A checklist for fertilization of loblolly, longleaf and slash pine stands

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Economically beneficial southern pine stand fertilization depends on three primary factors:
1. expected wood yield and pine straw increases from the application of the fertilizer materials,
2. wood market values at time of harvest, and
3. fertilizer material and application costs.

The resulting revenues from the extra wood and pine straw grown with fertilization must exceed the cost of fertilization. For reasonable rates of returns, the increased forest product revenues will often need to be 1.5 to two-fold the fertilization cost within a five to eight year window. There are investment risks with fertilization such as ice or snow storms, tornados, hurricanes, and insect (pine beetles) or diseases that can reduce the stand’s additional wood or pine straw yields that should be considered. There are cases where a nutrient or nutrients are determined to be below sufficiency but other stand or site limiting factors (competing vegetation, high pine basal area, low nutrient and water holding capacity soils, shallow soils, etc) prevent the pines from responding to the added nutrient(s). To realize the full mid-rotation fertilization benefit, a clear-cut (to capture all the extra wood grown) is warranted. Thinning a stand five to eight years after fertilization will only capture a portion (typically 40 to 60 percent) of fertilizer benefit.

Due to large price fluctuations of fertilizer materials, forest landowners, foresters, natural resource managers, and county agents should be diligent in recommending phosphorus (P), nitrogen (N), N+P, or N+P+K (potassium), the most common fertilizer prescriptions. Therefore the landowner, forester, and/or agent needs to address as many of the following stand factors as possible. These stand factors are:

- Species, age, genetics, basal area (stocking/size)
- Soil series present (including problem soils; shallow soils, deep sands, barrow pits, fragipans, hard- or plow-pans)
- Soil moisture status or drainage class (well to excessively well drained soils may be nutrient deficient but inadequate soil moisture may limit pine growth after fertilization)
- Land use history (cut-over, old-field, hayfield, or former pasture site)
- Competition (% stems/ac or basal area/ac of hardwoods, shrubs, or herbaceous vegetation)
- Presence or risk of insect(s) (bark beetles – Southern pine beetles (SPB), Ips or black turpentine) or disease(s) (pitch canker, heterobasidion root disease/annosum root rot, % stem fusiform rust which should be less than (<) 25% for all species)
- Number of years to a thinning or final harvest
- Wood products grown (stage of stand development) and product’s value (pulpwood, superpulp, chip-n-saw, sawtimber, poles)
- Pine straw (number and frequency of raking, current bales/ac production rate, bale/ac production trends)
- Live crown ratio (very important for slash pine, needs to be greater than (> 33%, preferably 40% or better)
Then the landowner, forester, and/or agent should use all fertilization diagnostic tools along with soil series knowledge and land use history to make sure that fertilization will be cost-effective. These diagnostic tools are:

1. Soil sampling (any time of year), for “routine” analysis. If soil available P is < 6 - 10 lbs/ac using the extraction procedure at the UGA Lab, then the stand is P deficient (refer to www.forestproductivity.net and “fertilization” section for more info).

2. Foliage sampling (dormant season) using nutrient sufficiency levels from Table 1 for fertilizer application decisions. See also www.bugwood.org and “fertilization” section.

3. Leaf area index (LAI) estimates (best N diagnostic tool), taken during peak LAI (usually July-Aug). If < 2.5 for loblolly, < 2.0 to 2.25 for slash and < 1.75 to 2.0 longleaf, there is good chance of response to N, NP, or NPK fertilization. How do the crowns look (healthy and vigorous, unhealthy, chlorotic, needles in tufts)?

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Loblolly pine</th>
<th>Longleaf pine</th>
<th>Slash pine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen (N)</td>
<td>1.2</td>
<td>0.95</td>
<td>1.0</td>
</tr>
<tr>
<td>Phosphorus (P)</td>
<td>0.10 - 0.12</td>
<td>0.08</td>
<td>0.09</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>0.25 - 0.30</td>
<td>0.25 - 0.30</td>
<td>0.25 – 0.30</td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>0.15</td>
<td>0.10</td>
<td>0.08 – 0.12</td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>0.08</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Sulfur (S)</td>
<td>0.10</td>
<td>--</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Examples of pine stands that will NOT respond dramatically (economically) to NP or NPK fertilization or where fertilization is not recommended due to stand factors

- fair to poor genetics; poor pine tree quality
- basal area > 90 ft²/acre
- stands that are within 4 to 5 years of being thinned or clear cut
- old-field, hayfields or former pasture sites (fertility is usually good to excellent for pine growth)
- hardwood trees/acre > 500, or hardwood basal area > 10 ft²/ac, or hardwood basal area > 10% of stand total or where shrub component (in Flatwoods) is abundant
- sites and soils have a moderate to high annosum root rot hazard rating, especially after a thinning
- stands that are in close proximity to an Ips, black turpentine, or southern pine beetle outbreak
- stands with a > 20% - 25% pitch canker
- stands that have > 20% - 25% stem fusiform canker incidence
- for slash pine where live crown ratios are < 25% - 30% and those older than 20-years-old
- foliar N, P, and K concentrations > those in Table 1 for the pine species in question
- surface (0-6” or 0-8”) soil available-P > 6 – 10 lbs/acre or 3-5 ppm
- leaf area index (LAI) is > 2.5 for loblolly, > 2.25 for slash, or > 1.75 to 2.0 for longleaf pine
- shallow soils to bedrock or deep (> 60”), excessively well drained sandy soils
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