Root Exudation Varies Between Clones of Loblolly Pine in Response to Fertilizer Application

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ESA Annual Mtg
Loblolly Pine

- **32** million acres (slash + lob) in plantations
- **5.6** billion cubic feet harvested in 2002
- **62%** of U.S. softwood production
- **37%** of total U.S. production

Data from Adams et al. 2006 and the Forest Nutrition Cooperative
Improving Production: Fertilizer

- 25% average increase in growth
- 1.2 million acres fertilized annually
- 16 million total acres fertilized

Data from the Fox et al. 2007
Improving Production: Clones

- **50%** increase in growth possible
- **~11** million clonal seedlings produced in 2009
- **~43** square miles planted at current rate

Data from McKeand et al. 2007, personal communications with Arborgen and Cellfor
Reynolds Clone x Fert: Research Questions

The graph shows the stem volume (in 1000 cm$^3$) for different clones, comparing those that were not fertilized (yellow bars) and those that were fertilized (green bars). The x-axis represents the clone ID, and the y-axis represents the stem volume. The error bars indicate the variability in the data.
Fertilization Reduces Heterotrophic Soil CO₂ Efflux


Hypotheses

[Diagram showing a tree with root exudation leading to CO₂ and a heterotrophic community]

Root Exudation

Heterotrophic Community

CO₂
Reynolds Homestead
Clone x Fertilizer
Reynolds Homestead
Clone x Fertilizer

XAD-7 Resin Capsule in coarse sand

~15 cm fine root < 2 mm diameter
Root Exudate TOC

(μg capsule⁻¹ day⁻¹ cm⁻³ root)

Clone p = 0.09

Clone ID

B1  B3  C2  D1

Not Fertilized
Fertilized
Clone x Fertilizer x Drought
Root Exudates: TOC (μg/capsule/day)

Clone x Fert x Irrigation

p = 0.02
Root Exudates: TOC

Sawtimber Ideotype
Clone x Fert x Irrigation
$p = 0.02$

Biomass Ideotype

![Bar chart showing TOC (μg/capsule/day) for different treatments.](chart.png)
Root Exudates: Anthrone Reactive Carbon

Clone \((p = 0.07)\)

<table>
<thead>
<tr>
<th>Day Removed (Capsules In Situ 21 Days Prior)</th>
<th>ARC (µg/capsule/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>3.0 ± 0.5</td>
</tr>
<tr>
<td>42</td>
<td>2.2 ± 0.3</td>
</tr>
<tr>
<td>63</td>
<td>2.1 ± 0.2</td>
</tr>
<tr>
<td>84</td>
<td>1.0 ± 0.1</td>
</tr>
<tr>
<td>104</td>
<td>2.3 ± 0.4</td>
</tr>
</tbody>
</table>

Sawtimber

Biomass
Greenhouse Clone x Fertilizer x Sequential Harvest

Egle et al. 2003
Clone x Fertilizer

$p = 0.04$
Heterotrophic Efflux data from GH

![Bar chart showing heterotrophic component of soil efflux for Biomass and Sawtimber clones with unfertilized (yellow) and fertilized (green) conditions. The chart includes error bars indicating variability. There is a p-value of less than 0.01 for the difference between fertilized and unfertilized conditions.]
Conclusions to Date

- Genotypic variability in exudation
- Varies with resource availability differently for each clone
- But, need biomass partitioning for whole story
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