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Key Factors Controlling the Growth of Biological Soil Crusts: Towards a Protocol to Produce Biocrusts in Greenhouse Facilities

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Biological soil crusts (= biocrusts) are topsoil communities comprise of, but not limited to, cyanobacteria, algae, lichens, and mosses that grow intimately associated with soil particles in drylands. Biocrusts have central ecological roles in these areas as sources of carbon and nutrients, and efficiently retain water and prevent soil erosion, which improves soil structure and promotes soil fertility. However, human activities, such as cattle grazing, hiking or military training, are rapidly striking biocrusts. Although it is well known that the inoculation with cyanobacteria or lichens can enhance the recovery of biocrusts in degraded soils, little is known about the factors that control their growth rates. Using soil and inocula from four different sites located in one cold desert (Utah) and in one hot desert (New Mexico), we performed a fractional factorial experiment involving seven factors (water, light, P, N, calcium carbonate, trace metals and type of inoculum) to screen their effects on the growth of biocrusts. After four months, we measured the concentration of chlorophyll a, and we discovered that water, light and P, N or P+N were the most important factors controlling the growth of biocrusts. In the experimental treatments involving these three factors we measured a similar concentration of chlorophyll a (or even higher) to this found in the field locations. Amplification of the 16S rRNA gene segment using universal bacteria primers revealed a microbial community composition in the biocrusts grown that closely corresponds to initial measurements made on inocula. In summary, based on our success in obtaining biocrust biomass from natural communities in greenhouse facilities, without significantly changing its community composition at the phylum and cyanobacterial level, we are paving the road to propose a protocol to produce a high quality-nursed inoculum aiming to assist restoration of arid and semi-arid ecosystems affected by large-scale disturbances.