

# **Survival and Growth of Tree Seedlings on Reclaimed Oil Sands Site in Response to Fertilizer and Ground Cover Grass Species**

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# Introduction



Surface mineable  
area 4800 km<sup>2</sup>

Already disturbed  
715 km<sup>2</sup>

Need to  
reclaim!

# Introduction

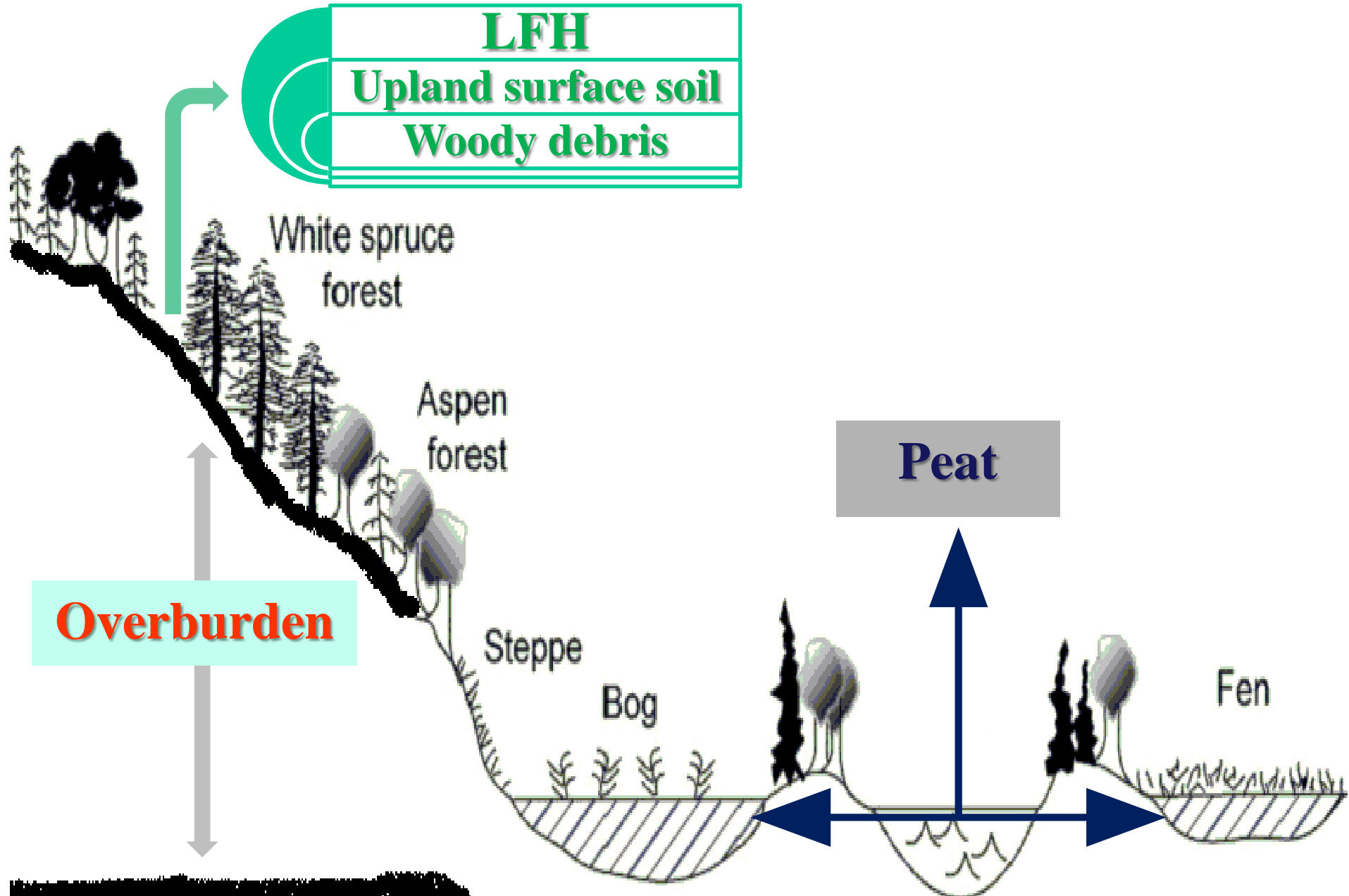


Photos courtesy of Repsol Canada Ltd. & Shell Canada Ltd.

## Surface mining and reclamation process at oil sands regions

(Government of Alberta, 2009)

# Introduction



# Introduction



**Before reclamation**

- ❖ **Waste materials (overburden, tailing sands) are used to fill-up mined pit**
- ❖ **Reclamation materials (Peat/ peat-mineral mix/ LFH/ upland soil) are used to create surface layer**

- ❖ **Ground cover**
- ❖ **Tree seedlings**



**After reclamation**

Source: OSSA

## Ground cover

- Native or planted species (Barley and Oats)
- Stabilize soil in reconstructed mine sites
- Minimize soil erosion
- Provide wildlife habitat
- Influence tree seedlings establishment?

## Why fertilizer application?

- Peat-mineral mix is deficient in P and K (Alberta Environment 2009)
- Nitrogen transformation ( $\text{NH}_4^+$  to  $\text{NO}_3^-$ ) and leaching during stockpiling of reclamation materials (Sheoran et al., 2010)
- Fertilization helps to develop a target ecosystem on reclamation sites (Rowland et al., 2009)

# Introduction

- Fertilizer application may influence ground cover and tree seedling growth. However, over application may increase competition between cover crop species and tree seedlings, and could lead to excess nutrient loss from the soil.
- Inter-specific interactions affecting tree seedling survival and growth in the Oil Sands Region are not clearly understood.



# Objectives

- ❖ To evaluate the effect of different fertilizer rates on survival and growth of trembling aspen and white spruce tree seedlings planted with two cover crops (barley and oats).

# Treatments and Design

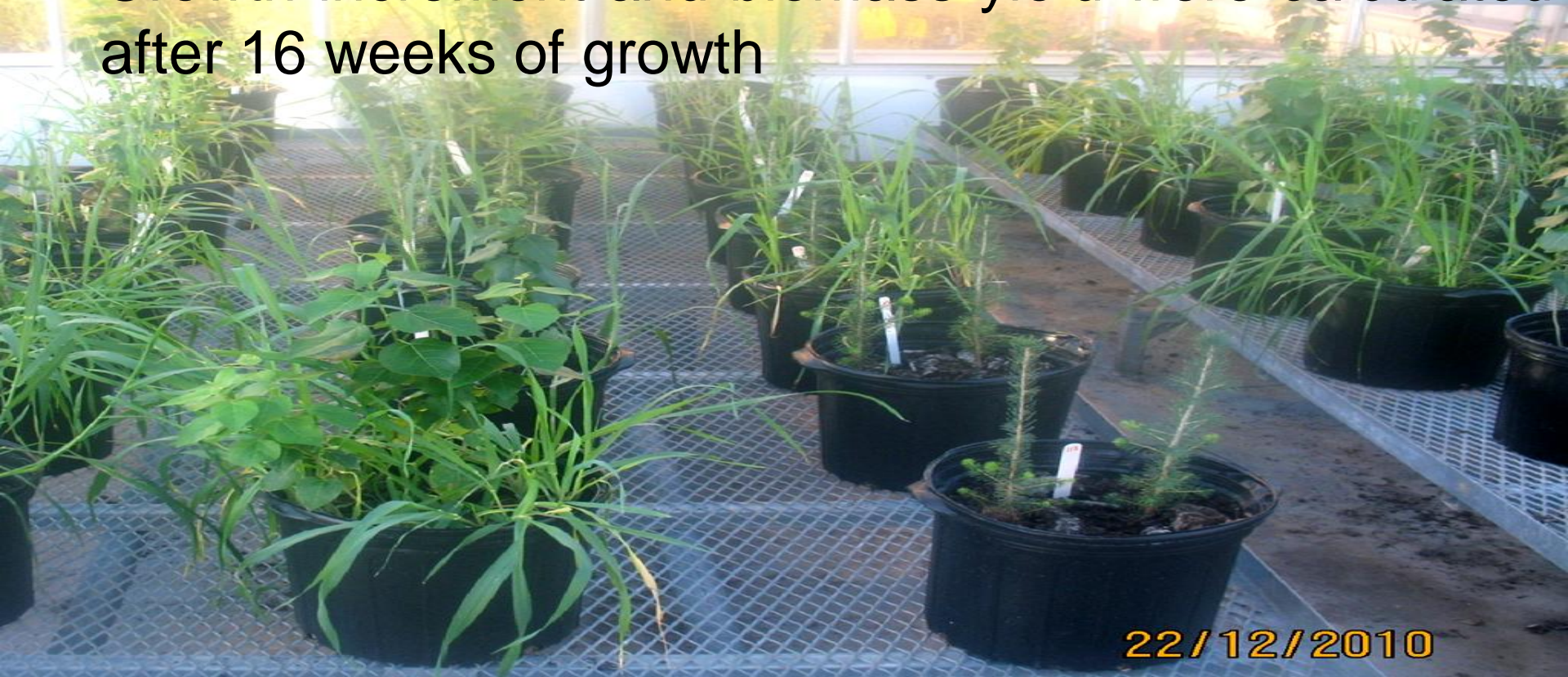
## Greenhouse experiment (U of S)

**2 x 2 x 3 x 3 bioassay factorial experiment with 4 replications (144 pots)**

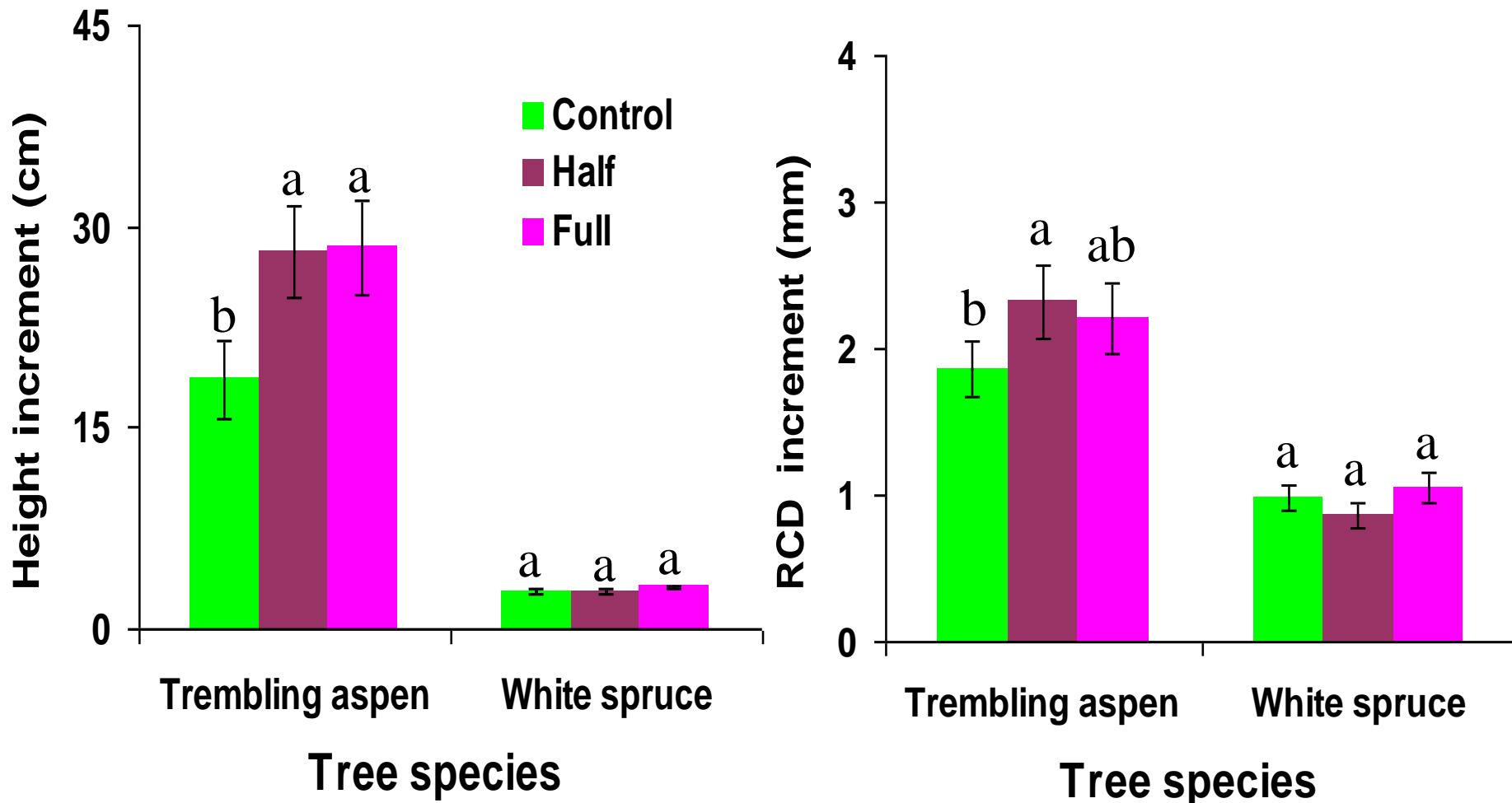
- ❖ Tree species: Trembling aspen and White spruce
- ❖ Moisture: 40 and 80 % FC
- ❖ Fertilizer: 0, 700 (half) and 1400 (full) kg ha<sup>-1</sup> (NPK 20-20-20)
- ❖ Ground cover species: Control, Barley and Oats

# Experimental management

- Seedlings were grown on peat-mineral mix
- Tree: grass ratio was 1:3
- Volumetric soil moisture was monitored by using time domain reflectometer (TDR)
- Growth increment and biomass yield were calculated after 16 weeks of growth



## Height and RCD Growth: Fertilizer x Tree species



# Results

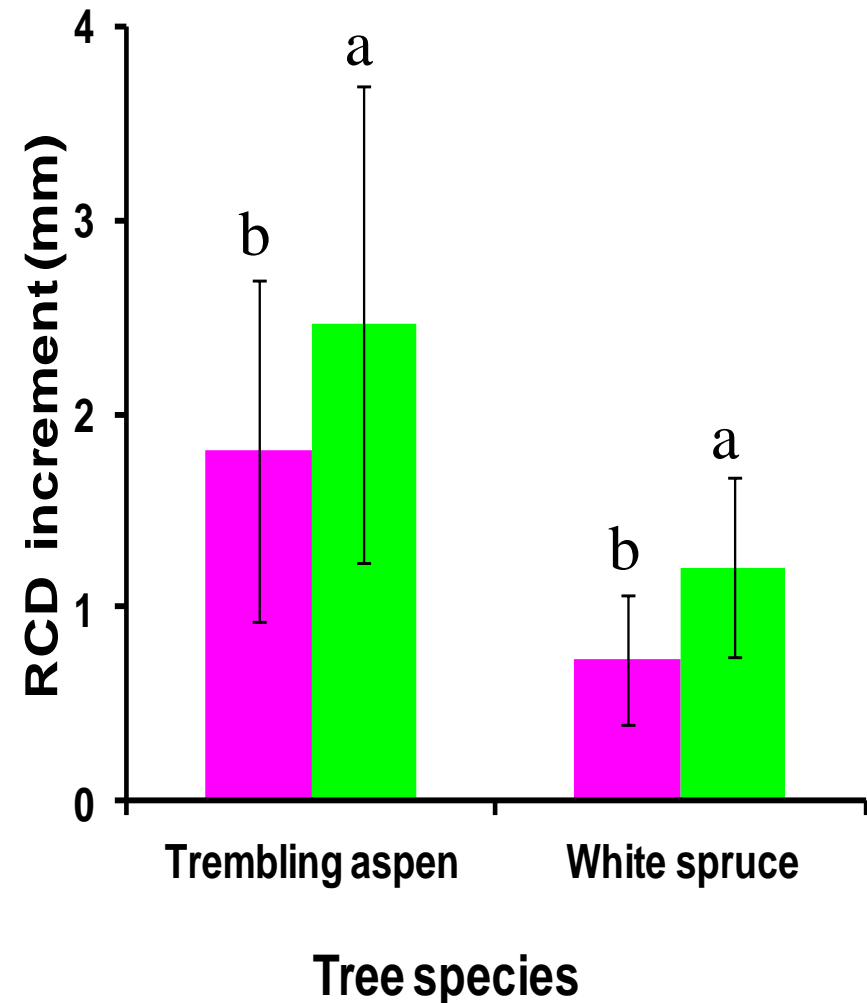
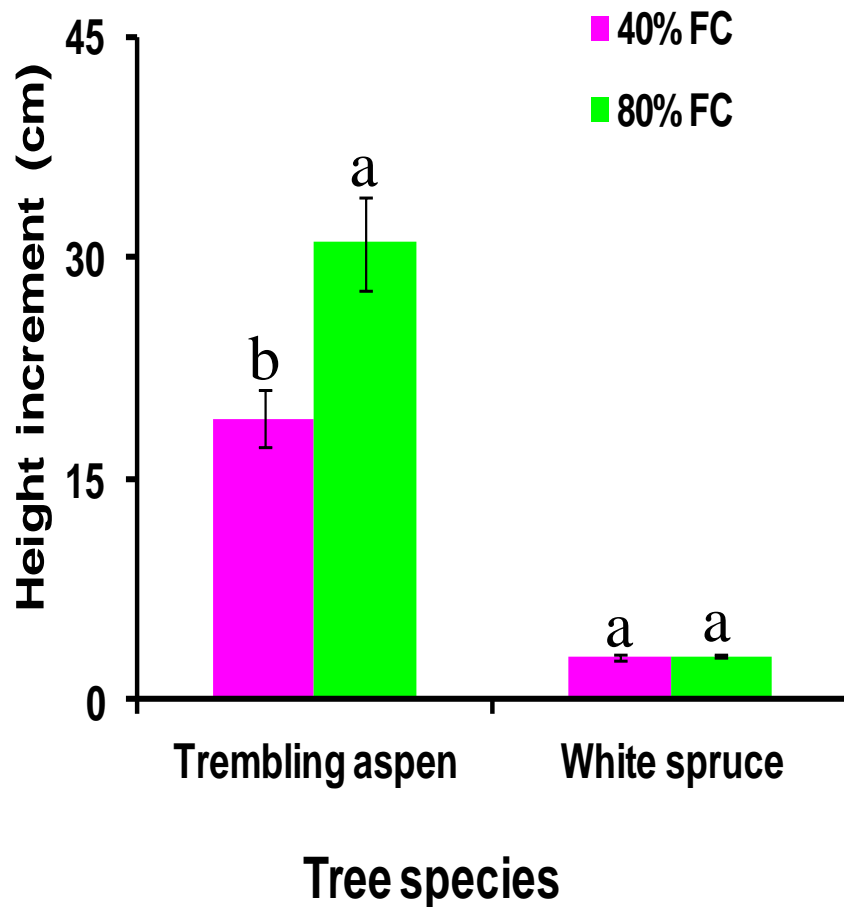
## Height and RCD Growth: Fertilizer x Tree species



22/12/2010

# Results

## Height and RCD Growth: Soil Moisture x Tree species



# Results

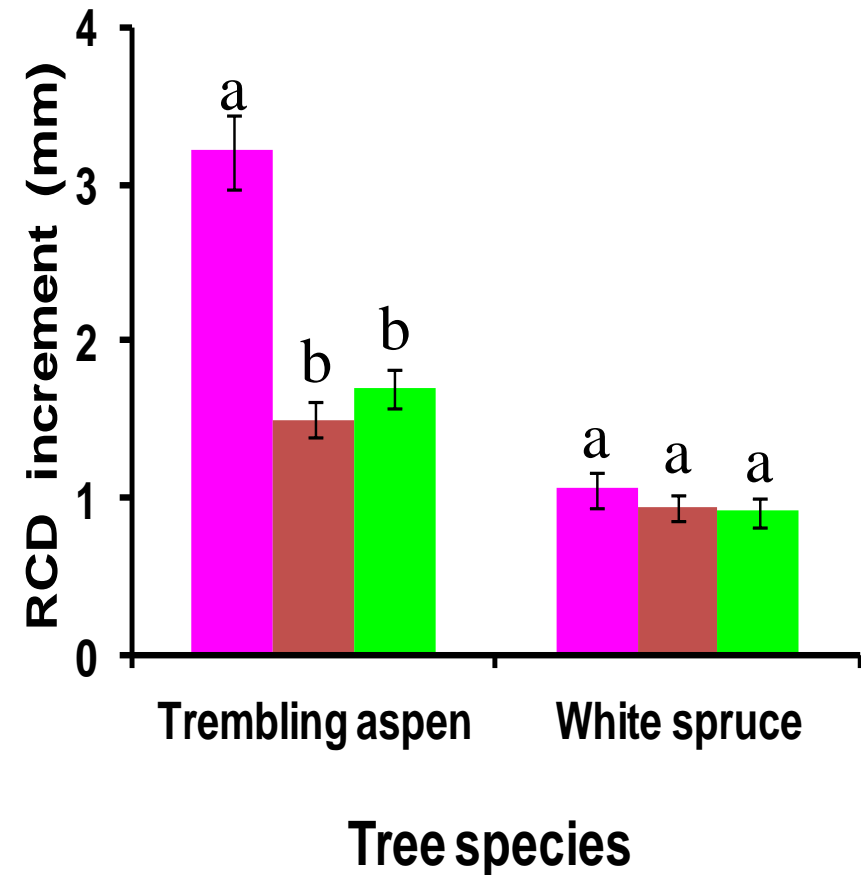
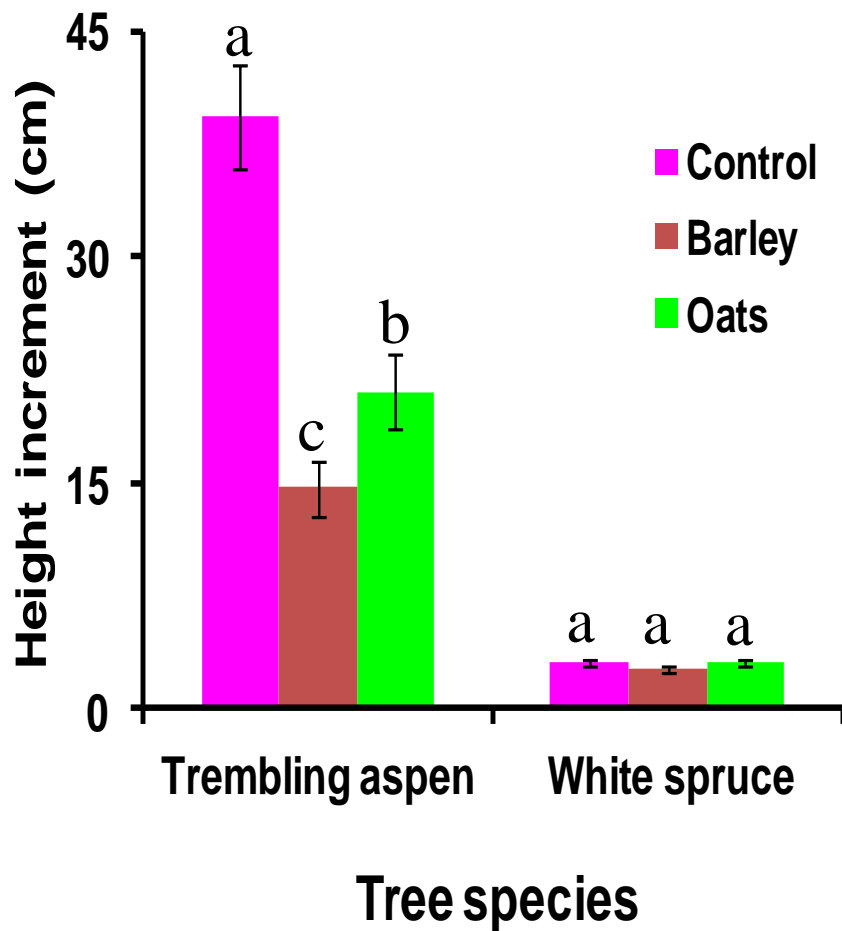
## Height and RCD Growth: Soil moisture x Tree species



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# Results

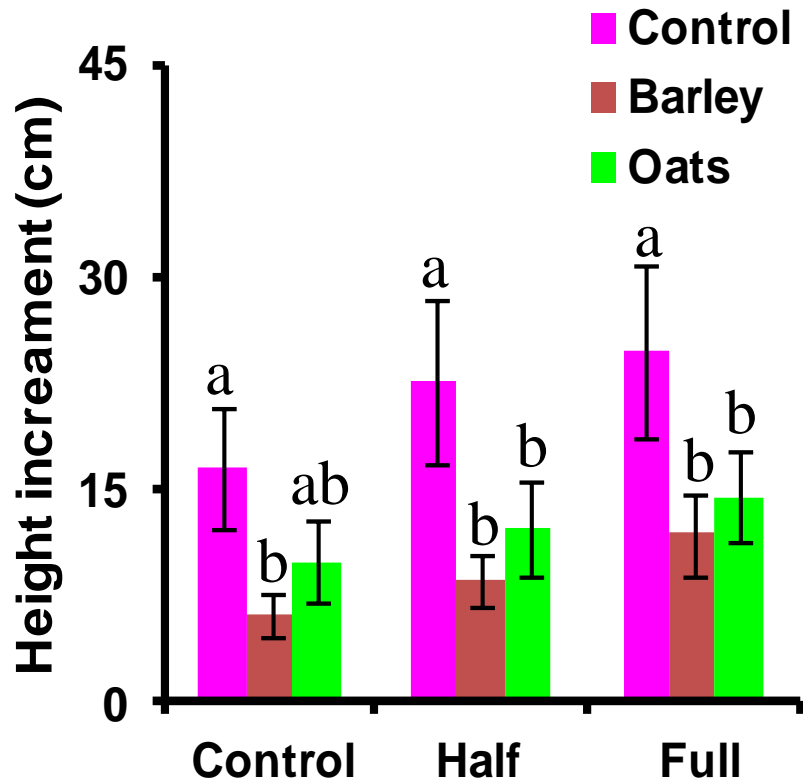
## Height and RCD Growth: Ground cover x Tree species



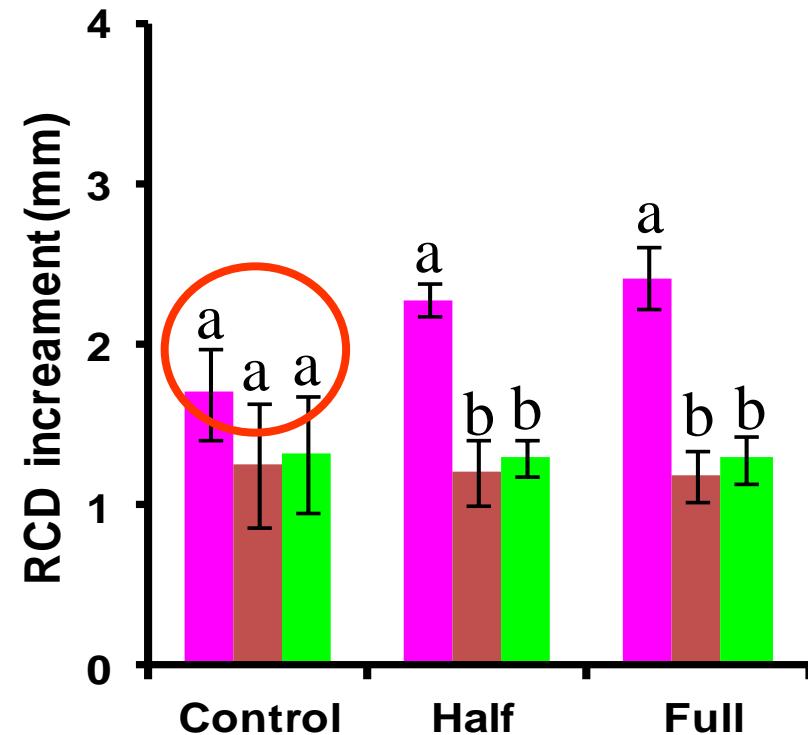


# Results

## Height and RCD Growth: Ground cover x Fertilizer



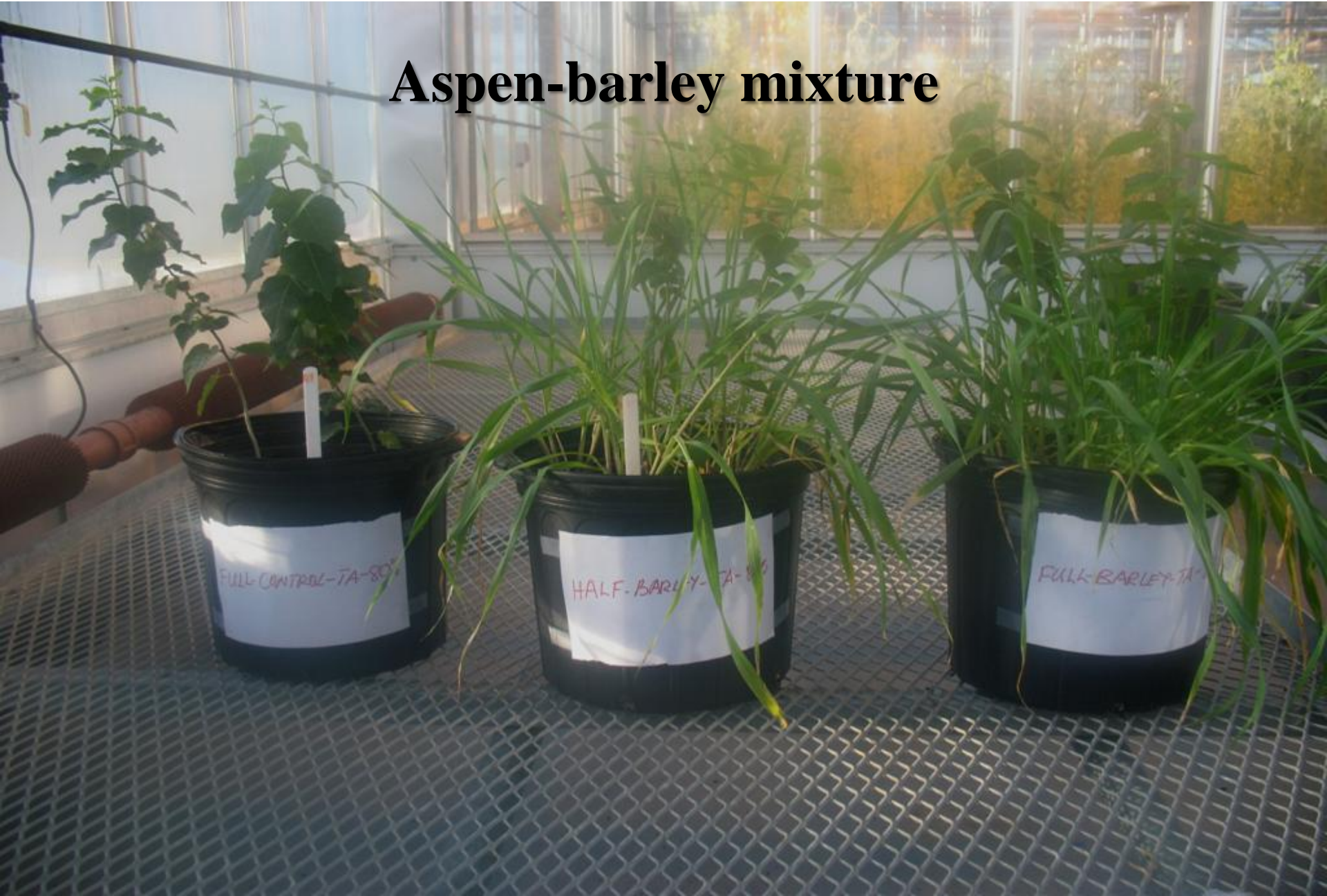
Fertilizer rate



Fertilizer rate

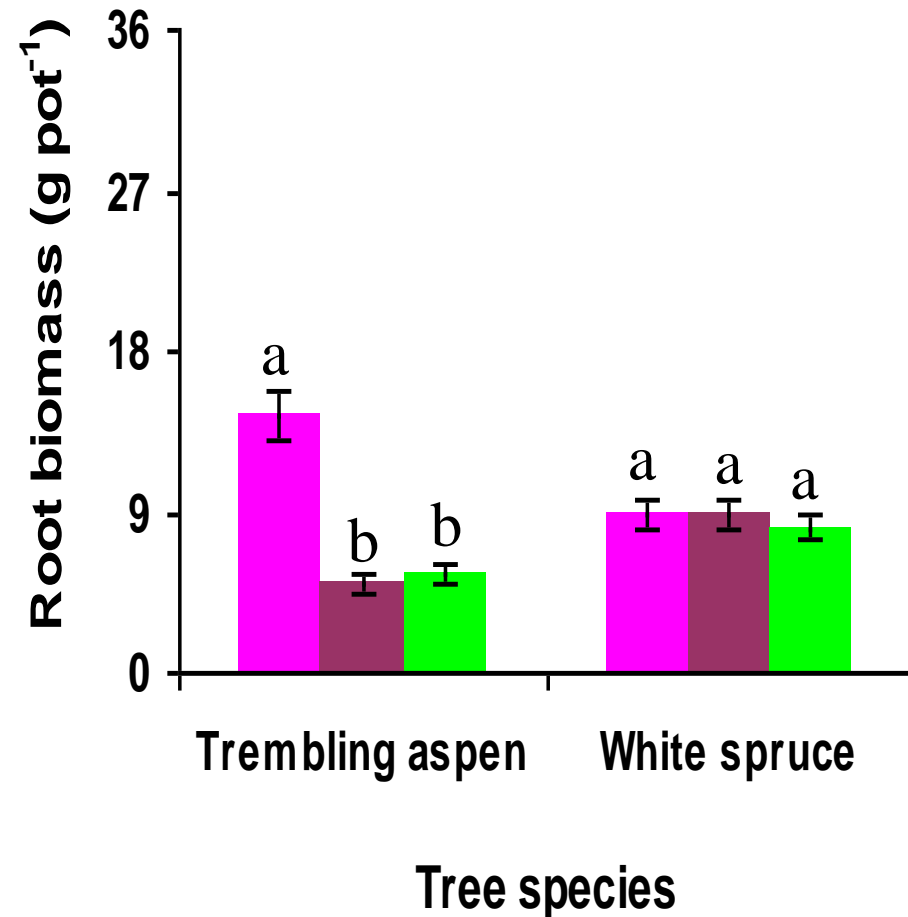
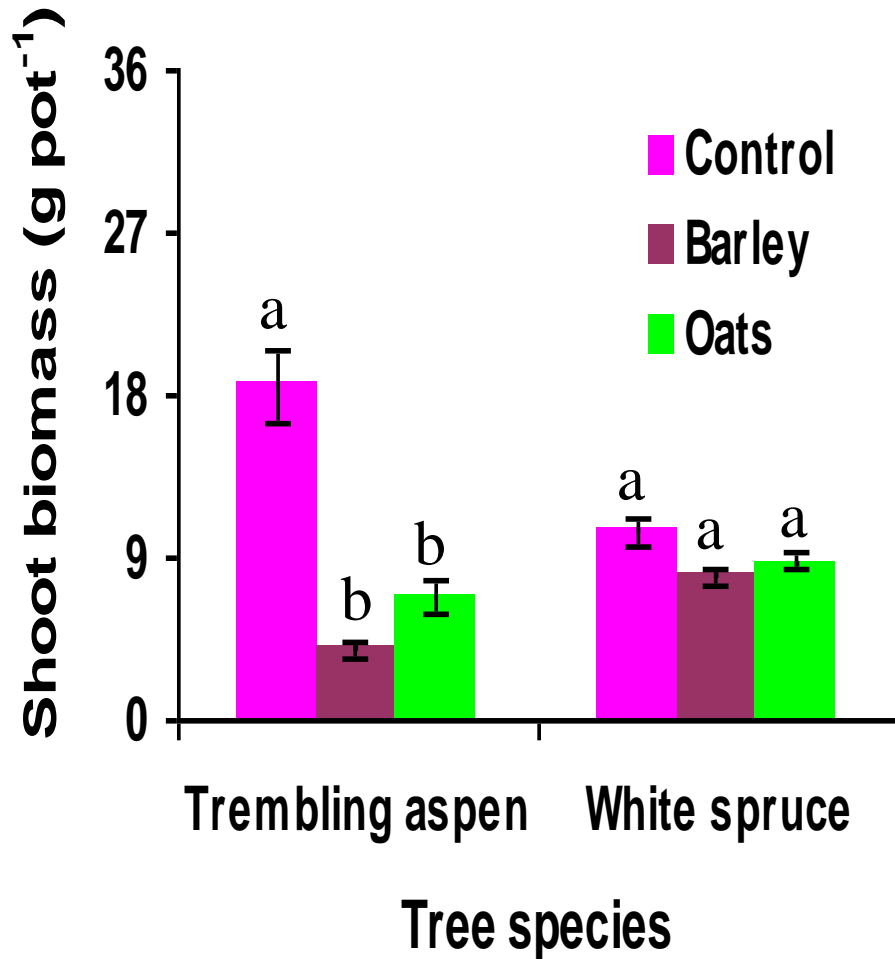
# Results

## Aspen-barley mixture



# Results

## Biomass Yield: Ground cover x Tree species



# Treatments and Design

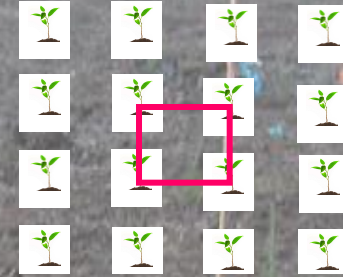
## Field experiment (Fort McMurray, Alberta)

**2 x 3 x 8 factorial experiment with 3 replications (144 plots)**

- Tree species: Trembling aspen and White spruce
- Ground cover species: Control, Barley and Oats
- Fertilizer: 0, 150, 300, 600, 750, 900, 1200 and 1500  
kg ha<sup>-1</sup>

# Experimental management

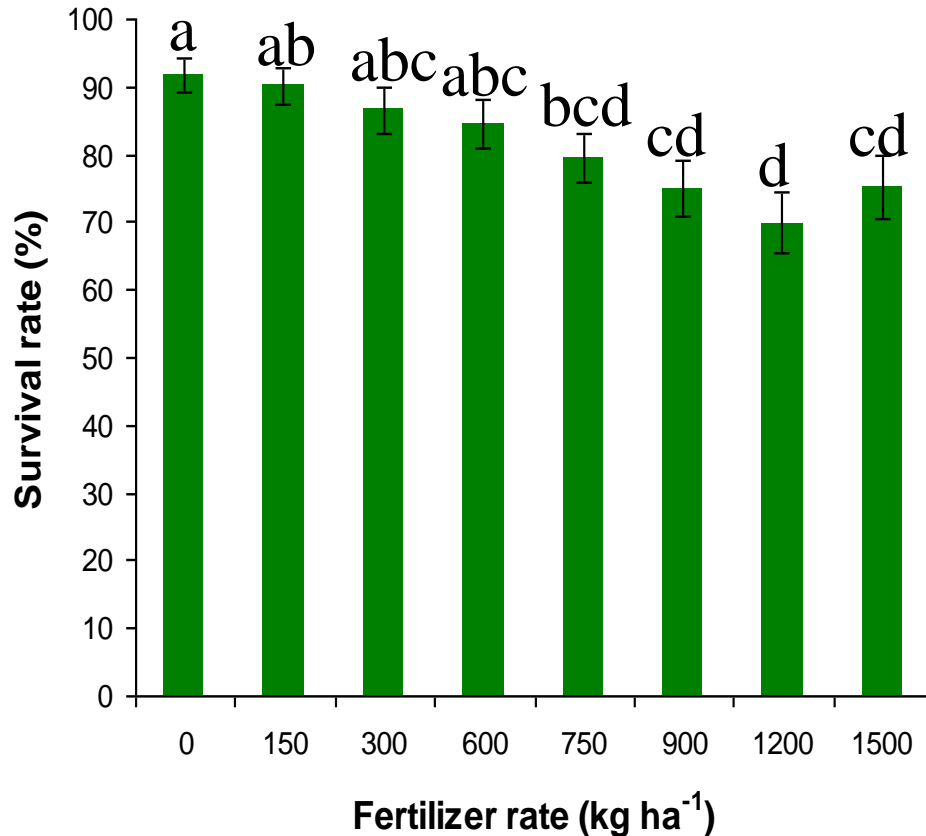
- Plot size: 10 m X 8 m
- Planting distance: 2.5 m X 2 m
- Plot to plot distance: 1m
- Block to Block distance: 3m
- Survival rate was recorded after one growing season
- Height and RCD were measured at planting and in the following two growing seasons
- Shoot and root biomass were measured after two growing seasons



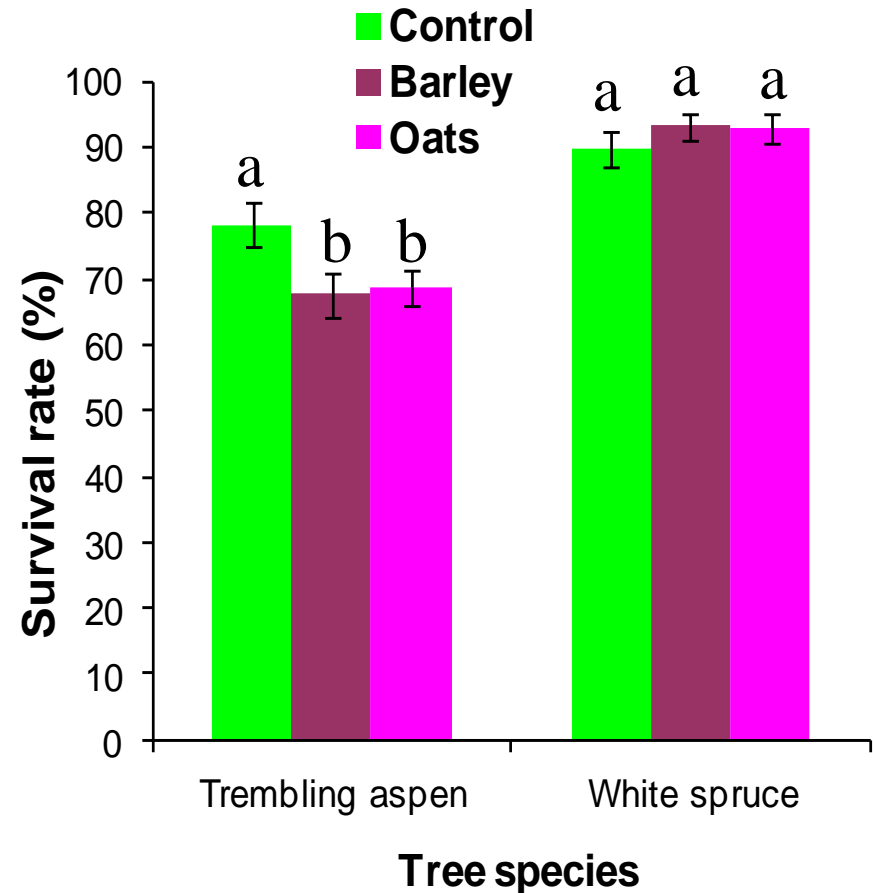
# Results

## *Survival Rate*

### Fertilizer effect

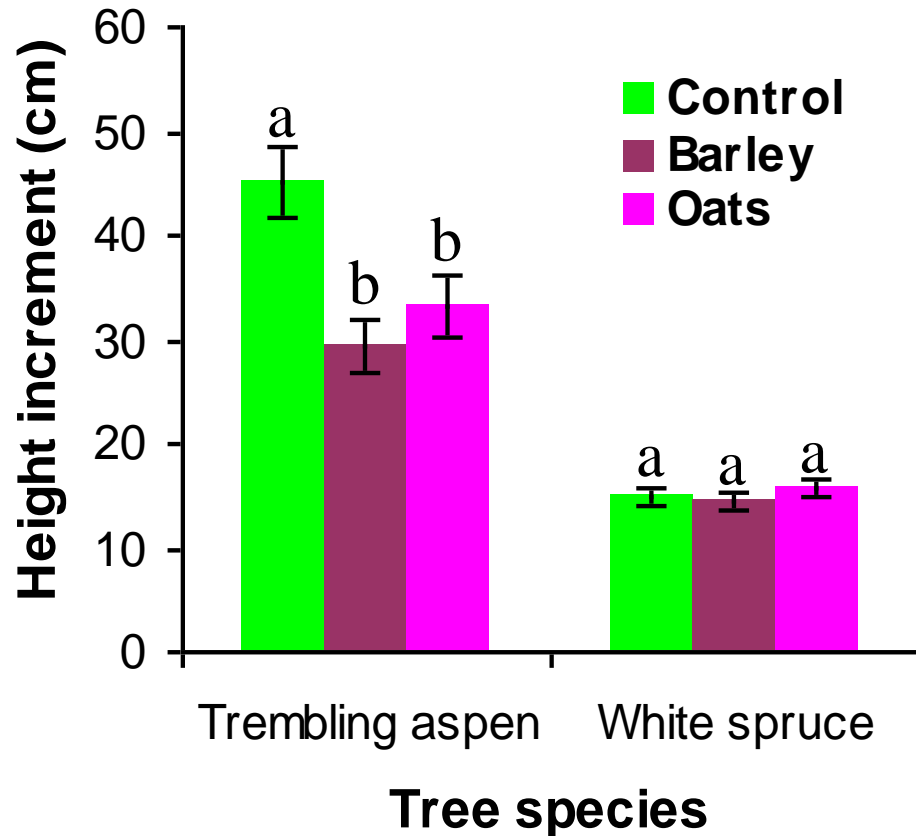


### Ground cover x Tree species



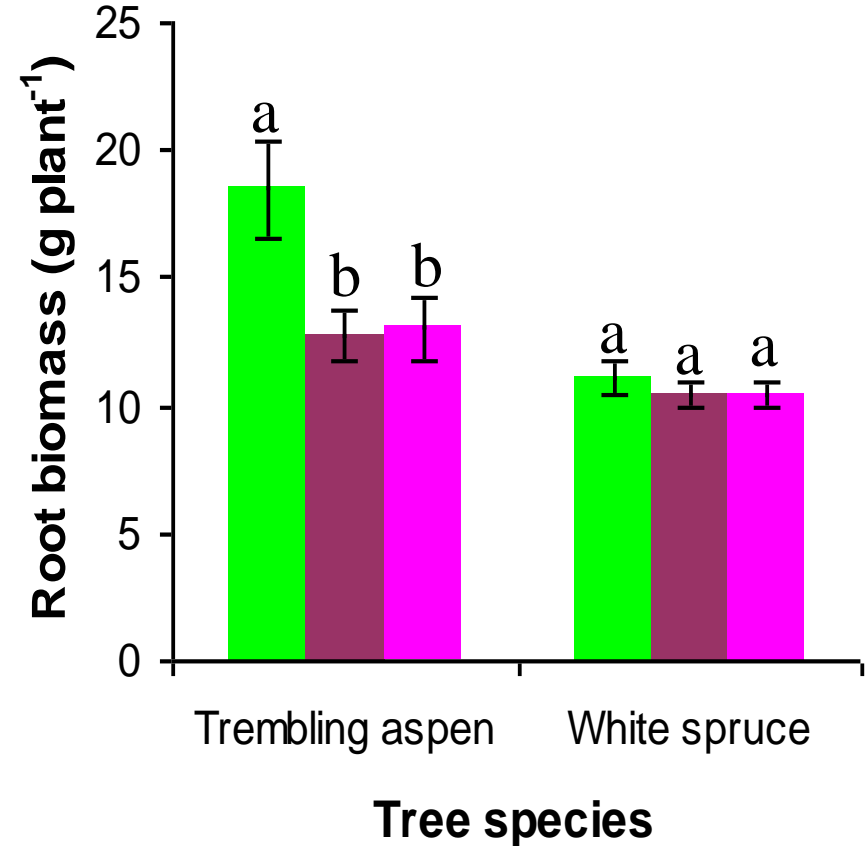
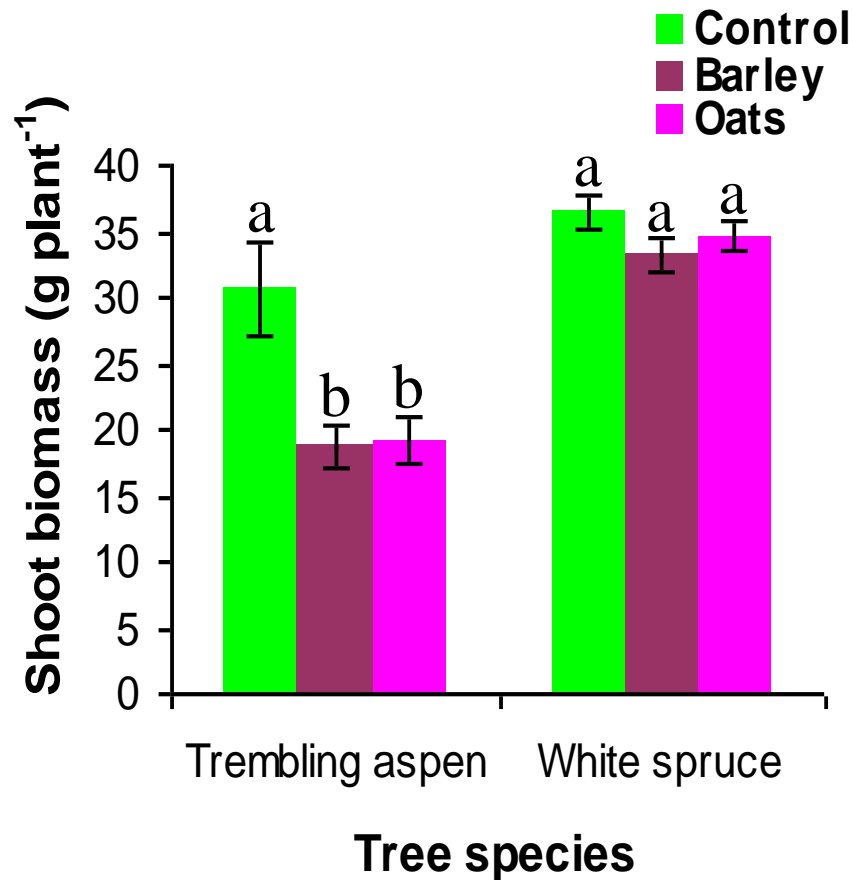
# Results

## Height and RCD Growth: Ground cover x Tree species



# Results

## Biomass Yield: Ground cover x Tree species





# Results

**No significant effect of fertilizer  
addition on tree seedling  
height, RCD and biomass**

**But weed growth was enhanced!**



# Results



# Results



# Conclusion

- Ground cover (barley, oat) has negative effect on growth of trembling aspen with added fertilizer. Not much effect on white spruce seedlings.
- Even without ground cover competition, trembling aspen and white spruce seedlings responded poorly to NPK fertilizer: reduced survival and no positive growth response in the field.
- Soil moisture depletion with ground cover growth is likely the limiting factor for seedling growth and yield
- Adding fertilizer to these systems appears to be of very little benefit to survival and early tree growth.

# References

Alberta Environment. 2009. The reclamation process: Status of all Disturbed Land in Oil Sand Mining, <http://oilsands.alberta.ca/reclamation.html>.

Rowland, S. M., Prescott, C. E., Grayston, S. J., Quideau S. A., Bradfield, G. E. 2009. Recreating a functioning forest soil in reclaimed oil sands in northern Alberta: An approach for measuring success in ecological restoration *J. Environl. Qual.* 1580 – 1590.

Sheoran, V., Sheoran, A. S. and Poonia, P. 2010. "Soil Reclamation of Abandoned Mine Land by Revegetation: A Review," *International Journal of Soil, Sediment and Water.* 3 (2). Article 13.

# Acknowledgements



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# Thank you



# Questions?

