic matrix may greatly depend on soil type. The objective of this study was to examine the EPS synthesis of two common arid soil cyanobacterial species, *Phormidium ambiguum* (non N-fixing) and *Scytonema javanicum* (N-fixing) in both liquid culture and a solid substrate, and to analyze the MW distribution and monosaccharidic composition of the polysaccharidic matrix developed in different soil types after inoculation with the two cyanobacterial species. We found that *P. ambiguum* showed a faster growth and a higher EPS synthesis in liquid culture, whereas *S. javanicum* showed a higher growth and led to a higher EPS content in the soil. EPS characterization in the induced biocrusts revealed important differences between species and soil types. *S. javanicum* led to a higher synthesis of more soluble and less condensed EPS (loosely-bound EPS), which were mainly composed of low MW weight (<50 kDa). *P. ambiguum* promoted a higher amount of more condensed EPS (tightly-bound EPS), mainly composed of high MW molecules (1100-2000 kDa), which likely contributed to soil particle consolidation and explain the higher surface resistance found in the soils inoculated with this cyanobacterium. Inoculated soils showed a complex composition, with a high number of monosaccharides (from 11 to 12). Glucose was the most abundant monosaccharide in all soil types, representing up to 90% of EPS in the sandy soil. In more complex soils (having higher EPS, organic carbon and nitrogen contents), galactose, mannose and xylose were also relatively abundant. On the whole, cyanobacterial species and soil type influenced the macromolecular distribution and chemical composition of the biocrust polysaccharidic matrix, which is expected to have an important role in biocrust succession and evolution of soil properties in dryland soils.