Managing Fertilization Prescriptions

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Pop Quiz 1

What is the primary goal of forest fertilizer application?

A. Increase financial returns
B. Increase diameter growth rates
C. Shift product distribution from pulpwood to sawtimber
D. Shorten rotation length

What is the goal of fertilization?

- Increase growth
  - Crop trees
  - Improves product class
  - Shortens rotation

What is the goal of fertilization?

- Fertilizer application is an investment
- All investments are subject to risk
  - Stand may not respond
  - Stand may not respond enough
  - Stand may respond, but then is subject to disturbance

Outline

A. Is your stand nutrient limited?
B. When should you fertilize?
C. How much should you fertilize?
D. How is fertilizer applied?

Pop Quiz 2

Who is applying the most fertilizer to forests?

A. Industry in the Pacific Northwest
B. Industry in South America
C. Industry in the US South
D. Private Forest Landowners Globally
Who is applying fertilizer?

- More than 16 Million acres fertilized in US South 1969 – 2004 by industrial forest landowners
- 91% of applications were in loblolly pine plantations
- 80% of applications were on the coastal plain
- Exceeds all other forest fertilization combined


Is your stand nutrient limited?

- What tools does ‘industry’ use?
  - LAI
  - Soil data models
- What tools can consultants or non-industrial private landowners use?
  - Foliar nutrient tests
  - Soil tests
  - Simplified soil models

Estimated Stand Peak LAI

<table>
<thead>
<tr>
<th>Peak LAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 - 2.3</td>
</tr>
<tr>
<td>2.3 - 3.3</td>
</tr>
<tr>
<td>&gt; 3.3</td>
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</table>


Critical Levels of Foliar Nutrients

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Dash ppm</th>
<th>Lethal ppm</th>
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<tbody>
<tr>
<td>N</td>
<td>0.05</td>
<td>0.15</td>
</tr>
<tr>
<td>P</td>
<td>0.02</td>
<td>0.15</td>
</tr>
<tr>
<td>K</td>
<td>0.25</td>
<td>1.0</td>
</tr>
<tr>
<td>Ca</td>
<td>0.08</td>
<td>0.5</td>
</tr>
<tr>
<td>Mg</td>
<td>0.5</td>
<td>2.0</td>
</tr>
<tr>
<td>S</td>
<td>0.10</td>
<td>1.0</td>
</tr>
<tr>
<td>B</td>
<td>0.05</td>
<td>1.0</td>
</tr>
<tr>
<td>Zn</td>
<td>0.25</td>
<td>1.0</td>
</tr>
<tr>
<td>Cu</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Mn</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>Fe</td>
<td>15</td>
<td>40</td>
</tr>
</tbody>
</table>


Soil Data Models

<table>
<thead>
<tr>
<th>Soil</th>
<th>Recommendation</th>
<th>Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment &amp; Juvenile Fertilization</td>
<td>B13c5Cux</td>
<td>1254/Ac DAP w/ veg control</td>
</tr>
<tr>
<td>C25c6Cxy</td>
<td>250/Ac DAP w/ veg control</td>
<td>24.8</td>
</tr>
<tr>
<td>Mid Rotation Fertilization Response</td>
<td>B13c5Cux</td>
<td>High</td>
</tr>
<tr>
<td>C25c6Cxy</td>
<td>Medium</td>
<td>24.8</td>
</tr>
</tbody>
</table>

Courtesy of Campbell Timberland Management, LLC.
Soil Tests

- Mehlich-3 results indicating stand may respond:
  - P < 5 ppm
  - K < 12 ppm
  - Ca < 40 ppm
  - Mg < 10 ppm
- Nitrogen much more difficult to predict from soil testing
- This is a MAJOR barrier to NIPF landowners fertilizing

Simplified Soil Models

CRIFF Forest Soil Classification

CRIFF A: Severely P deficient soils tend to occur in a band near the coast

Objective A Review

- The US South leads the world in forest fertilizer application.
- Most forests in the US South are nutrient limited, primarily by N and P, but also by K, B, or other micronutrients.
- It is important to determine what nutrients are limiting on your stand as a first step in prescribing fertilizer application.

Outline

A. Is your stand nutrient limited?
B. When should you fertilize?
C. How much should you fertilize?
D. How is fertilizer applied?
Pop Quiz 3

When should you apply nitrogen fertilizer in a rotation?

A. During site prep
B. Two years before thinning
C. Right after thinning
D. One year before clearcutting

When are nutrients limiting?

• P, K, or micronutrients may be limiting at establishment.
  – If such a deficiency exists, a site-prep or establishment application may be recommended.
• N is usually not limiting until a stand approaches canopy closure.
  – Industry has moved away from establishment applications of N, and more towards midrotation treatments.

How long does a stand take to respond to a fertilizer application?

Figure 1. Cumulative mean height growth (BM) over time for five poorly drained sites located in the Lower Coastal Plain of North Carolina.


When should you apply fertilizer?

• When are nutrients limiting?
• How long does a stand take to respond?
• How long is the duration of the response?


How long is the duration of the growth response?

When do you apply each year?

- Avoid hot weather
  - N volatilization of urea
  - Can be reduced by combining with boron
- Various products
  - Efficacy TBD
- Apply during growing season
- March – May ideal

Objective B Review

- Fertilize with P at establishment on poorly drained clayey soils in the lower coastal plain
- Fertilize with N and P at midrotation
  - Midrotation applications should be at least 5 years before a harvest (thin or clearcut)
  - Midrotation treatments can be spaced at ~5-8 year intervals
  - The goal of midrotation treatments should be to increase diameter of the final crop trees

Outline

A. Is your stand nutrient limited?
B. When should you fertilize?
C. How much should you fertilize?
D. How is fertilizer applied?

Pop Quiz 4

What is a typical rate of nitrogen applied at midrotation?

A. 38 pounds per acre
B. 75 pounds per acre
C. 150 pounds per acre
D. 300 pounds per acre

How much fertilizer should you apply?

Determining Fertilizer Rates

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expressed</td>
<td>elemental N</td>
<td>P ka</td>
<td>K ka</td>
</tr>
<tr>
<td>Elemental Weight</td>
<td>14.00</td>
<td>30.97</td>
<td>39.10</td>
</tr>
<tr>
<td>Atoms of Target Element</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Weight of Target Element Only</td>
<td>14.00</td>
<td>61.94</td>
<td>76.20</td>
</tr>
<tr>
<td>Weight of Entire Molecule*</td>
<td>14.00</td>
<td>141.54</td>
<td>194.20</td>
</tr>
<tr>
<td>Conversion to Elemental</td>
<td>100%</td>
<td>44%</td>
<td>83%</td>
</tr>
</tbody>
</table>

* Atomic weight of oxygen = 16.00

Determining Fertilizer Rates

<table>
<thead>
<tr>
<th>Material</th>
<th>Analysis</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Nitrogen Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>urea</td>
<td>45-0-0</td>
<td>Volatilization an issue</td>
</tr>
<tr>
<td>ammonium nitrate</td>
<td>33-0-0</td>
<td>Hydroscopic &amp; explosive (no longer sold)</td>
</tr>
<tr>
<td>diammonium phosphate (DAP)</td>
<td>18-46-0</td>
<td>Primary P source</td>
</tr>
<tr>
<td>Phosphorus materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrated superphosphate</td>
<td>0-44-0</td>
<td>Common water-soluble P-fertilizer</td>
</tr>
<tr>
<td>DAP</td>
<td>18-46-0</td>
<td>Water soluble N &amp; P</td>
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<tr>
<td>Rock phosphate</td>
<td>0-5-0</td>
<td>Not water soluble, but soluble in acids</td>
</tr>
<tr>
<td>Potassium Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muriate of potash</td>
<td>0-0-60</td>
<td>Common K fertilizer; water soluble</td>
</tr>
</tbody>
</table>

Determine Fertilizer Rates

<table>
<thead>
<tr>
<th>Element</th>
<th>Fert Rate</th>
<th>Fert Source</th>
<th>Elemental Ratio</th>
<th>N</th>
<th>P</th>
<th>K</th>
<th>Scale Factor</th>
<th>Source (lbs)</th>
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<tbody>
<tr>
<td>N</td>
<td>290</td>
<td>Urea 45-0-0</td>
<td>45-0-0</td>
<td>177.5</td>
<td>0</td>
<td>0</td>
<td>0.45</td>
<td>395</td>
</tr>
<tr>
<td>P</td>
<td>25</td>
<td>DAP 18-46-0</td>
<td>18-46-0 N-P</td>
<td>22.5</td>
<td>25</td>
<td>0</td>
<td>0.20</td>
<td>125</td>
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<tr>
<td>K</td>
<td>50</td>
<td>Potash 0-0-60</td>
<td>0-0-50 K&lt;sub&gt;2&lt;/sub&gt;O</td>
<td>0</td>
<td>50</td>
<td>0</td>
<td>0.50</td>
<td>100</td>
</tr>
</tbody>
</table>

Objective C Review

- Fertilize with P at establishment on poorly drained clayey soils in the lower coastal plain
- Fertilize with N and P at midrotation
  - Midrotation applications should be at least 5 years before a harvest (thin or clearcut)
  - Midrotation treatments can be spaced at ~5-8 year intervals
  - The goal of midrotation treatments should be to increase diameter of the final crop trees

Outline

A. Is your stand nutrient limited?
B. When should you fertilize?
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D. How is fertilizer applied?

Pop Quiz 5

How is most fertilizer applied operationally in the US South?
A. By hand
B. By helicopter
C. By fixed wing aircraft
D. By skidder

Ground Fertilizer Equipment
Application Considerations

- Application over canopy?
- Abundant shrubs?
- Tract location?
  - Near chicken houses or horse farms?
Environmental Considerations

- Drift less of an issue than herbicides
  - Little mortality, although longleaf can be damaged or killed by foliobly rates
  - Still should avoid
- Almost any SMZ will keep nutrients out of streams
- Can leach on sandy soils


Checking Contractors

- Collect calibration data
- Collect catch data
  - Place a number of containers of known area in stand
  - Weigh fertilizer collected during or following operation
  - Scale to per acre basis


Objective D Review

- Fertilize with P at establishment on poorly drained clayey soils in the lower coastal plain
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Synthesis

- On average, fertilizer application increases growth in southern pine stands
  - It does not increase the growth of all stands the same
  - Different stands are limited by different nutrients
  - There are tools available to determine if a stand is nutrient limited, and by what nutrients
- Fertilizer application can yield economic returns, but not without risks

Questions?