Stem growth and form of clonal *Pinus taeda* following fertilization in the Virginia piedmont

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Clonal forestry offers the opportunity to increase yields, enhance uniformity and improve wood characteristics. Intensive silvicultural practices, including fertilization, will be required to capture the full growth potential of clonal plantations. However, variation in nutrient use efficiency that exists among clones could affect growth responses. Our research objective was to determine the range of growth response and biomass partitioning due to fertilization in clones of *Pinus taeda*. A split plot experimental design was used, with the whole plots being two levels of fertilization (with or without) and the split plot factor being 25 clones. Whole plot treatments were blocked and replicated four times. Trees were planted in May 2003, with fertilizer (224 kg ha\(^{-1}\) DAP and 184 kg ha\(^{-1}\) ammonium nitrate) applied in May 2004 and May 2006. Four years after planting, a repeated measures analysis showed fertilizer by time and clone by time interactions significantly affected volume. Although there were no fertilizer by clone interactions in this trial across all 25 clones, the response to fertilizer varied, with 40% of the clones showing a volume improvement at 3.5 years of $< 3\%$ while 20% showed improvement $> 15\%$. Our results suggest that a screening technique for clonal response to silvicultural treatments such as fertilization may be necessary given the wide range of fertilizer responses found among clones in this field trial and the large numbers of clones being developed by forest industry.

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Growth of clonal *Pinus taeda* following fertilization in the Virginia piedmont

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June 2, 2009
30th SFTIC Meeting
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

• **35 - 50%** gains possible
• **~ 11** million seedlings produced in 2009
• **~ 43** square miles if planted at 400 TPA

Data from McKeand et al. 2003
<table>
<thead>
<tr>
<th></th>
<th>Background</th>
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<tbody>
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<td>Clone x Fert</td>
<td>?</td>
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Hypotheses

Clone x fertilizer interactions for:
1. Stem volume growth
2. A crown ideotype
3. Stem form
Experimental Design

- Split plot replicated 4 times
  - Whole plot: Fertilizer (none versus fertilized)
  - Split plot: Single tree plots (25 clones)
Methods

- Site
  - Upper Piedmont
  - Clay loams

- Planted
  - May 2003

- Fertilized
  - 224 kg ha\(^{-1}\) DAP
  - 184 kg ha\(^{-1}\) am. Nitrate

- Measurements
  - Height, diameter, crown width, sinuosity, forking, branch angle
5-Year Stem Growth: Full Trial

Clone x Fert: \( p = 0.08 \)
5-Year Stem Growth: Best Clones

<table>
<thead>
<tr>
<th>Clone ID</th>
<th>Not Fertilized</th>
<th>Fertilized</th>
<th>Growth</th>
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<tbody>
<tr>
<td>B3</td>
<td>63%</td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>68%</td>
<td>88%</td>
<td></td>
</tr>
<tr>
<td>D2</td>
<td></td>
<td>89%</td>
<td></td>
</tr>
<tr>
<td>D4</td>
<td></td>
<td>89%</td>
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</tbody>
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Stem Volume (1000 cm³)
5-Year Crown Ideotype

Stem Volume (1000 cm³) vs. Crown Volume (m³)

Different symbols represent fertilized and not fertilized trees.

R² = 0.48
5-Year Crown Ideotype

Fertilizer

\[ p = 0.07 \]
5-Year Stem Sinuosity

Clone $p = 0.01$

(Higher is more severe)

Clone ID

Clone not fertilized

Clone fertilized
5-Year Stem Forking

Forked (%)

Not Fertilized
Fertilized

 Clone ID

p = 0.78
5-Year Branch Angles

\[ p = 0.99 \]
Conclusions

Clone x fertilizer interactions for:

1. Stem volume growth: yes
2. Crown ideotype: Not statistically, but...
3. Stem form: Not statistically, but...

![Diagram]

- No Fert: A > B
- Fert: A < B
Implications

• Inference space limited, further testing needed but...

• Clone x Fertilizer Interactions
  – May require screening
  – May offer opportunities
    • Precision silviculture