

Fertilizing Pine Plantations

A County Agents' Guide for making Fertilization Recommendations

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The Entomology and Forest Resources
Digital Information Work Group

Introduction

Fertilization of pine plantations in the South has increased dramatically with over 1,000,000 acres fertilized in 1997 alone. Fertilization is used to correct inherent site nutrient deficiencies such as a limited phosphorus on wet flatwoods sites and on some upland coastal plain sites, to boost growth of established plantations, and to replace nutrients removed in pine straw harvests. Many landowners are now willing or anxious to fertilize pine stands and are looking for fertilizer recommendations that will meet their production goals and can be economically justified. To do this we must look at several diagnostic criteria including: *Stand Age & Development; Product/Rotation Management Objectives; Soil Characteristics; Foliar Analyses; Soil Analyses; and Stand Leaf Area*. Note that while a soil sample is the basic diagnostic tool for row crop production systems, soil tests provide only limited information for making forest fertilization recommendations.

In develop recommendations, it is important to remember that with tree crops we are not dealing with an annual crop that must have its' nutrition requirements met in a span of a few months during the growing season. As individual trees grow, their root systems expand and exploit more of the site resources. However, as tree size increases, N supply becomes limiting. This typically begins when individual trees begin to compete with each other as the crowns of the pines close and shade out the understory. The goal of a forest fertilization program is to provide sufficient nutrients at growth stages when nutrient demand is high in order to maximize leaf surface area.

Typically you will be asked to make fertilizer recommendations for 1) site preparation and planting, 2) remedial early post-plant treatments, 3) mid-rotation pre- and post-thinning treatments, and 4) pine straw maintenance. Each situation requires review of specific diagnostic criteria detailed in the following:

Fertilization at Site Preparation and Planting - Phosphorus is the element that is added as a preplant treatment. Typically, very poorly to somewhat poorly drained flatwoods sites in the Lower Coastal Plain have the greatest need for preplant P additions. Sites with poor surface drainage are normally bedded creating raised planting beds so seedling roots are above the standing water table in the spring. P is generally added just ahead of the bedding operation. There are also upland sites in the Upper Coastal Plain that are P deficient as well. Generally, these are well-drained loamy to clayey soils which have not been in cultivation.

Early post-plant Fertilization - Sites which are P deficient can be ameliorated with P fertilization after planting. Seedlings will exhibit sparse pale yellow-green foliage. Loblolly pine is more sensitive to low P than slash. A foliar analyses will confirm the problem.

Most planting sites will have enough N in the soil nutrient pool to supply the needs of newly established plantations for several years. Cut-over sites in particular will have increased rates of N mineralization from the breakdown of the litter and logging debris and exposure of mineral soil. Control of herbaceous weed following planting is a greater priority than supplemental N fertilization.

Mid-rotation Fertilization - This is the most common application of N or N + P in forestry. While most sites can supply the initial demand for N, as the stand develops and tree size increases, N can become limiting. Generally, at ages 5 to 10 years this occurs leading to reduced leaf area. If growth is to be accelerated or maximized, stand leaf area must be increased. This is done with N or N + P fertilization. The duration of a growth increase from N fertilization is 5 to 7 years so the value of the treatment need not be captured by a harvest at the end of the response period. Like wise if you fertilize with N at young ages, N will have to be periodically added to maintain the growth response.

¹1998. Fertilizing Pine Plantations. Georgia Cooperative Extension Service, College of Agricultural and Environmental Sciences, The University of Georgia, Athens, GA 30602 U.S.A.

1998. The Entomology and Forest Resources Digital Information Work Group, College of Agricultural and Environmental Sciences and Warnell School of Forest Resources, The University of Georgia, Tifton, Georgia 31793 U.S.A. BUGWOOD 98-009

<http://www.bugwood.caes.uga.edu/>

Intensively managed sites for fiber production on rotations of 15 years or less, may receive multiple N or N + P fertilization starting at age 3 to 8. Treatments are repeated every 5 years to maintain the rapid growth response.

Fertilization in conjunction with thinning is a common mid-rotation treatment. N or N + P are added following thinning where crop trees have been selected. The stand is then thinned or harvested in 7 to 10 years to capture the fertilizer growth response. A variation is to fertilize 5 to 7 years before the first thinning to increase the thinning yield. Following thinning, repeat the fertilizer treatment to maintain growth, scheduling a second thinning or final harvest in 7 to 10 years.

Pine Straw Maintenance Fertilization - Pine straw operations generally like to setup to rake stands for several years in a row. Five-year contracts are normal and some means of replacing nutrients removed during the operations should be agreed upon before raking begins. Baseline soil and foliar sample should be collected prior to the first raking. It is most common to add an N + P + K fertilizer at the end of the contract period. However, annual checks of foliar nutrient status can help to reveal if foliar nutrients fall below “Target” levels recommended for sustained growth. If that occurs, fertilization should be done as soon as possible.

Fertilization Diagnostics

Fertilizer prescriptions are based on site/soil conditions, foliar analyses, stand leaf area, and rotation/product management goals. These are the common fertilization regimes and diagnostic keys.

Fertilization at time of planting

- P most commonly applied to poorly drained soils, although some Upper Coastal Plain loam and clay soils are P deficient.
- Phosphorus is often critical for seedling establishment & growth on wet flatwoods sites.
- Apply 40 to 50 lbs of elemental P at planting.
- Time of application is not critical, but generally done when beds are prepared.
- P may be broadcast, side dressed, or banded.
- Average growth response of 50 cubic feet per acre per year (90 cubic feet to a cord).
- P response lasts for 15 to 20 years.
- N fertilization at planting is not recommended.

Seedling demand for N can generally be met by the soil N pool during the first years of establishment. Weed control is a critical component in seedling establishment and should be a priority before N fertilization.

Wet sites - Very poorly to somewhat poorly drained loamy to clayey textured soils, with less than 8 - 12 pounds of P per acre

as indicated by a soil test. Apply 40 to 50 lbs of elemental P at planting.

Upland sites - Upper Coastal Plain loamy & clayey soils that have never been in row crop production and not previously fertilized. These soils are commonly found in Citronelle formations throughout in the Altamaha Upland which runs from Effingham, Liberty, Wayne, Pierce and Clinch Counties in the southeast, north along a line from Jefferson, Laurens, Crisp, Worth to Decatur County (eastern border of the Flint River). With a soil test indicating less than 8-12 lbs/ac of P, apply 40 to 50 lbs of elemental P at planting.

Early Post-planting Fertilization

Remedial P Fertilization -Pines planted on P deficient sites will foliar deficiency symptoms within a year of planting. Seedlings will have sparse crowns with new foliage a pale yellow-green color; older needles will have a purple tinge. A foliar sample with percent P < 0.10 indicates deficiency. Apply 40 to 50 lbs of elemental P per acre using triple super phosphate. Diammonium phosphate may be used if weed control has been provided.

Nitrogen Fertilization for trees less than 5 years old - Not recommended unless foliar analyses indicates low N (<1.20%). Herbaceous and woody vegetation must be controlled before N is added. If applied, use a rate on N not exceeding 50 lbs per acre + 25 lbs P per acre. Repeat fertilization is necessary to maintain growth rates.

Mid-rotation Fertilization

- Nitrogen can become a limiting when tree crowns are rapidly expanding at ages ranging from 5 to 10 depending on management and site.
- Maintaining “target” foliar nutrient levels can increase growth by increasing stand leaf area.
- N or N + P is applied to stands beginning at age 5 in intensive management, or following thinnings in conventional operations to boost leaf area production.
- The tree growth response to N peaks two to four years after fertilization. Additional N fertilization is required to maintain high growth response levels.
- Generally, a 0.5 to 0.75 cord per acre per year increase in growth can be attained following fertilization. The growth response diminished in 5 to 7 years following application, so additional fertilization is required to maintain the growth rates, or the value of the treatment can be captured in a harvest.

Pine Straw maintenance Fertilization

- Use foliar sampling in December through February to determine nutrient status.
- Common treatment is 200 lbs of N + 25 lbs of P, when P is low in foliage (<0.09%) & foliage has a high N/P ratio (>11).
- Use 150 to 200 lbs of N alone if foliar N is low (<1.0%) but P is adequate, & the foliar N/P ratio is low (<10.5).
- Apply 25 lbs of P alone if foliar P is <0.085% and the foliar N/P ratio is high (>13).
- Repeated annual rakings deplete nutrient reserves of the site. Each raking removes 20 lbs of N and 2 lbs of P per acre.
- Before rakings begin, take a soil sample & foliar sample to use as a baseline to track nutrient removals.
- Apply 175 to 200 lbs N, 50 lbs P, & 50 lbs K per acre every five years on areas annually raked. Use 175 lbs N rate on sand to loamy sand soils, & 200 lbs N on sandy loam to clay soils.
- Pine straw production (needle yield) can be increased 40 to 50% two years following fertilization

Table 1. Critical ranges for foliar and soil macro-nutrients in loblolly and slash pine.

Component	Species	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium
% in foliage ¹	Slash	0.8 - 1.2	0.08 - 0.09	0.25 - 0.30	0.08 - 0.12	0.04 - 0.06
% in foliage ¹	Loblolly	1.10	0.10	0.35	0.12	0.07
% in foliage ¹	Longleaf	0.90	0.08	0.30	0.10	0.06
ppm in soil ²	Slash	-	4 - 6	8 - 12	25 - 40	6 - 10
lbs/ac in soil ³	Slash	-	8 - 12	19.2 - 28.8	70 - 112	19.8 - 33
ppm in soil ²	Longleaf	-	5	-	-	-
lbs/ac in soil ³	Longleaf	-	10	-	-	-

¹Foliage sampled in December - February from last growth flush in upper 1/3 of tree crown.

²Sampled in surface soil (0-20 cm). Double acid (HCL + H₂SO₄) extraction.

³See conversions in Table 2.

Table 2. Conversion of ppm to lbs/ac.

ppm of:	To lbs/ac of:	Multiply ppm by:
P	P	2
P	P ₂ O ₅	4.6
K	K ₂ O	2.4
Ca	CaO	2.8
Mg	MgO	3.3

Example: 5 ppm of P in soil test = 10 lb/ac P (5 ppm x 2), and 23 lb/ac P₂O₅ (5 ppm x 4.6)

Table 3. Foliar nutrient levels and for sustained growth responses.

Element	Percent ¹	Ratio with N ²
N	1.20	100
P	0.12	10
K	0.40	35
Ca	0.15	12
Mg	0.08	6
S	0.10	10

¹Foliage collected in December to February from the last fully formed flush of needles in the upper 1/3 of the tree crown.

²Calculated as % of an element divided by % N (N = 1.20% & P = 0.12%, the ratio of P:N = 0.12/1.20 x 100 = 10).

Foliar Sampling

- Take samples from December through February
- Collect needles from a primary lateral branch in the upper 1/3 of the crown.
- Pull foliage (include needle fascicles or sheaths) from the first growth flush of last season.
- Make a composite sample from 6 to 7 trees.
- Keep samples on ice until the are sent for analysis.
- The University of Georgia will run a standar foliar analyses N, P, K, Ca, Mg, + micro for \$15.00 per sample. Private labs can also run foliar analyses.

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