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RESEARCH NOTES
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Reconstructed soils in Alberta oil sands limit fine root growth of trees

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The Challenge

Oil sands mining removes large areas of vegetation and soil across the landscape, thus post-mining reclamation requires the development of reconstructed soils to support tree growth. These reconstructed soils are generally made up of a top layer of peat mineral soil mix, and an underlying layer of either tailings sand or fine-textured overburden materials. Differences in the structure of these materials create a change in texture across the boundary where the two materials meet.

This 'textural interface' can cause changes in water and nutrient fluxes through the reconstructed soil profile. This study examines the fine root biomass of two tree species (lodgepole pine (*Pinus contorta*) on tailings sand; white spruce (*Picea glauca*) on overburden) across this interface, as an indicator of ecosystem development on the reclaimed landscape.

The Approach

The researchers studied nine sites on each substrate type (tailings sand and overburden), along a gradient from low to high site productivity. At each site, they measured the characteristics of the top 10 cm of the peat mineral mix (bulk density, soil texture, carbon, nitrogen, gravimetric and volumetric soil water content) and of the overlying vegetation (aboveground biomass). They also collected site data from 10 cm above to 10 cm below the textural interface (peat mineral mix–tailings sand or peat mineral mix-overburden), including pH, electrical conductivity, soluble cations, dissolved organic carbon and nitrogen, and fine root biomass. Statistical analyses of these data were used to identify differences in fine root biomass, and the potential causes of these differences.

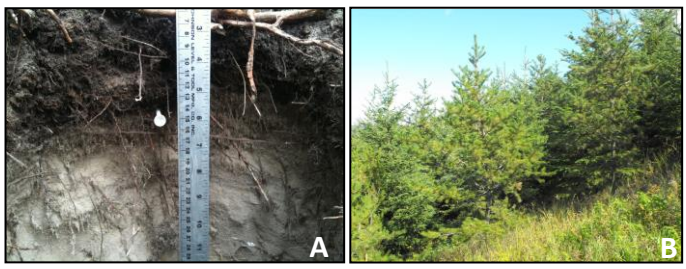

Fig. 1 (A) Roots in reconstructed soil profile (B) White spruce growing on peat mineral mix on top of overburden (Photos: M. Duan, J. House, S. Chang).

The Results

At both site types, fine root biomass was directly affected by the textural interface, which was linked with aboveground tree growth.

At the tailings sand sites, fine root biomass decreased with depth and proximity to the textural interface. The low water holding capacity and low water availability of the tailings sand led to a shortage of water and associated nutrients (both cations and nitrogen), reducing fine root and tree growth.

At the overburden sites, fine root biomass decreased abruptly at the textural interface, while electrical conductivity increased. This was associated with compaction and higher salinity levels in the overburden layer. The compaction reduced the ability of roots to penetrate the soils, while the saline soils caused salinity stress – both of which could reduce both nutrient uptake and fine root biomass.

Management Implications

- At tailings sand sites, a deeper peat mineral mix layer will help to store water and improve tree growth. Alternatively, tailings sand sites could be established in areas of low slope or with a shallow groundwater table, to maintain water and nutrient supply for fine root and tree growth.
- Although compacted soils can increase soil water availability in topsoil by reducing drainage, they also limit fine root growth. Thus, care should be taken to reduce compaction at overburden sites.
- Management techniques should be employed at overburden sites to reduce salt stress, such as capping saline overburden materials with non-saline material.

Further Reading

Jung K, Duan M, House, J, Chang SX. 2014. Textural interfaces affected the distribution of roots, water, and nutrients in some reconstructed forest soils in the Athabasca oil sands region. *Ecological Engineering* **64**: 240-249.

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