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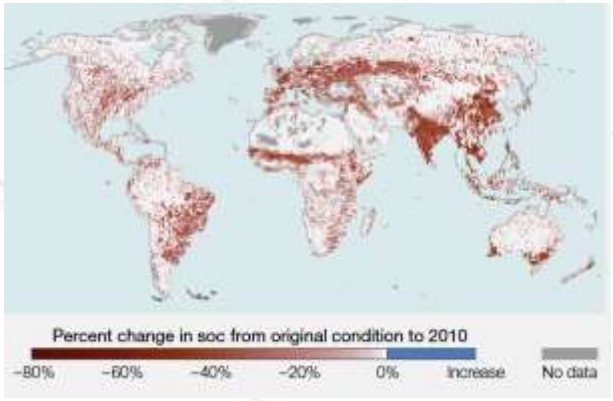
GLOBAL SYMPOSIUM ON SOIL BIODIVERSITY | 19-22 April 2021

Recent Successes and Persistent Challenges in Restoration of Degraded Dryland Soils

Global Land Degradation

- Land degradation negatively impacts the well-being of 3.2 billion people.
- In drylands (home to 2.7 billion people or 38% of global population) investing in restoring degraded land is especially vital to human well being.
- Only 25% of the Earth's land surface is substantively free of human alteration
  - Cropland, managed forest, grazing lands, habitation and infrastructure occupy the other 75%.
- By 2050, less than 10% will remain free of human impact.
- More than half of the land base in many regions is constrained by poor soil quality and loss of soil fertility.



IPBES (2018)

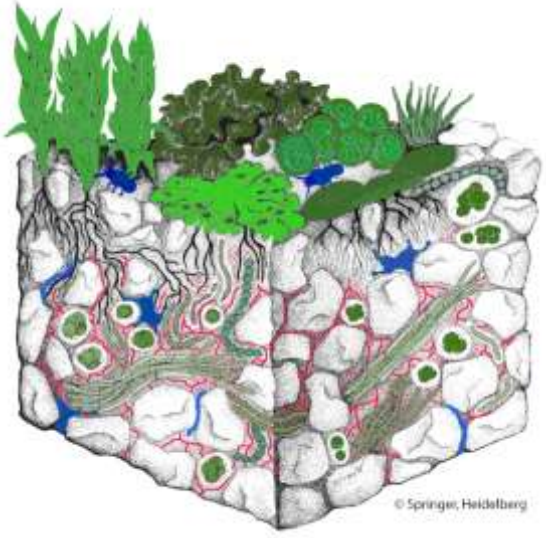
UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

- The UN Decade on Ecosystem Restoration is a rallying call for the protection and revival of ecosystems all around the world, for the benefit of people and nature.
- The Decade will accelerate existing global restoration goals which aims to restore 350 million hectares of degraded ecosystems by 2030 – an area almost the size of India.

Need for Soil Restoration

- Soil surface disturbance may increase soil erosion and alter nutrient and water cycles
- An important component of soil recovery in some dryland environments is contingent on recovery of the biological soil crust (‘biocrust’) community
- Biocrust recovery after soil surface disturbance is slow, thus there may be limited capacity for natural recovery
- Effective biocrust restoration strategies are needed for disturbed dryland soils

What are biocrusts?



modified, Weber (2016)

~2 mm

Use of Microbial Inoculants in Soil Restoration and Rehabilitation

Management of Indigenous Plant-Microbe Symbioses Aids Restoration of Desertified Ecosystems

Natalia Requena, Estefanía Pérez-Solís, Concepción Azcón-Aguilar, Peter Jeffries, José-Miguel Barea

DOI: 10.1128/AEM.67.2.495-498.2001

Biomed Res Int. 2013; 2013: 863240.
Published online 2013 Jul 11. doi: 10.1155/2013/863240

PMCID: PMC3728534
PMID: 23957006

Microbial Inoculants and Their Impact on Soil Microbial Communities: A Review

Darine Trabelsi and Ridha Mhamdi*

ELSEVIER

Journal of Environmental Management

Volume 134, 15 February 2014, Pages 1-7

Microbial inoculants and organic amendment improves plant establishment and soil rehabilitation under semiarid conditions

Carmen Mengual [a], Mauricio Schoebitz [a], Rosario Azcón [b], Antonio Roldán [a]

Cyanobacteria inoculation enhances carbon sequestration in soil substrates used in dryland restoration

M. Muñoz-Rojas [a, b, c], J.R. Román [d], B. Roncero-Ramos [d], T.E. Erickson [a, b], D.J. Merritt [a, b], P. Aguila-Carricondo [d], Y. Cantón [d]

Journal of Applied Ecology

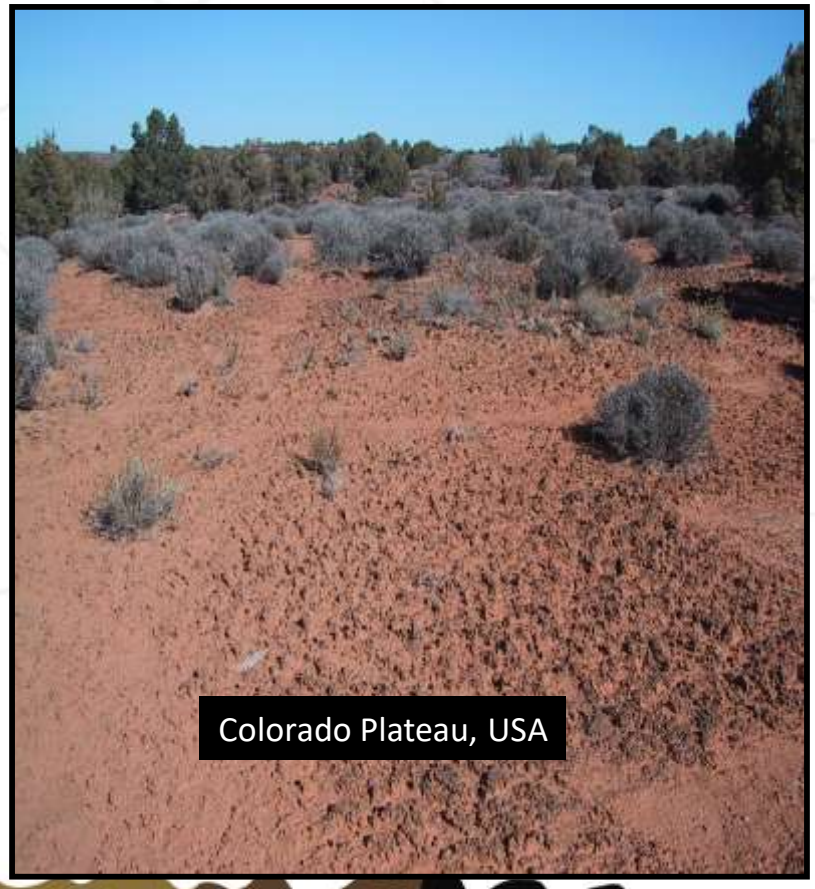
BRITISH ECOLOGICAL SOCIETY

Standard Paper | Open Access

The missing link in grassland restoration: arbuscular mycorrhizal fungi inoculation increases plant diversity and accelerates succession

Liz Koziol, James D. Bever

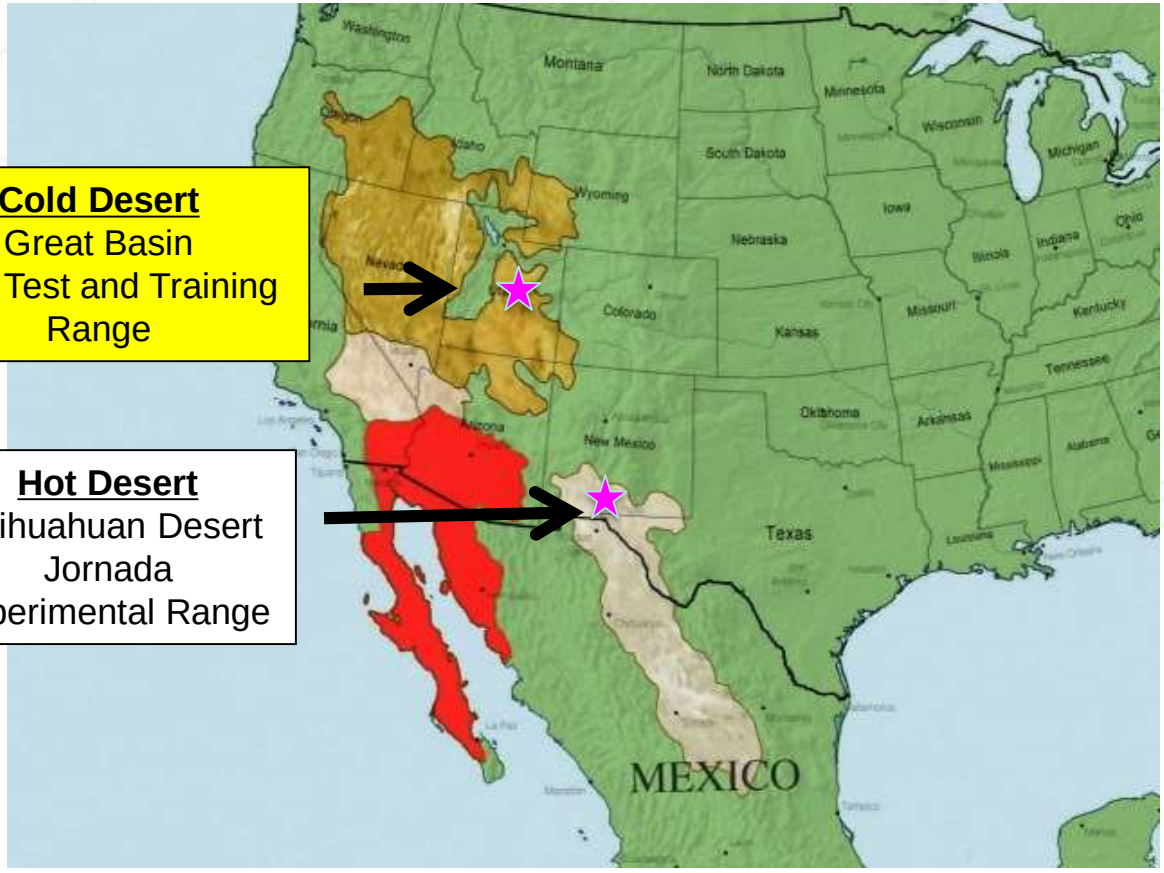
Biocrusts are Functionally Important in Drylands



Research Sites

Cold Desert
Great Basin
Utah Test and Training Range

Hot Desert
Chihuahuan Desert
Jornada Experimental Range



Staged Approach to Biocrust Restoration

Objective: Facilitate the recovery of degraded arid and semi-arid land soils by restoring biocrust communities

Develop biocrust inoculum

Identify best candidate biocrust restoration strategies

Evaluate soil responses to biocrust restoration

Develop Biocrust Nurseries

Field collected biocrust sample

LOCALLY COLLECTED BIOCRUST (LB) - GREENHOUSE GROWN

Field Experiments

MIXED ISOLATE (MI) - LAB GROWN CULTURES

Staged Approach to Biocrust Restoration

Develop biocrust inoculum

Identify best candidate biocrust restoration strategies

Evaluate responses to biocrust restoration

Best candidate restoration strategies

soil stabilization before applying inoculum identified

Straw checkerboard

Polyacrylamide

Experimental Design

Target

Intact Control

Disturbed

No inoculum (DIS)

No inoculum (NO)

Field collected inoculum (FC)

Local Biomass (LB)

Mixed Isolates (MI)

Poly (PM)

Straw (ST)

Poly

Straw

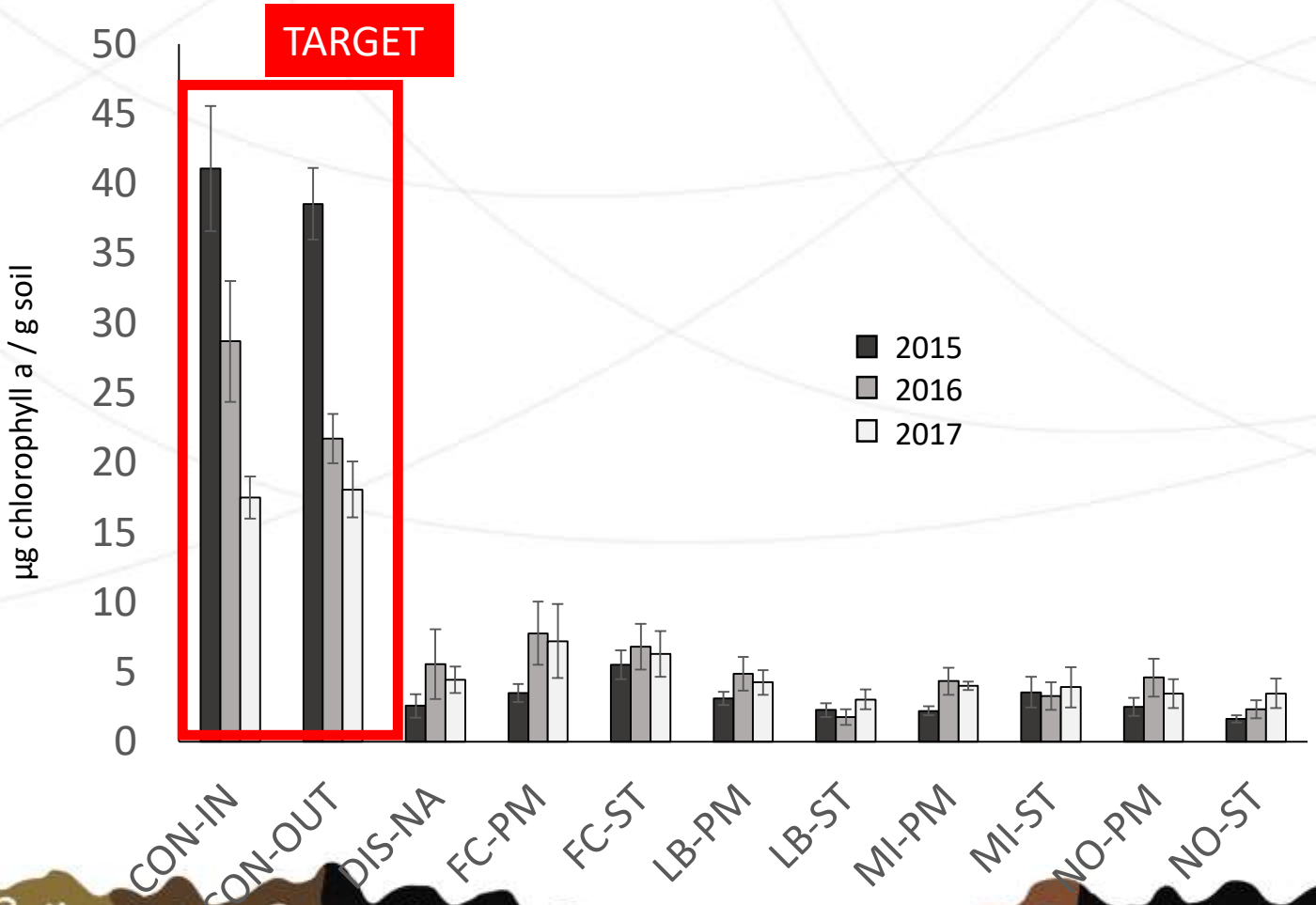
Poly

Straw

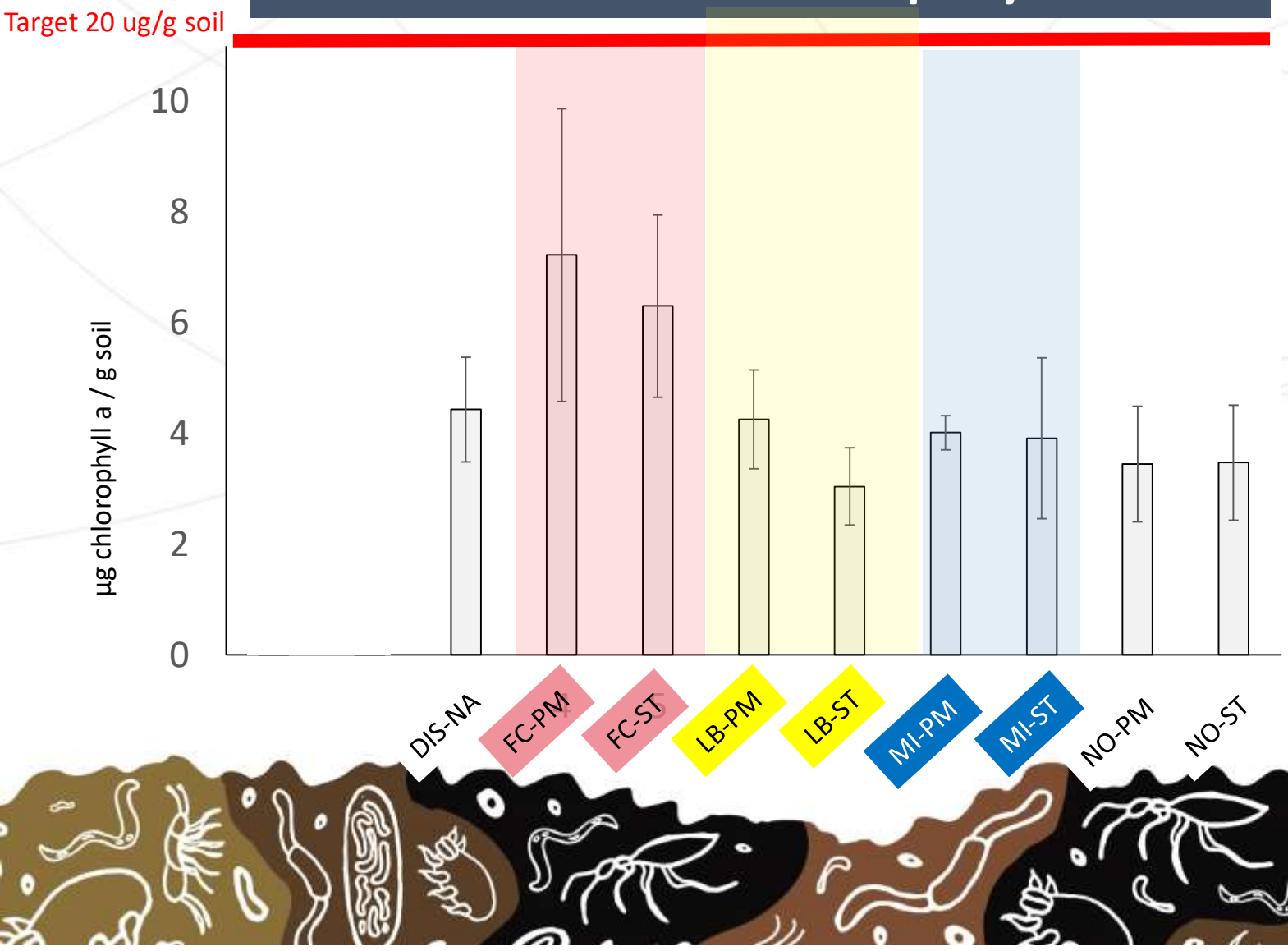
Poly

Straw

Chlorophyll a

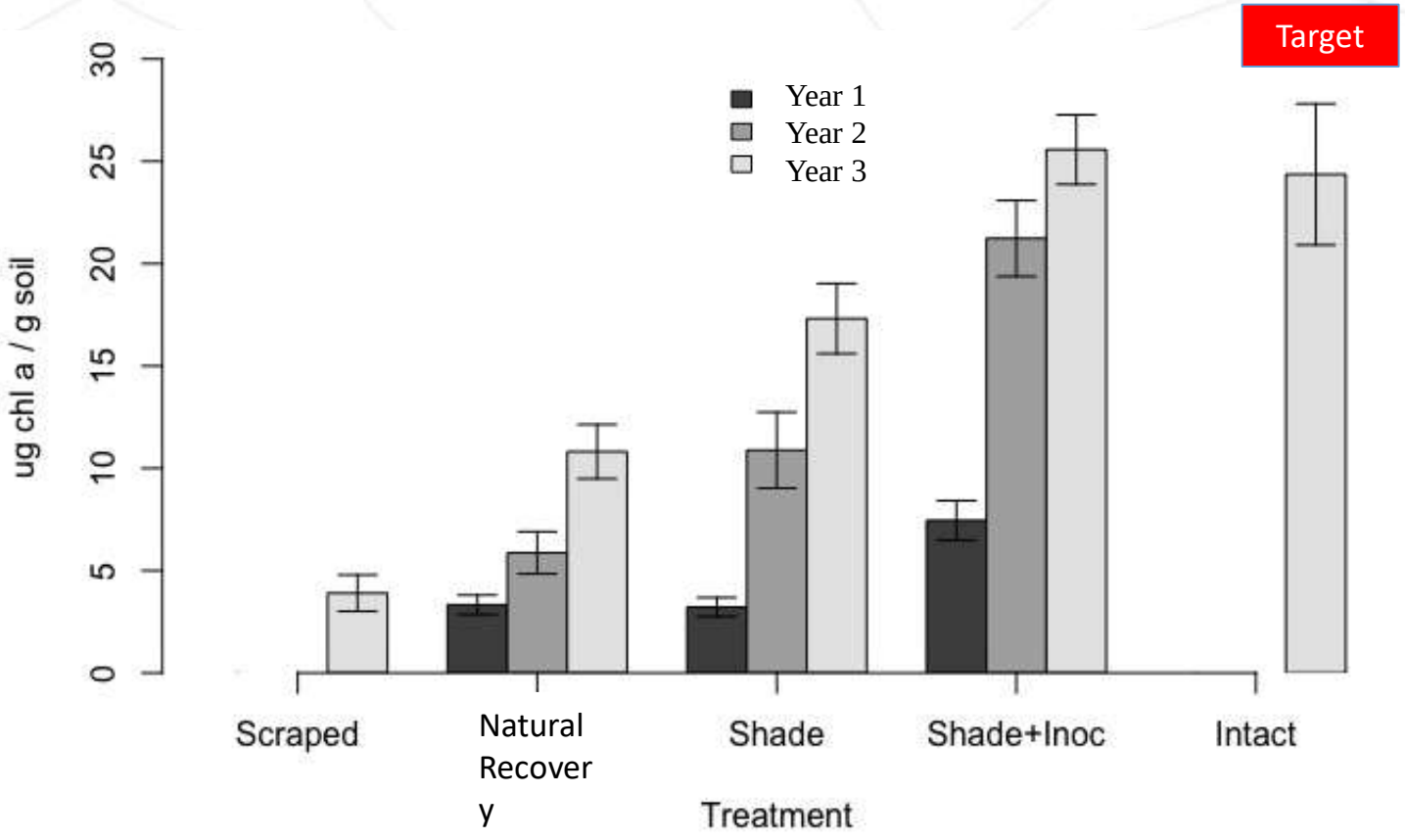


Year 3 - Chlorophyll a

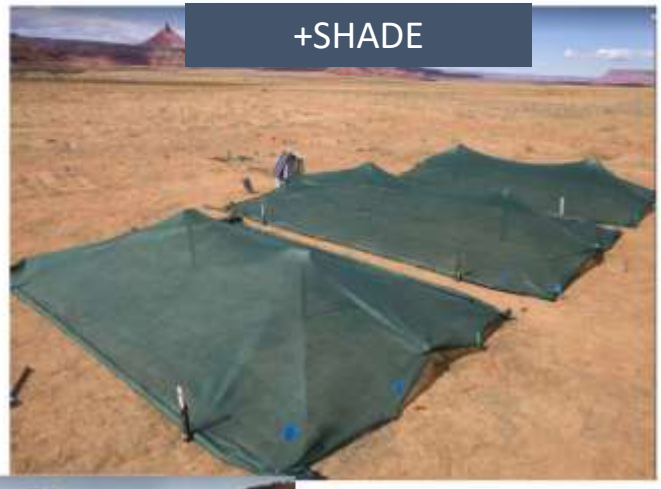


What are the likely constraints to biocrust recovery under field settings?

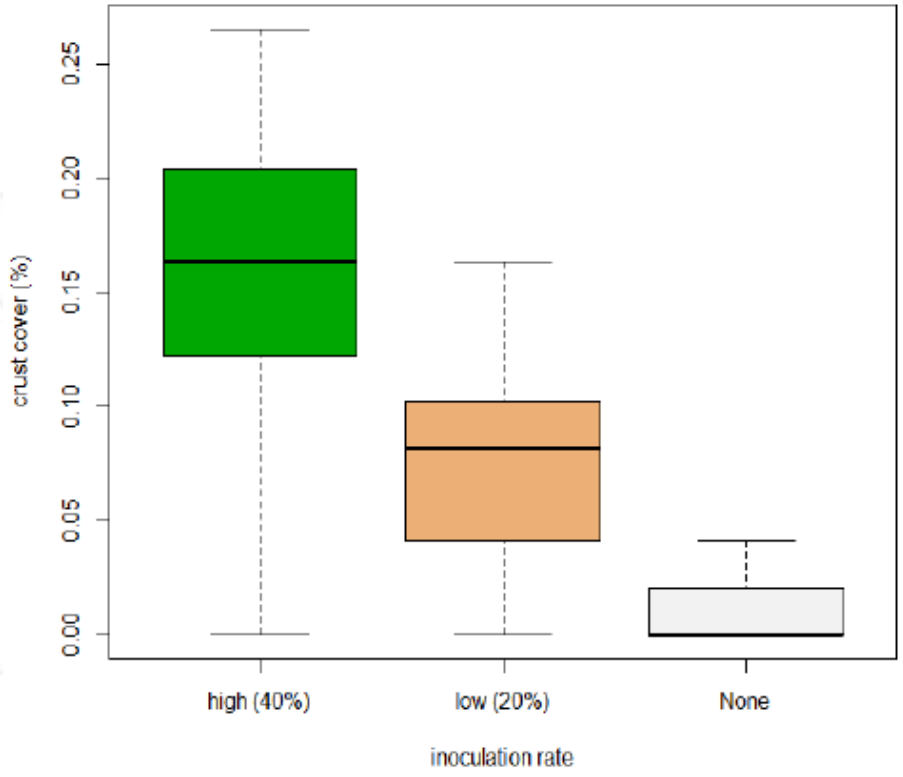
Shading Promotes Biocrust Recovery

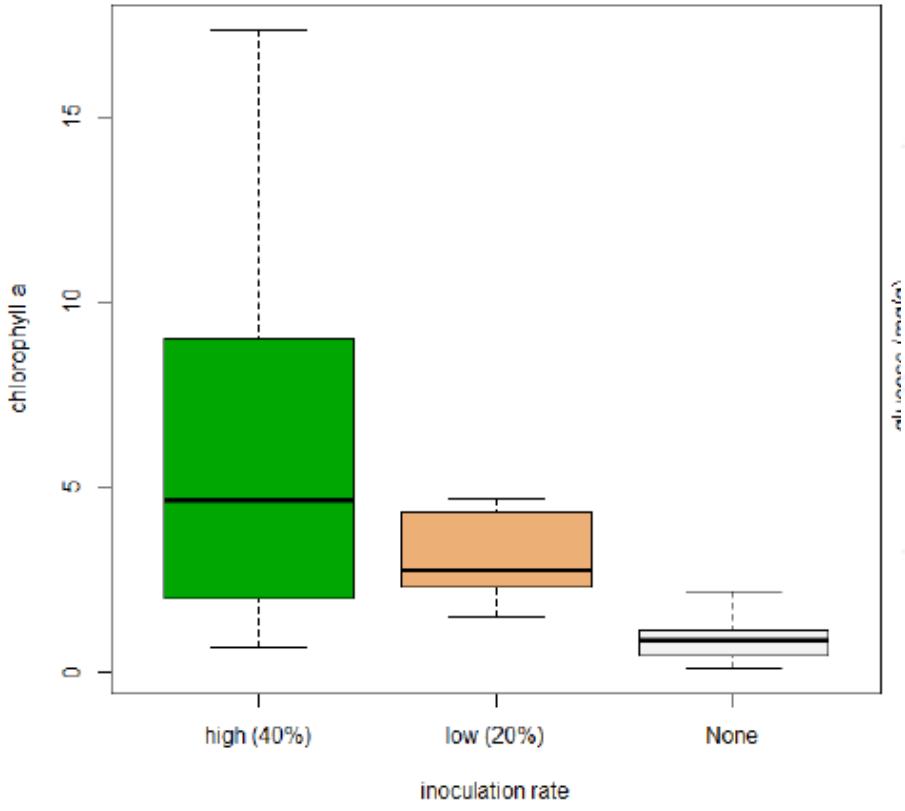


Biocrust Rapid Recovery Experiment – 4 months



Biocrust cover and chl a after 4 months





Key Messages

- Barriers and challenges still exist in biocrust recovery with inoculation under field settings.
- Irrigation and shading likely alleviate resource constraints and UV stress resulting in enhanced biocrust recovery over a short period of time.
- Future challenge is to scaling these approaches to larger landscape scale restoration approaches.

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CU UROP and BSI program also provided much support to the undergrads on the project.

Thank you for your attention