# Influence of biological soil crusts on grass germination and establishment of native and non-native grasses

Cheryl L. McIntyre[1,2], Steve R. Archer[1], and Jayne Belnap[3]

[1]School of Natural Resources and the Environment, University of Arizona, Tucson, Arizona 85721 USA, [2]Chihuahuan Desert Network, National Park Service, Las Cruces, New Mexico 88003 USA, [3]U.S. Geological Survey, Southwest Biological Science Center, Moab, Utah 84532 USA

## Introduction

Biocrusts (biological soil crusts) are communities of cyanobacteria, other microbes, mosses, and lichens, that live in and on the soil surface. Biocrusts provide important ecosystem services (e.g. reducing soil erosion and contributing nutrients), but their influence on plant community composition is somewhat limited. We know that:

- Biocrusts have a variable effect on plant seed germination[1]; less is known about establishment
- Undisturbed biocrusts inhibit some non-native annuals (e.g. cheatgrass, Bromus tectorum)[1]
- Mechanisms underlying grass germination and establishment outcomes are poorly understood
- Knowledge of these mechanisms could be used to develop more effective restoration strategies

### Question

Do biocrusts differentially affect the germination/establishment of native vs. non-native grasses?

### Predictions

1. Biocrust characteristics (dominant species, microtopography, integrity) and seed morphology (size, appendages) interact to determine seed-soil contact and the ability of seeds to enter the soil and hence their germination/establishment
2. Small seeds, seeds with small or no appendages, and native grasses are more likely to germinate/establish on intact biocrusts

## Approach

- Complimentary experiments (field and semi-controlled environments)
- Contrasting bioclimatic zones: Colorado Plateau & Sonoran Desert
- Contrasting biocrust composition and microtopography


Biocrusts on the Colorado Plateau have up to 10 cm of microtopography and support a greater moss/lichen cover.

In contrast, biocrusts in the Sonoran Desert are relatively smooth with < 3 cm of microtopography and have limited lichen/moss cover.

- Grasses with contrasting seed and appendage sizes:

native
1. purple threeawn (*Aristida purpurea*)
2. red threeawn (*A. purpurea* var. *longiseta*)
3. blue grama (*Bouteloua gracilis*)
4. bush muhly (*Muhlenbergia porteri*)
5. sand dropseed (*Sporobolus cryptandrus*)
6. sixweeks fescue (*Vulpia octoflora*)
7. needle-and-thread (*Hesperostipa comata*)

non-native
8. buffelgrass (*Pennisetum ciliare*)
9. red brome (*Bromus rubens*)
10. cheatgrass (*B. tectorum*)

subset of species used in each experiment

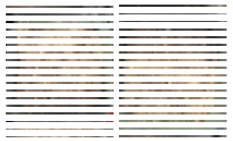

Seeds posed on Sonoran Desert lichen biocrust

## Preliminary Results

**Sonoran Desert semi-controlled environment with species #1-6, 8-9 (see bottom left-hand column):**

- Mean (+ SE) emergence higher (P<0.01) for seeds in cracks of cyanobacteria (54% ± 4) and lichen biocrusts (55% ± 4) compared to seeds on surface of intact cyanobacteria (8% ± 1), lichen biocrusts (10% ± 1) or bare soil (33% ± 3).
- Emergence higher (P<0.05) on broken cyanobacteria (21% ± 2) and lichen biocrusts (32% ± 4) compared to intact biocrusts; emergence on broken lichen biocrusts comparable to bare soil.
- Emergence of native (10% ± 1) and non-native (7% ± 2) grasses similar on intact biocrusts.
- For natives: species with lemma and awn lengths < 10mm more likely to emerge on intact biocrusts (14% ± 1) compared to those with lemmas ≥ 10mm and awns ≥ 30mm (6% ± 1).
- Removing awn(s) decreased emergence for native grasses on intact biocrusts.

**Seed Placement**

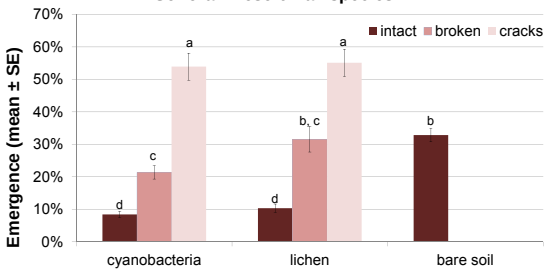


surface cracks

**Surface Disturbance**

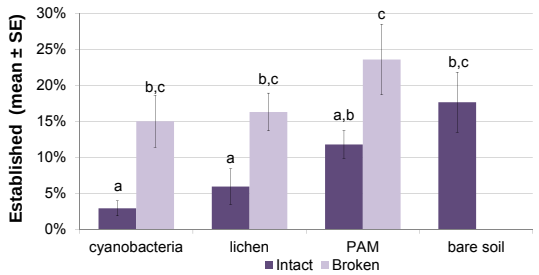
intact broken

**Sonoran Desert – all species**




**Cheatgrass field experiment, Colorado Plateau, Fall 2015:**

- Least likely to establish (4 weeks) on intact cyanobacteria (3% ± 1) or lichen biocrusts (6% ± 2) compared to disturbed cyanobacteria (15% ± 4),lichen biocrusts (16% ± 3), soil stabilizing polyacrylamide gel (PAM) crusts (12% ± 2 intact, 24% ± 5 broken), or bare soil (18% ± 4).
- Awns did not significantly affect short-term establishment on intact biocrusts (5% ± 2 vs. 4% ± 1 for seed with intact awns vs. awns removed).




## Discussion

- Placing seeds in cracks of biocrusts facilitated seed-soil contact and resulted in high germination/emergence. This supports the notion that seeds that can enter cracks, such as small seeds and seeds with small or no appendages, may be favored on biocrusts[2].
- As predicted, small seeds of native grasses emerged at higher rates compared to larger seeds on intact biocrusts (Sonoran Desert). Larger seeds also had longer awns, but contrary to predictions, removing awns decreased emergence, potentially due to changes in water absorption and dispersal ability[2].
- Higher rates of germination and early-establishment on broken biocrusts may be due to enhanced seed capture/retention, seed burial, or biocrust nutrient release[1,2]. However, other studies report increased and decreased establishment in broken biocrusts[2].


Schematic of grass seeds on surface of biocrust (modified from [3])

## Next Steps

- Repeat field establishment experiments on native and non-native grasses on the Colorado Plateau.
- Quantify persistence of near-surface moisture.
- Field experiments on establishment of native and non-native grasses on restored biocrusts in areas where non-native grasses have been removed.

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