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Bugs and Veggies - Optimization of plant based dewatering and deployment technology for fluid tailings

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Oil Sands Tailings – The Volume Problem

https://www.cbc.ca/news/canada/edmonton/oilsands-tailings-ponds-to-be-limited-by-new-rules-alberta-says-1.2993923

Composition:

- Water, sand, silt, clay, residual bitumen, unrecovered solvents

Problem:

- High affinity for water

Solids:

- Untreated tailings 10% − 30% solids
- Treated tailings 40% − 60% solids

Volume:

- 1.24 Bm^3 of fluid fine tailings in 2017*

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* osip.alberta.ca/map/

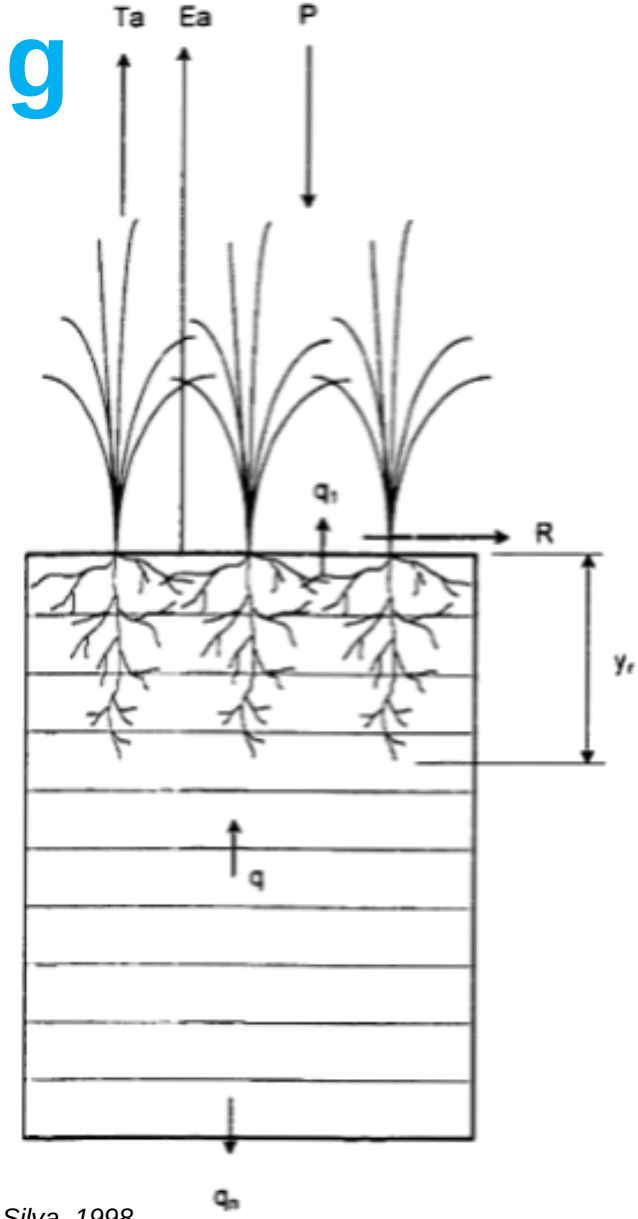
Plant Mediated Tailings Dewatering

Several studies have suggested that certain plant species may be able to grow in tailings

- Tailings pond bank stabilization
- Tailings dewatering

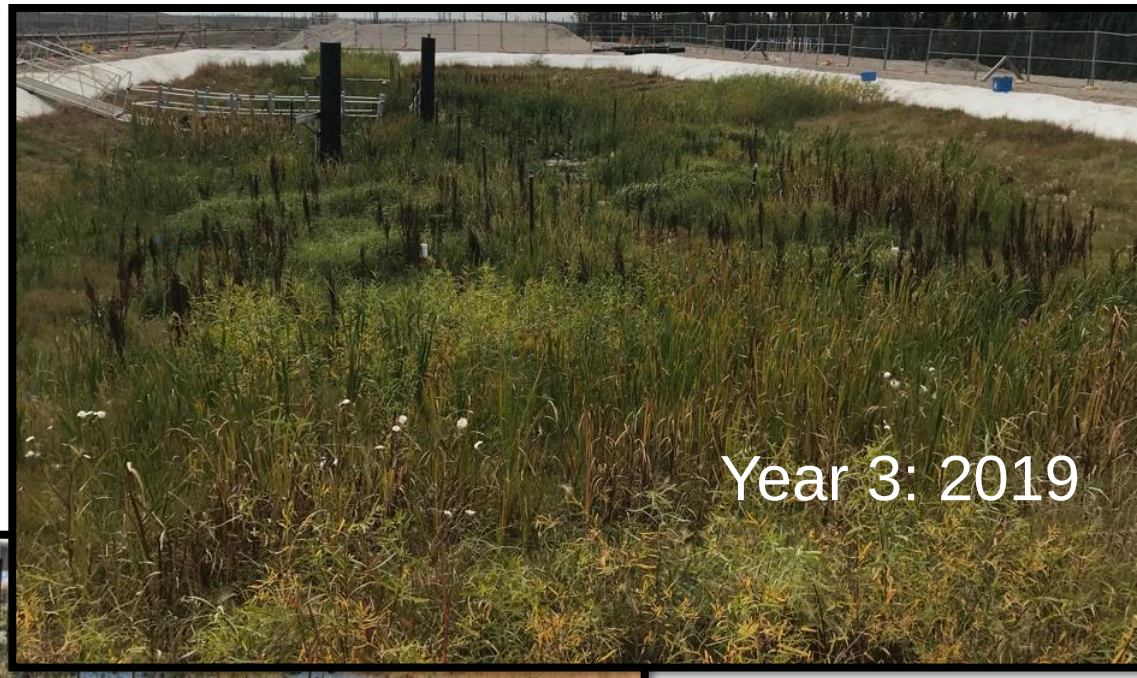
Factors that limit growth

  - Saline conditions
  - Limited nutrients
  - Hydrocarbons or organic acids



Silva, 1998

Plants Growing on Tailings



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Bioaugmentation In Plants

- **Plant growth promoting microorganisms can:**
  - Provide nutrients for plant growth
  - Degrade plant stress hormones associated with drought and salinity
  - Produce growth hormones
  - Assist in the biodegradation of organic contaminants
- **Previous studies have found improved:**
  - Seed germination
  - Plant growth
  - Yield
  - Nutrient content: nitrogen, phosphorous and potassium
  - Overall phytoremediation

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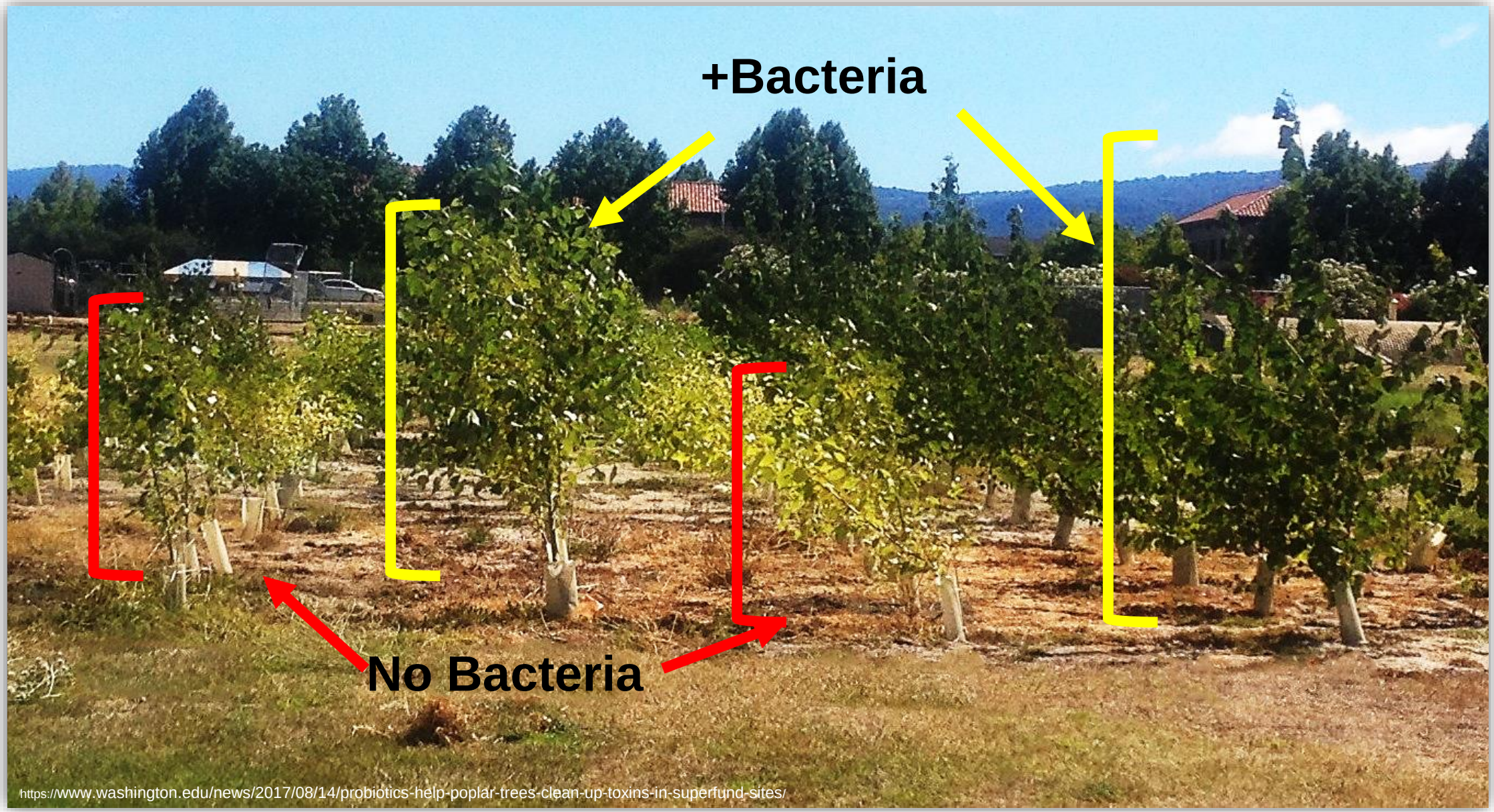
Bioaugmentation In Plants



Previous Work

Bugs and Veggies

- Evaluated sandbar willow and slender wheatgrass on thickened tailings and centrifuge cake
- Amended with peat and hydrochar
- Inoculated with enriched tailings microorganisms
- Grown in columns outdoors for 3.5 months

Key Findings

Plants

- Sandbar willows improved consolidation, removed water, and increased shear strength in tailings materials.

Amendments

- Hydrochar increased willow leaf biomass, which correlates to increased shear strength
- Bacteria significantly improved root biomass
- Bacteria with hydrochar, produced higher mean average shear strengths than hydrochar alone

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Ongoing Work – Deployment Optimization

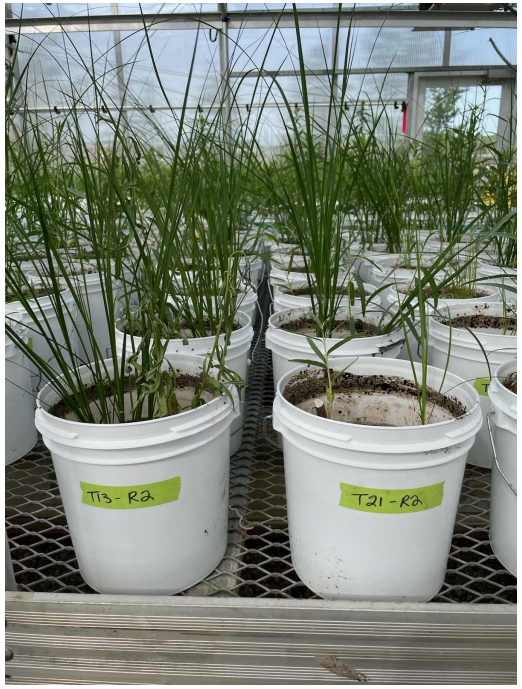

Site Supply, Inc

Objective

To optimize and utilize cost effective, low-maintenance augmented plant technology to progressively dewater tailings with low solids content

Phase 1

- **Trial 1:** Determine the effects of growing selected plant species in close proximity
- **Trial 2:** Determine if floating mats can support wetland species and willows on untreated tailings for dewatering purposes
- **Trial 3:** Determine if the addition of amendments such as hydrochar and bacteria improve plant growth for application on floating mats



Phase 2

- Scale-up successful treatments

Trial 1 – Plant Species Evaluation

***Carex Aquatilis* (Water Sedge)**

https://ksgrowers.com/carex-aquatilis-water-sedge

http://ravensongseeds.com/herbs/western-dock

***Rumex occidentalis* (Western Dock)**

https://garden.org/plants/photo/296415/

***Salix interior* (Sand-Bar Willow)**

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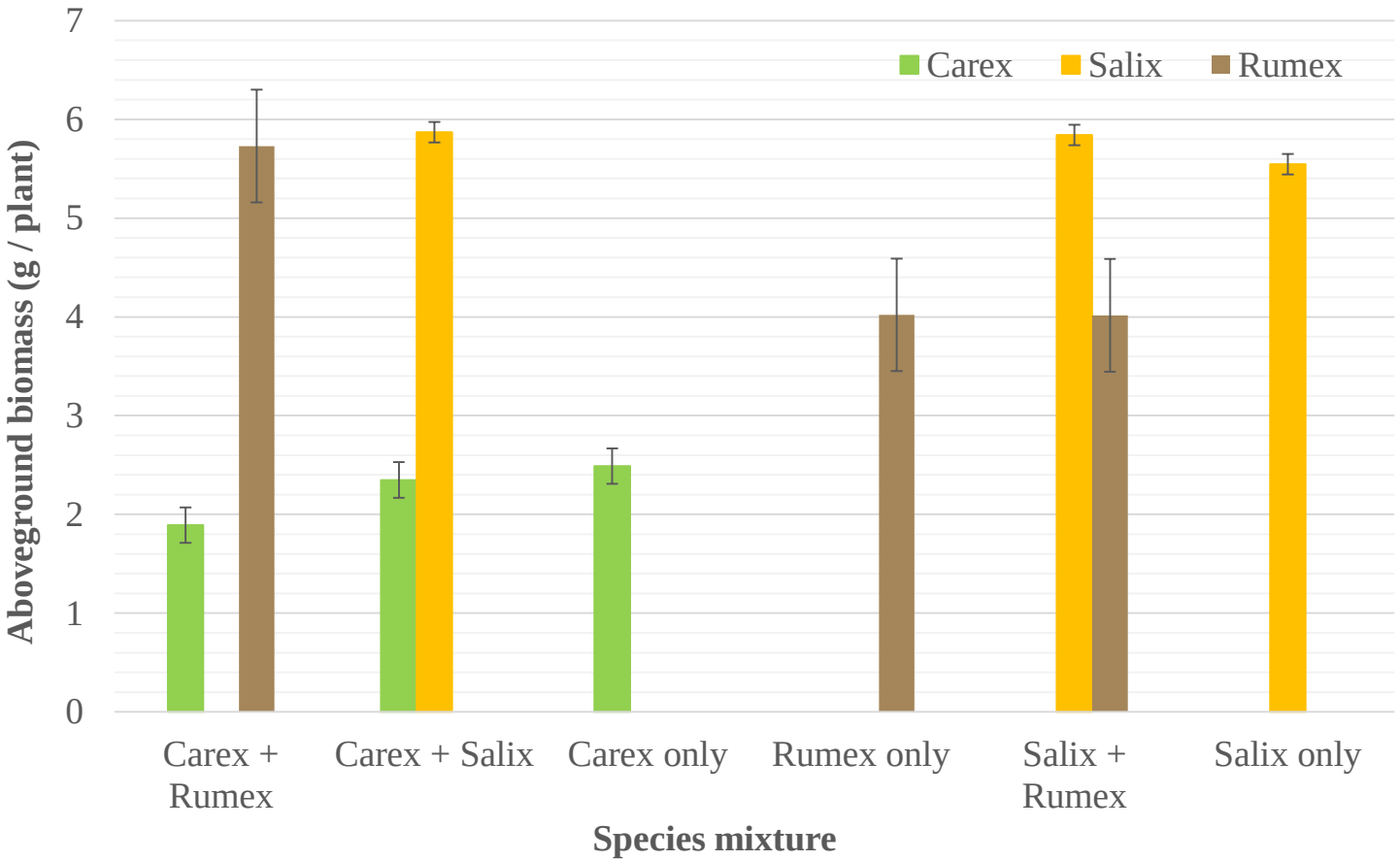
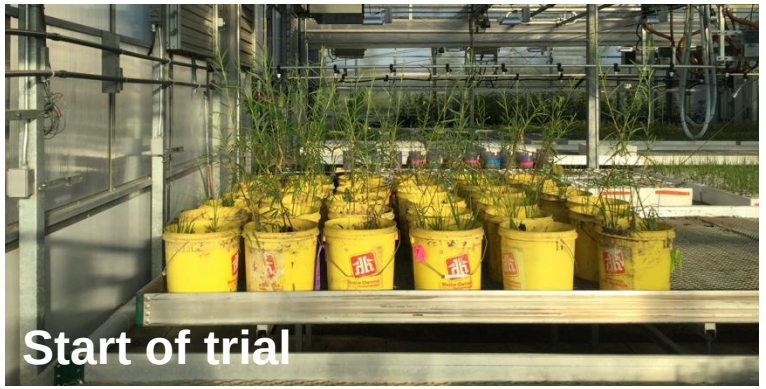
Trial 1 – Results



30 Days



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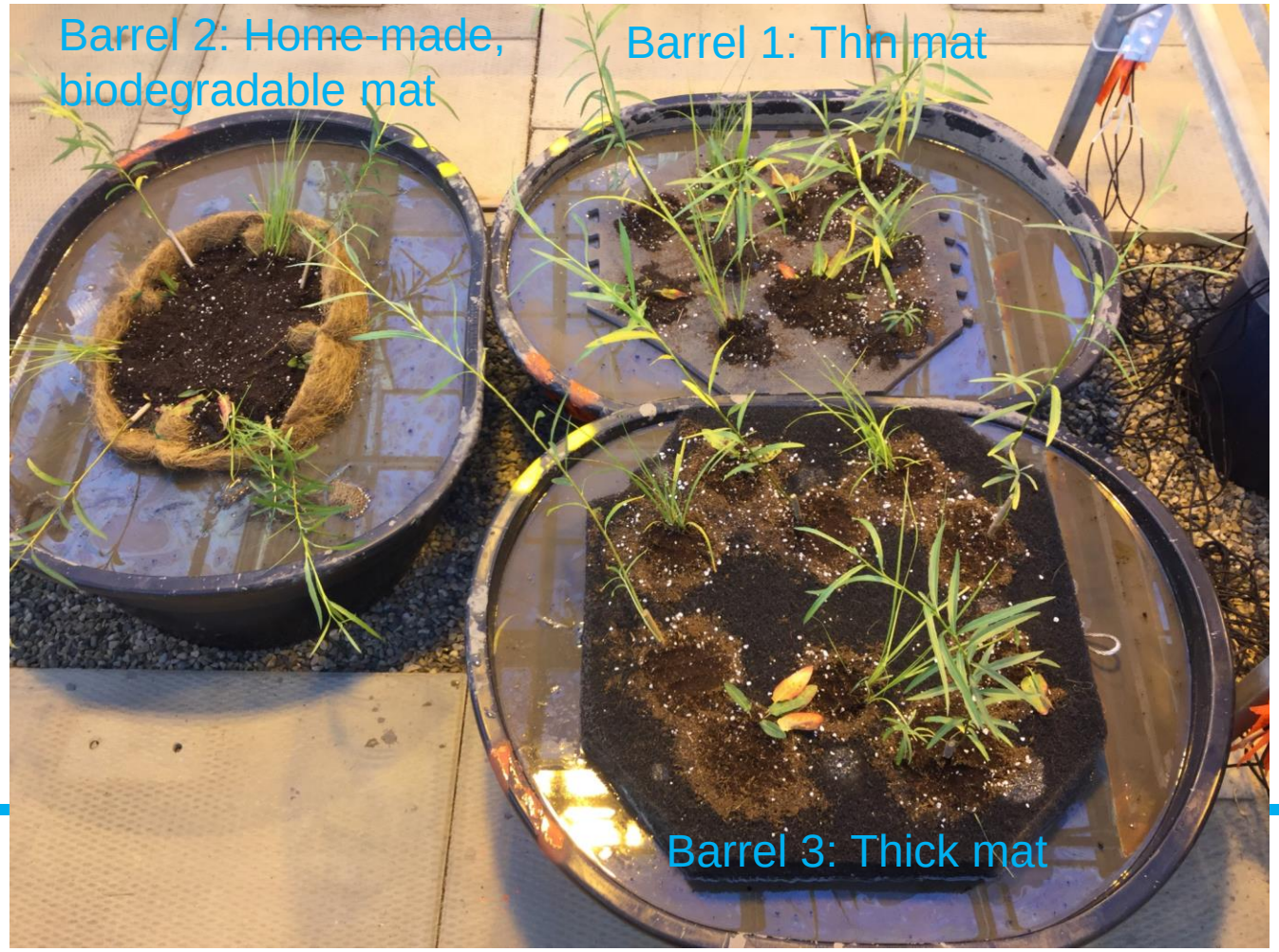
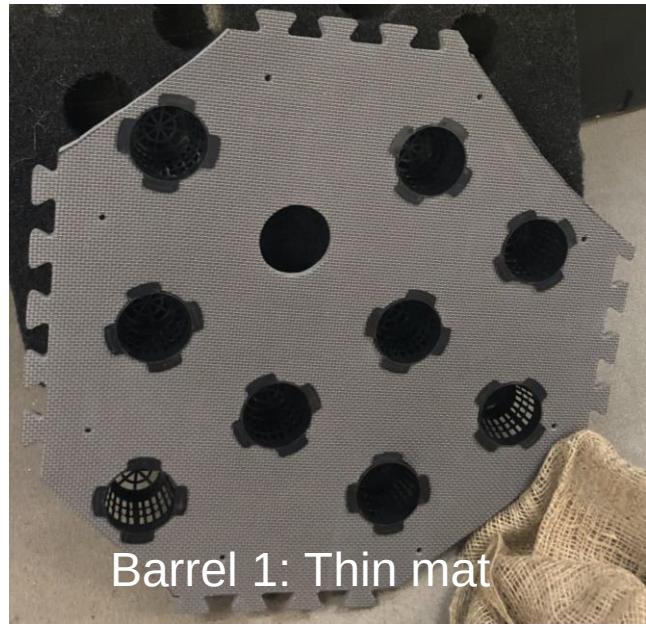
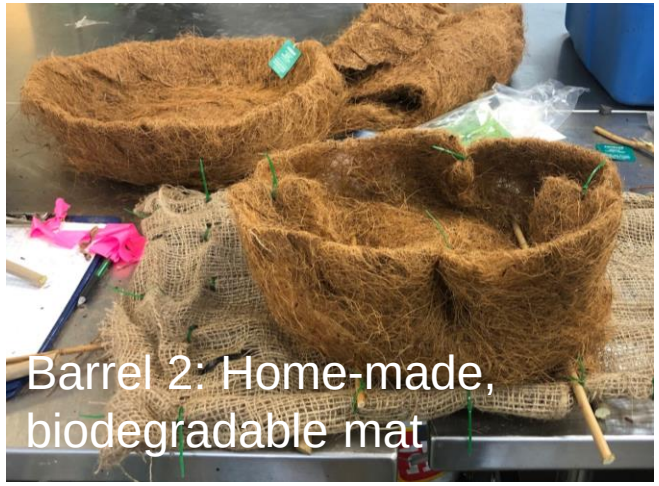
Trial 2 – Floating Mats







Solids content at start of study: 32%

Trial 2 – Harvest After 15 Weeks

Barrel 1

Barrel 2

Barrel 3

Barrel 1 – Thin Mat

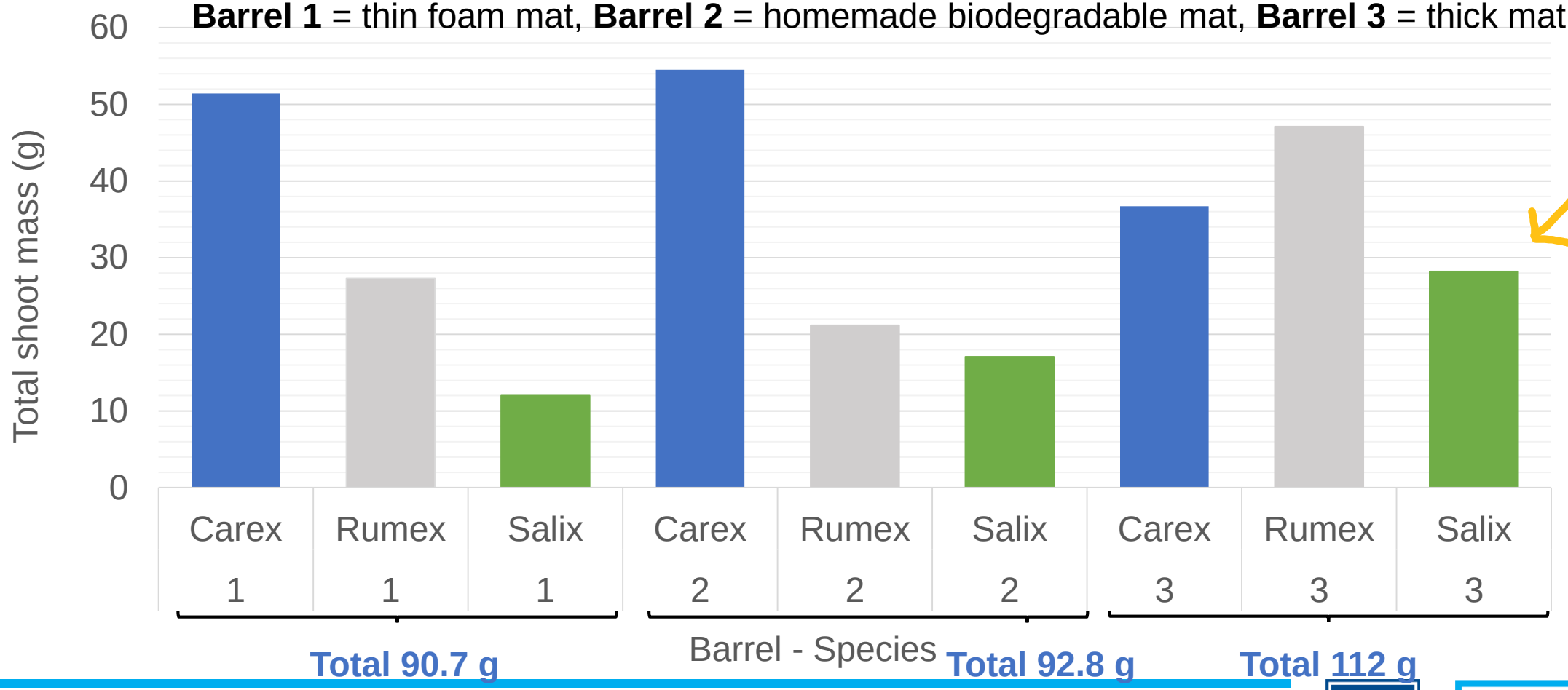
Barrel 2 – Biodegradable Mat

Barrel 3 – Thick Mat

Trial 2 – Biomass Results

Only 3 willows (rather than 4) as one died shortly after planting

Barrel 1 = thin foam mat, **Barrel 2** = homemade biodegradable mat, **Barrel 3** = thick mat



Solids content at end of trial: 56 − 60%

Trial 3 – Amendments

Treatments

- Fully factorial
- 4 microbial amendments, one control, one no-treatment
- Fertilizer
- Hydrochar

Conditions

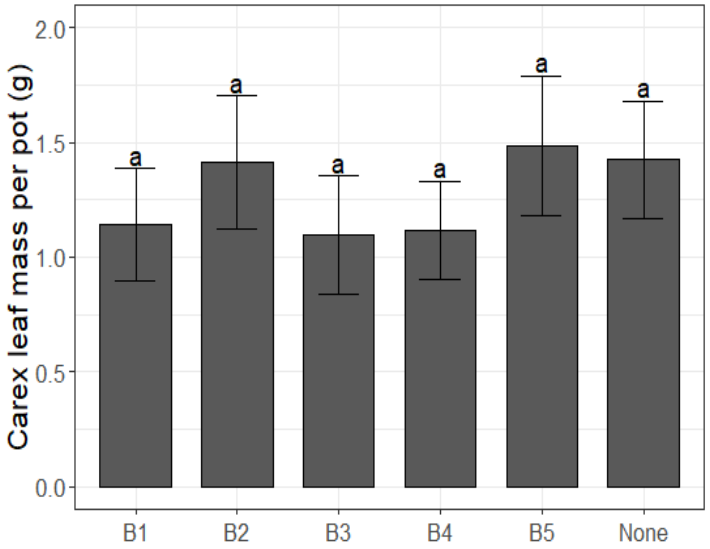
- 10 L pails, 6 replicates
- Carex and Salix only
- Grown for ~6 weeks

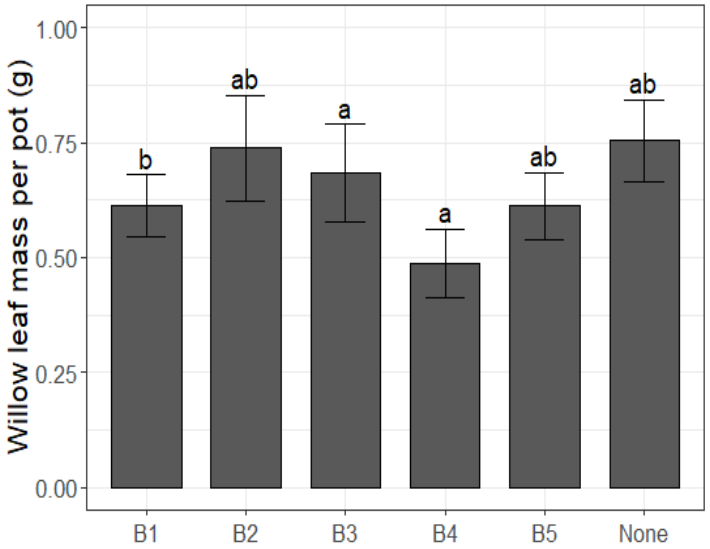
Analyses

- Above ground biomass
- Ions, TN in tailings, TN in plants
- Microbial characterization of roots and tailings

Trial 3 – Amendments

Microorganisms

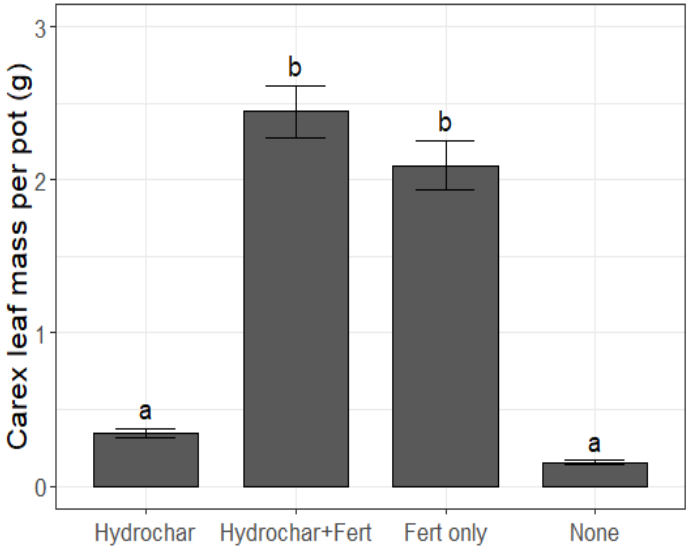


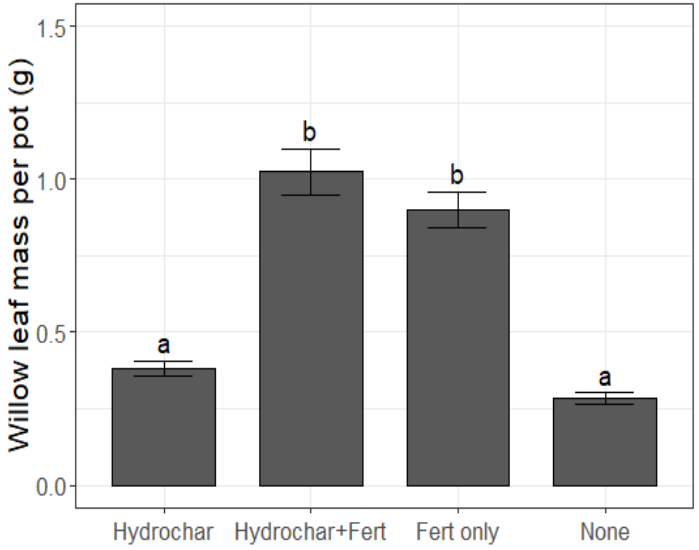


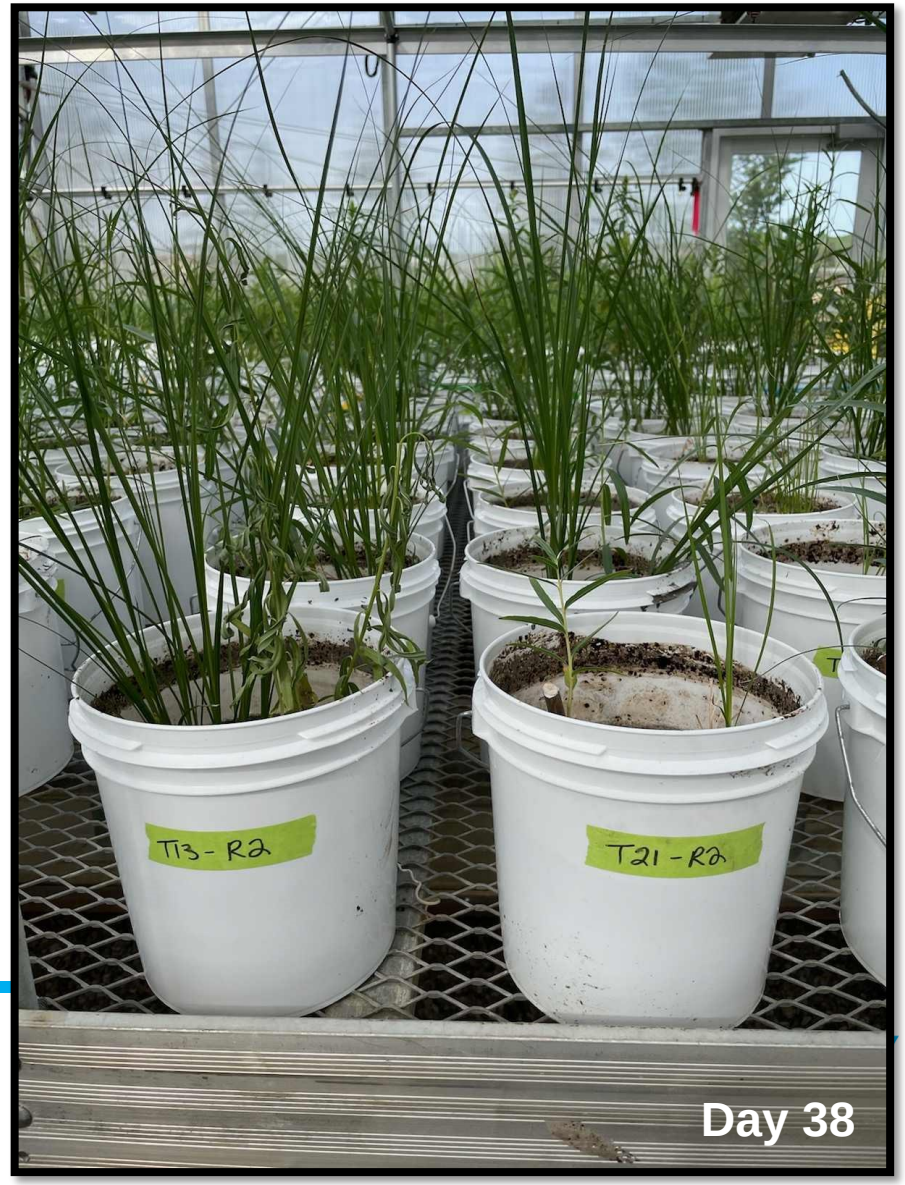
B1 – Endo/ecto mycorhizeal fungi (Premier Tech)
B2 – *Baccilus pumilus* (Premier Tech)
B3 – Custom Biologicals (5 strains *Bacillus* + N_2-fixing *Paenibacillus* + 4 strains *Trichoderma*)
B4 – Microbes enriched from Tailings
B5 – Control

Trial 3 – Amendments


Hydrochar







Phase 2 – Scale-up

Treatments

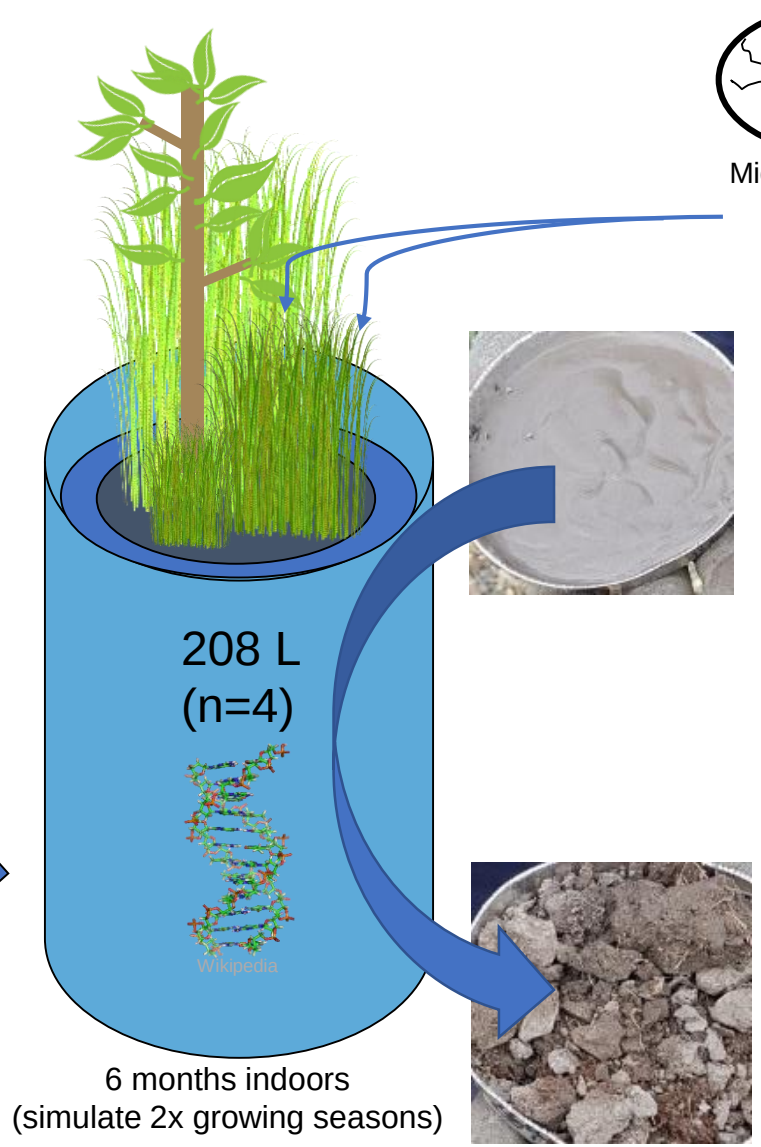
- Plants on mats with fertilizer
- Plants on mats + microbe
- Plants on mat + microbe 2 or hydrochar
- 1 barrel tailings only (evaporation control)

Conditions

- 55 gallon/208 L
- 4 replicates (1 rep evaporation control)
- 6 months growth

Analyses

- Shear strength
- Solids content
- Microbial function
- Biomass



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