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Cyanobacterial crust induction using two non-previously tested cyanobacterial inoculants: crusting capability and role of EPSs

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The use of cyanobacteria as soil improvers and bio-conditioners (a technique often referred to as algalization) has been studied for decades. Several studies proved that cyanobacteria are feasible eco-friendly candidates to trigger soil fertilization and enrichment from agricultural to arid and hyper-arid systems. This approach can be successful to achieve stabilization and rehabilitation of degraded environments.

Much of the effectiveness of algalization is due to the productivity and the characteristics of extracellular polysaccharides (EPSs) which, among their features, embed soil particles and promote the development of a first stable organo-mineral layer (cyanobacterial crusts). In natural settings, cyanobacterial crust induction represents a first step of a succession that may lead to the formation of mature biological soil crusts (Lan et al., 2014).

The aim of this research was to investigate the crusting capabilities, and the characteristics of excreted EPSs by two newly tested non-heterocystous cyanobacterial inoculants, in microcosm experiments carried out using oligothrophic sand collected from sand dunes in Negev Desert, Israel. The cyanobacteria tested were Schizothrix AMPL1601, originally isolated from biocrusts collected in Hobq Desert, Inner Mongolia (China) and Leptolyngbia ohadii, originally isolated from biocrusts collected in Negev Desert, Israel.

Inoculated microcosms were maintained at 30 °C in a growth chamber under continuous illumination and minimal water availability. Under such stressing conditions, and for a three-months incubation time, the growth and the colonization of the strains in the microcosms were monitored. At the same time, EPSs production and their chemical and macromolecular characteristics were determined by applying a methodology optimized for the purpose. Notably, EPSs were analyzed in two operationally-defined fractions, one more dispersed in the crust matrix (loosely bound EPSs, LB-EPSs) and one more condensed and stable (tightly bound EPSs, TB-EPSs), which were deemed having different functions (Chen et al., 2014).

The results demonstrated how differently (and complementarily in some ways) these two strains behave when applied on a poor sandy substrate, producing cyanobacterial crusts having different morphology. The outcomes of this study suggest the potential of Schizothrix AMPL1601 and Leptolyngbia ohadii as valid biotechnological tools for improving the properties of poor arid soils, allowing to design proper rehabilitation or restoration models. In addition, this study provided new insight on the characteristics of the cyanobacterial EPSs, secreted under a constrained condition, compared to a non-nutrient limited and optimal one.

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