North Carolina Forest Service

FORESTRY Leaflets

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Fertilizing Guidelines for Established Loblolly Pine Forest Stands

Forest trees require several soil-based elements to grow and maintain health. These include the "big three" macronutrients, nitrogen, phosphorus and potassium, as well as several important micronutrients. Many forest soils in North Carolina lack one or more nutrients in quantities sufficient for optimum tree growth. Adding these deficient nutrients through fertilization increases forest stand value by temporarily increasing tree growth, health and vigor and wood volume. Loblolly pine stands respond well to fertilization at mid-rotation age with increased growth. Landowners can use fertilization to increase financial return.

What the Research Tells Us

- Poorly drained soils in eastern North Carolina and clay soils in the Piedmont respond well to phosphorus fertilization at the time of seedling establishment.
- Fertilizing pine stands at mid-rotation (8-to-20 years) or late-rotation (20-to-35 years) also produces strong growth response in loblolly pine.
- As trees grow they demand more soil nutrients. Between ages 6 and 8 (or when the tree-tops start to touch each other, known as 'crown closure'), the young loblolly pine trees often need more nutrients than the soil can supply.
- Adding nitrogen (N), phosphorus (P), and potassium (K) supplements soil deficiencies.
- Fertilizing with (N), or (N + P), or (N+P+K + boron) shortly after crown closure or after a thinning can increase crown size (number of needles) and wood production (diameter and height growth).
- Growth responses after fertilization generally last 6-to-8 years.
- Growth response to fertilization decreases as the percentage of sand or clay content in a soil increases.
- Growth response to fertilization is better on well-drained soils. Soils that have a gray color, or gray spotting located at or near the surface are poorly drained.

Make Fertilizers Work for You

Not all forest stands benefit from fertilization. To make fertilization work for you, be sure your stand is: 1) responsive to the nutrient amendments, 2) operable in size (greater than 40 acres), and most importantly, 3) nutrient deficient. Tree growth is often limited by soil conditions other than poor nutrition. NOTE: The cost of using fertilizer will not be cost effective where other factors limit tree growth (such as too little or too much moisture, or shallow topsoil). Carefully examine your site and soil to assess if the cost of fertilization is cost effective. Obtain the services of a forester to help you with this determination.

Know Your Soil

- Compacted soils (common in former agriculture fields and pastures) and poorly drained soils have poor soil aeration, thus limiting root growth.
- Shallow soils with heavy clay or rocky subsoil restrict rooting depth.
- Sandy soils are low in organic matter, have low soil moisture, have poor cation exchange, and are infertile (deficient in N, P, K and boron).
- Clay soils are easily compacted, have low soil strength, poor aeration, rocky subsoil, and are nutrient deficient (as determined by underlying bedrock).
- Organic soils are poorly drained, have a low cation exchange, and are infertile (deficient in N,P,K).
- Soils situated atop granite or diorite bedrock have a high silica content and are phosphate deficient, but because they contain feldspar are high in potassium (K).
- Soils derived from shale or sandstone are also high in potassium (K) and low in phosphorus (P).
- Soils derived from basalt are some of the richest soils found in the Piedmont. A dusky, red color is a good indicator of a nutrient-rich soil.

Visual Clues on When to Fertilize

- Look up at your trees! Trees that exhibit a flat-topped crown, a sparse crown (few needles), and yellowing foliage are nutrient-deficient.
- For a fully stocked pine stand, the more sky you see the greater amount of nutrients the trees need, and the greater its response to fertilization will likely be.

Fertilizing Like the Professionals Do

1) Soil nutrient tests can show what nutrients are immediately available to a stand of trees, but they do not measure how much nutrient a tree needs. The exception is phosphorus (P) deficiency, which can be identified from soil tests. A soil test with a P-index value of less than 3-to-5 ppm indicates phosphorus (P) deficiency.

2) Foliar analysis provides the best information on what nutrients the tree is able to use from the soil. Foliage samples must be collected in the winter from the last foliage flush in the top one-third of the crown. Values shown in Table 1 indicate a nutrient deficiency.

Table 1. Critical values for foliar and soil nutrient content for loblolly pine. (expressed as % unless noted)

	N	P	K	Ca	Mg	S	B	Cu
Foliar*	1.2	0.12	0.35	0.12	0.07	0.12	4-8 ppm	2-3 ppm
Soil (0-6 inches)*		<3-5 ppm	<15 ppm					

**Contact the N.C. Cooperative Extension Service or the N.C. Division of Forest Resources for information on how soil and foliar sampling is done.*

When Fertilizer Pays the Biggest Dividend

- High quality sites (a high site index) produce the greatest volume response.
- High quality Coastal Plain sites respond better than comparable Piedmont sites.
- Poor quality sites (a low site index) respond only when nutrient deficiencies are limiting growth and nothing else.
- Growth is greatest at lower basal areas (fewer trees) where the trees have room to grow and have sufficient foliage to use the added nutrients. Overcrowded stands do not respond well.
- Maximize growth by maintaining stand density at 90-to-140 square feet of basal area (BA).
- Do not fertilize stands with BA greater than 130 due to increased risk of bark beetle infestation, unless a thinning is planned within three years or a harvest within five years after fertilization.
- P- deficient soils respond to fertilization with a long-lived and dramatic volume gain that can extend well into the future, even enhancing growth on the next generation of trees planted on the same P-fertilized site.

Thinning and Fertilization

- Because the growth response is additive, fertilization in conjunction with thinning is a beneficial mid-rotation practice. To realize the full benefits of fertilization, do not thin or harvest within six years of fertilizing.
- Thin dense stands (those with a BA greater than 130) prior to or within two years of fertilization.
- Leave the best quality trees when thinning. The extra growth on the largest and best trees produces more wood, resulting in the highest-value timber products such as plylogs, sawtimber, chip-n-saw or utility poles.

The Payoff

Volume gains vary and are hard to predict, but:

- Growth gains of 50-to-100 cubic feet per acre per year during a six-year period are possible depending on your soil.
- More than 85 percent of research studies installed by the N.C. State University Forest Nutrition Cooperative exhibited significant growth after (N+P) fertilization.
- Potassium (K) -deficient sites averaged less than 40 cubic feet per acre with (N + P) fertilization but increased to 75 cubic feet per acre per year when (K) fertilizer was applied.
- Wait 6-to-8 years before thinning or harvesting to fully realize volume gain after fertilization.

How Much and When to Apply

- Apply 150-to-200 pounds per acre of (N) + 25 pounds per acre of (P) for most sites.
- On (K) or Boron (B) deficient sites, add 30 pounds of (K) + 1.5 pounds of (B) for each 100 pounds of (N) applied.
- The growth response is better when you combine (N + P). Do not apply separately.
- Two of the most frequently-used fertilizers on forest stands are "DAP" (18-46-0) and "Urea" (46-0-0).
- The best time to apply fertilizer is from November to early March in North Carolina.
- Re-apply fertilizer every 6-to-8 years to maintain the optimum desired growth response.
- Keep fertilizers out of streams, ponds and other bodies of water and maintain an appropriate Streamside Management Zone (SMZ) as required by North Carolina's water quality regulations "Forest Practices Guidelines Related to Water Quality," referred to as the FPGs. **The N.C. Forest Service can advise you on the FPG requirements**.