UTILIZATION OF PLANTS TO DEWATER AND STABILIZE MATURE FINE TAILINGS

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The next 15 minutes looks like this:

- Context for study
- Study objectives
- Field trial: results to-date
- Greenhouse trials: results to-date
- Summary of what we have learned and thoughts for future work.
Why use plants??

REASON #1: SPAC
(soil-plant-atmosphere-continuum)

- Water uptake by plants is a passive process driven by an integrated water potential gradient.
- This is analogous to the wick drain approach used for tailings de-watering.

\[
\begin{align*}
\Psi_w \text{ Atmosphere} &= -100 \text{ MPa} \\
\Psi_w \text{ Leaf} &= -10 \text{ MPa} \\
\Psi_w \text{ Root} &= -0.1 \text{ MPa} \\
\Psi_w \text{ Soil} &= -0.1 \text{ MPa}
\end{align*}
\]

Why use plants??

**REASON #2:**
Roots stabilize (strengthen) the material they grown in (typically soil).

- Well known fact that is used in slope stabilization and for soil conservation during stockpiling.
• Preliminary investigations have shown early promise in the utilization of plants for de-watering (Silva 1999). This work was focused on agronomic species.

• However, knowledge gaps still exist:
  * Broader use of native species (this was suggest by Silva)
  * Establishment methods (seed, seedlings, cuttings, root material)
  * Toxicological and nutritional limitations
  * How to combine plants with other de-watering technologies
Study objectives

1. Evaluate direct seeding of grasses (native and agronomic) under field conditions
2. Quantify germination and early growth potential of a broader range of non-native and native plant species on MFT
3. Over a five month growing period:
   (a) Evaluate two types of inorganic nitrogen-addition on growth and production of plant species
   (b) Determine daily water-use of plants

Two types of treated MFT were utilized throughout these trials: atmospheric fine drying (AFD) and centrifuge cake, each originating from different mines
Objective 1. Evaluate direct seeding in field conditions

Experiment set-up June 2015

- Seeds hand-broadcasted within a single AFD deposit at a rate of 200 seeds per m².
- Species: barley, fall rye, slender wheatgrass, slough grass and tufted hair grass.
- A low concentration starter fertilizer blend was applied concurrent with seeding.
- Urea (46-0-0) was applied in early August 2015.
### Objective 1. Evaluate direct seeding in field conditions

<table>
<thead>
<tr>
<th>Species</th>
<th>2015 (year 1) % emergent and established plants</th>
<th>2016 (year 2) % emergent and established plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall rye</td>
<td>5.7 ± 5.2</td>
<td>23.5 ± 17.0</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>4.7 ± 7.2</td>
<td>3.1 ± 2.8</td>
</tr>
<tr>
<td>Barley</td>
<td>20.3 ± 13.8</td>
<td>-</td>
</tr>
</tbody>
</table>

*Slough grass and tufted hair grass did not develop (germinate).*
Objective 1. Evaluate direct seeding in field conditions

**September 2015**

**August 2016**
Objective 1. Evaluate direct seeding in field conditions

September 2015

August 2016
Objective 2. Germination and early growth potential of non-native and native plant species on oil sands tailings

Germination tests were conducted on the following species:

Six agricultural: Barley, Fall rye, Canola, Flax, Sweet clover, Alfalfa

Five perennial native grasses: Slender wheatgrass, Tufted hairgrass, Northern wheatgrass, Fringed brome

Four perennial native woody species: Bebb’s willow, Balsam poplar, Aspen, Green alder

Three substrates

AFD (atmospheric fine drying) processed tailings
Centrifuge processed tailings
Control (non-tailings) substrate (1:1 sand + peat mixture)
Objective 2. Germination and early growth potential of non-native and native plant species on oil sands tailings

Differences in seed germination and early survival behavior primarily driven by seed size.

Larger seeds take longer to imbibe water (slower to germinate in tailings compared with control) but generally show lower mortality due to increased C reserves in seed.
Impact of small seed size (size gradient for woody species)

Balsam poplar

Aspen

Green alder

Bebb’s willow

Decreasing seed size
Objective 3. Evaluate inorganic nitrogen-addition on plant species grown on oil sands MFT and determine daily water-use of plants

Three species: Pussy willow (native shrub), Fall rye (grass), Slender wheatgrass (grass)

Two N addition types: SuperU, Urea *This treatment ended up showing no growth or water-use difference*

Three substrates: AFD and Centrifuge tailings, Control (non-tailings) pure silica sand

•Plant water-use was tracked by weighing buckets before and after watering until the end of the experiment.
•Above and belowground biomass was harvested, oven dried at 70°C and weighed.
Objective 3. Evaluate inorganic nitrogen-addition on plant species grown on oil sands MFT and determine daily water-use of plants.
Objective 3. In two contrasting processed tailings determine daily water-use of plants

(a) willow

(b) fall rye

(c) slender wheatgrass

(d) willow

(e) fall rye

(f) slender wheatgrass

Slide 15
Objective 3. In two contrasting processed tailings determine daily water-use of plants.

(a) willow

(b) fall rye

(c) slender wheatgrass

(d) willow

(e) fall rye

(f) slender wheatgrass
What have we learned and where do we go from here?

- Agronomic and native plants can grow on mine tailings.
- Direct seeding is effective where seeds are large – with small-seeded species (most woody plants), utilization of seedlings or cuttings (where appropriate) is a better approach.
  - Further technology development required to deploy plant material on soft deposits.
- Nutrition (nitrogen) is a limiting factor that must be managed and planned for.
  - Room for optimization and further study on alternative nitrogen sources (organic versus inorganic).
- De-watering potential of plants is compelling and would be significant over a growing season providing dense and vigorous plant establishment.
  - Continue field testing under a broad range of tailings (different mines, processes etc.)
Acknowledgments

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