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Cyanobacterial crust induction to restore arid an semiarid degraded soils: effect of water availability

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Restoration programs in arid and semiarid degraded regions often do not offer satisfactory results due to water scarcity and poor soil fertility and structure. For this reason, before restoring an area with vascular plants, soil conditions should be enhanced. To achieve this goal, we propose a useful and innovative biotechnological tool: cyanobacteria inoculation. Cyanobacteria organisms naturally improve soil water availability, fix carbon and nitrogen and increase the stability of the soils they colonize. Furthermore, they survive under high levels of UV radiation and temperature, and can be easily isolated and cultured ex-situ, which makes them a perfect candidate for restoring degraded arid and semiarid zones. However, induced cyanobacteria response to differing soil water contents, mimicking those found in the field, has not been explored so far.

The aim of this research was to test the effect of water availability on induced biocrust growth in soil substrates from two semiarid areas of Almeria (Spain): Amoladeras and Gádor quarry, which have distinct degradation levels. Three native N-fixing cyanobacteria strains: Nostoc commune, Scytonema hyalinum and Tolypothrix distorta, were inoculated in soil samples of the study areas, individually and as a consortium. Two different irrigation treatments reproducing water conditions found naturally in the selected zones were applied during 3 months at laboratory conditions and a constant temperature of 25 ºC: a dry year (180 mm/year) and a wet year (360 mm/year). Then, cyanobacteria cover, chlorophyll a and expopolysaccharides (EPS) content were measured as indicators of biocrust development.

Cyanobacteria crust cover increased in inoculated soils as compared to non-inoculated soils. Inoculated soils showed higher levels of chlorophyll a and EPS compared to non-inoculated soils. Generally, the mixture of the three species showed better performance in wet conditions versus dry conditions. However, Nostoc inoculation provided the same results in wet and dry conditions, suggesting that water availability was not a key driver for Nostoc colonization under laboratory conditions. This proves that Nostoc has a large potential for growing under water limited conditions, and would be a good candidate to be selected as inoculant to restore semiarid degraded areas.