Development of cyanobacterial application methods for soil protection and restoration: case studies in Australian drylands

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Background

Land degradation, as a result of increased soil erosion and loss of fertility among other factors, is currently one of the most serious environmental problems. In recent years, the role of **cyanobacteria from soil biocrusts** in re-establishing soil function in degraded areas is gaining interest due to the potential of these organisms for soil structure stabilization and increase of soil fertility.

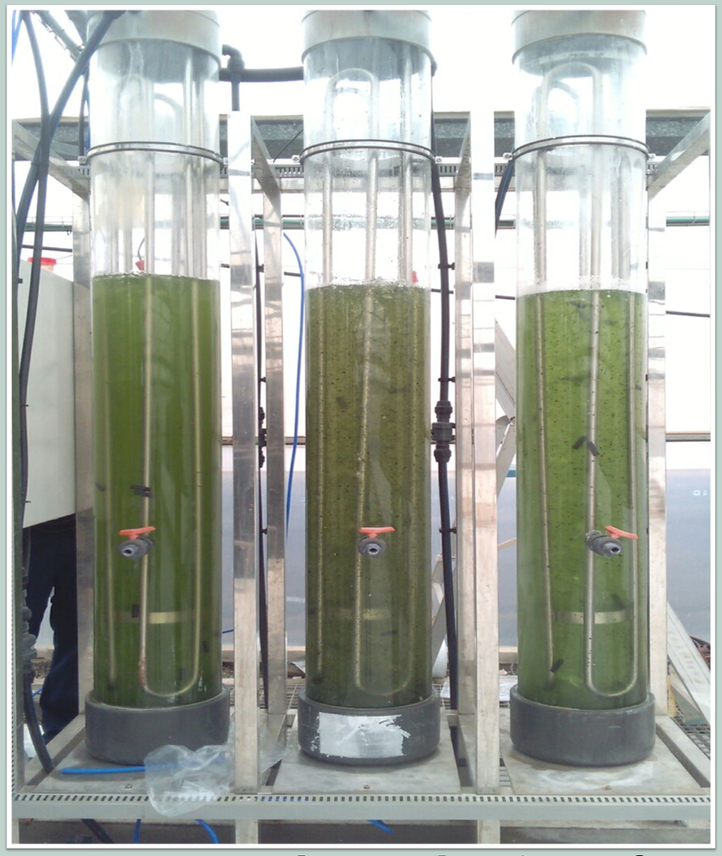
Soil biocrust

Soil biocrust

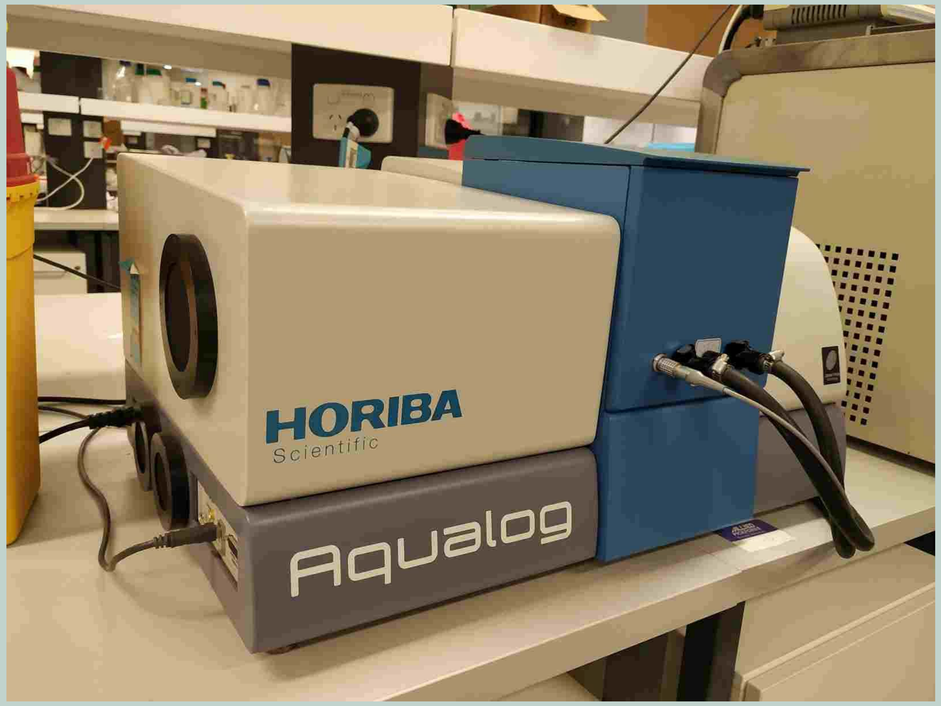
In order to fully exploit the use of cyanobacteria in large-scale restoration of degraded lands, **new approaches** that facilitate their application must be explored in order to face with the harsh abiotic conditions of these environments.

Materials and Methods

Three soil native cyanobacterial strains from two representative N-fixing genera (*Nostoc* and *Scytonema*) and a non-heterocystous filamentous genus (*Leptolyngbya*) previously collected from the Pilbara region (north-west Western Australia), were used as inoculum. Then, in a multifactorial microcosm experiment under laboratory conditions, we evaluated the survival and establishment of the cyanobacteria for both methods.



Large-scale production of cyanobacteria in 100 L bioreactors.

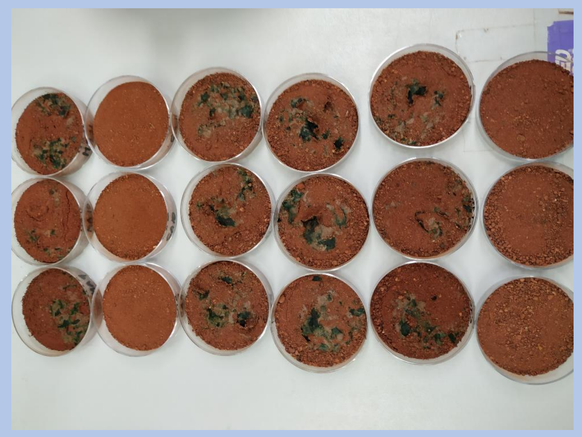


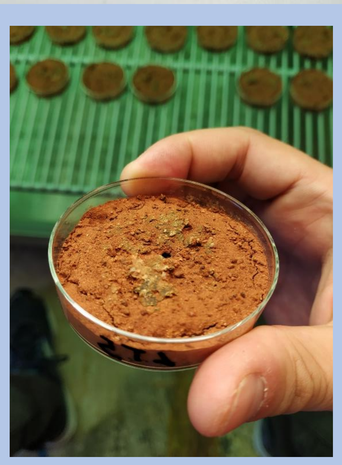
Chlorophyll *a*, soil spectral response and cyanobacteria coverage were periodically measured as a surrogate of cyanobacterial establishment. The visible spectroscopy was used to quantify the chlorophyll *a*.

Materials and Methods

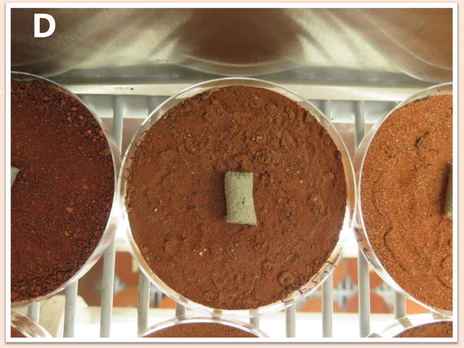
Direct inoculation of cyanobacteria cultures

For the direct inoculation, cultures of isolated cyanobacteria and a mixture of them were applied as a liquid inoculum directly into a degraded soil from the Pilbara.





Incorporation of cyanobacteria within extruded pellets



For the extruded pellets, fresh cultures of each strain alone and an equal mixed of them were added into a substrate composed of commercial bentonite powder and sand (1:10 weight ratio) (A). The composed solution was extruded through a jerky gun with an extruder nozzle into pellets (1 cm diameter × 2 cm length) (B) and dried at 30 °C for 24h (C). Pellets were then placed on the surface of samples from three degraded soils representative of Australian drylands (D).

Results and discussion

In both experiments, cyanobacteria growth and establishment were monitored.

Soils covered with *Scytonema* pellets after A) 15 days, B) 45 days and C) 90 days.

In the case of direct inoculation, a decrease of chlorophyll a was observed in the beginning but then it stabilized and started to increase at the final stage of the experiment. This process may be due to the adaptation period of the cyanobacteria in the new environment, which is most progressive in the case of pellets application.

Results and discussion

Overall, our results showed that cyanobacteria can be successfully applied as a liquid inoculum and incorporated into extruded pellets, quickly colonizing degraded soil substrates.

5 days after direct inoculation

30 days after direct inoculation

These technologies are ready for further testing and refining through field trials, opening a wide range of opportunities to face with large scale restoration programs.

Thank you!

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References:

Muñoz-Rojas M, Román JR, Roncero-Ramos B, Erickson TE, Merritt DJ, Aguila-Carricondo P, Cantón Y (2018) Cyanobacteria inoculation enhances carbon sequestration in soil substrates used in dryland restoration. Sciences of the Total Environment 636, 1149–1154. https://doi.org/10.1016/j.scitotenv.2018.04.265

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