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New strategies to increase the restoration success of post-mining landscapes: the application of cyanobacteria to seed-based rehabilitation programs

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Despite the large efforts and investments to dryland ecosystems restoration worldwide, land rehabilitation in these areas has very low rates of success. Most of the challenges in landscape-scale restoration come from the lack of suitable soil substrates to support plant establishment and to ultimately achieve functional ecosystems. A common practice during extractive operations such as open-cut and strip mining is the removal of the topsoil layer that is subsequently stockpiled and respread in areas targeted for restoration. This topsoil is a crucial source of seeds, nutrients, and microorganisms but is a scarce resource which challenges the success of many restoration programs. In these conditions, the use of direct seeding of key native plant species becomes critical to reinstate biodiverse vegetation communities. Alternative soil substrates such as overburden or waste materials produced in mining operations are increasingly being used as growth media in restoration. However, these soil substrates can have inadequate levels of pH or salinity for plant growth and in most cases are depleted in organic materials and nutrients. In these conditions, the establishment of native plant species can be extremely difficult with a consequent potential loss of biodiversity. Development of appropriate soil structures such as technosols can be extremely expensive and demanding in terms of time and natural resources soils and therefore new approached need to be explored. In the last years, the potential of cyanobacteria biological crust to restore soil functionality in degraded has been highlighted because of their important role in controlling soil structure, preventing soil erosion and N and C fixation. Nevertheless, many research gaps still remain in their application to restore soil functionality in seed-based restoration practices. In this study, we test the potential of cyanobacteria inoculation to restore soil functions of soil materials used in post-mine restoration. Soil substrates consisted of topsoil retrieved from previously stockpiled material, an overburden waste material commonly used in landform reconstruction due to its erosive stability and physical competency, and a mixture of both substrates. These materials were collected from an active mine site in the mining intensive Pilbara region and inoculated with a mixture of soil cyanobacteria from three nitrogen-fixing genera (Nostoc, Scytonema and Tolypothrix). Further analyses need to be undertaken but preliminary results showed that after only 4 weeks, cyanobacteria rapidly colonized the mine substrates as cyanobacteria surface cover significantly increased during the time of study.The output of this research is the first step to effectively address the reconstruction of soil substrates that can provide support to the establishment of biodiverse vegetation communities in landscape-scale seed-based mine restoration.