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Harnessing biocrust cyanobacteria for dryland restoration: effects on recruitment of native plants and soil function

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Despite the widely-accepted importance of drylands - which store 45% of the global carbon and comprise a third of global biodiversity hotspots - and the large amounts of money invested in restoration, success rates are generally low. Given the large scale of restoration required, and severe deficits of locally-sourced soil materials that contain beneficial nutrients, microbes and a residual soil seedbank, direct seeding is often needed for reinstating biodiverse vegetation communities. However, seed-based restoration is extremely inefficient, and rates or seed mortality are frequently above 90%. Cyanobacteria from soil biocrusts have the capacity to act as bio fertilizers by promoting growth of certain plant species, and contribute to multiple key ecosystem services and functions in desert ecosystems including soil structure, stability, improved surface hydrology, C sequestration, and N fixation. These organisms can survive extreme conditions such as low precipitation, high solar radiation and extreme temperatures. However, despite their global importance, and their many environmental applications, the potential of cyanobacteria for ecosystem restoration in drylands, is yet to be harnessed.

Here, we investigated i) the effects of bio-priming seeds of native plants used in restoration with a consortium of cyanobacteria species, on seed germination, seedling recruitment and growth; and, ii) the potential of inoculating cyanobacteria on soil substrates used in dryland restoration, including topsoil and mine waste, to restore soil functions such as soil carbon sequestration. Our results showed that cyanobacteria does not inhibit and can promote germination and early seedling growth of native arid species - phases known to be problematic for restoration success in dryland ecosystems. We also found that cyanobacteria inoculation can rapidly modify properties of reconstructed soil substrates such as increased soil carbon, underpinning the potential key role of these organisms as bio-tools to initiate recovery of soil functions in infertile, reconstructed soil substrates.