Nutrient Management in Pine Forests

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INTRODUCTION

Nutrient management includes managing harvest residue and additions of waste products as well as adding fertilizer to maintain and increase productivity of forests while minimizing any negative effects to the environment. Successful nutrient management requires understanding of the nutrient reserves in the soil, the amounts of each kind of nutrient removed by harvesting and the effects of displacing or retaining harvest residue on the site. Nutrient management is linked to other management practices that affect productivity such as past land use and weed control.

SOIL FERTILITY LEVELS

Compared to most annual crops, pine trees require much lower levels of nutrients for good growth. As an example, phosphorus in clay loam soils used for cotton is considered to be very low when soil test values are below 50 (Bray 2 extractant). On coastal'plain soils where most of the pines are grown in Louisiana, values below 2 are very low. Soil test values above 7 are considered high for pines and fertilization is not recommended.
The level of fertility may not affect the productivity of a stand until later in the rotation. The stands illustrated in Figure 1 were planted at the same time on Malbis soil series. Growth continued at a suitable rate in the stand where the soil test value was above 7 indicating nodeficiency. However, on the site where the amount of phosphorus in the surface of the soil was marginal, the growth of loblolly pine slowed considerably 20 years after planting. When nutrient levels are very low, fertilization may increase growth when applied at planting. Figure 2 shows the response of slash pine to fertilization on a soil that had a very low soil test value for phosphorus. Phosphorus applied at planting increased volume of the stand at age 18 years by 1500 cu. ft. per acre. When shearing was used as site preparation, growth was increased by only 325 cu ft. per acre in the first 18 years. The response to shearing was the same with and without fertilization, which indicates that the added phosphorus did not increase weed competition on this site

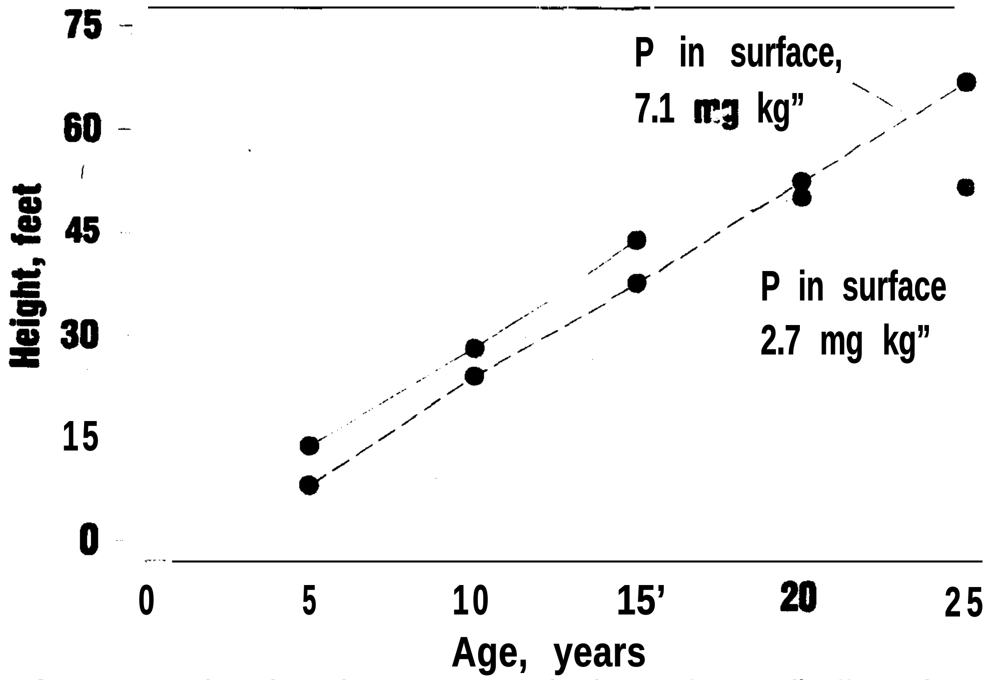

Figure 1. The phosphorus content in the surface soil affected the growth of loblolly pine 20 years after planting. The soil series at both locations is the Malbis series.

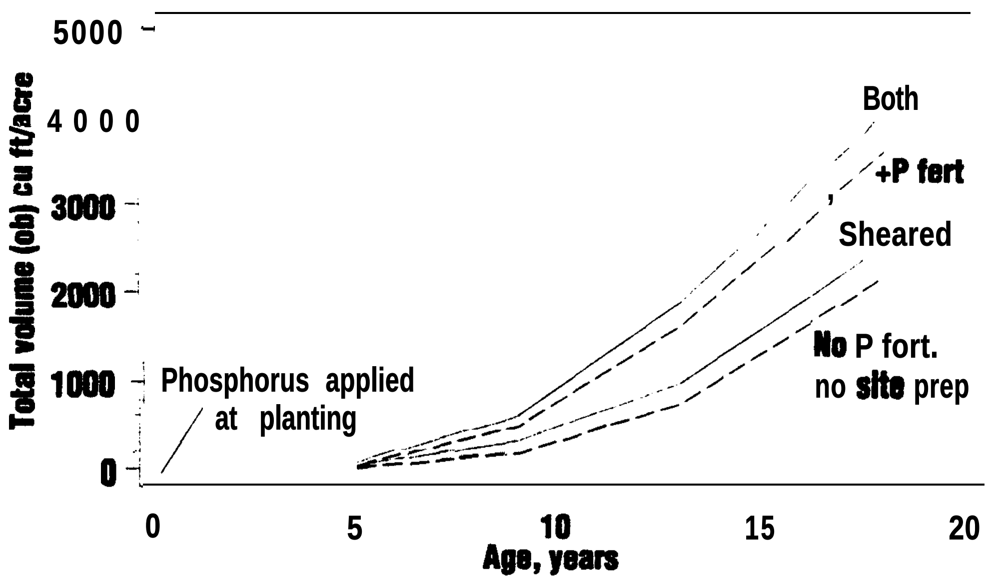

Figure 2. Phosphorus applied at planting increased the growth of slash pine planted near Oberlin for 18 years and increased growth more than shearing site preparation.

EFFECTS OF REMOVALS BY HARVESTING

When pine stands are harvested, some nutrients are removed in the wood and bark. On sites that are very low in soil test values, these removals by harvesting can affect productivity of the next rotation. In Figure 3, the height of loblolly pines are shown for the first ten years of two rotations. The second rotation was planted on the site after the first rotation was removed. The rainfall pattern was about the same for both periods, so the removal of soil nutrients during the first harvest is probably responsible for the much slower rate of growth in the second rotation. While the decline is obviously serious, it is easily

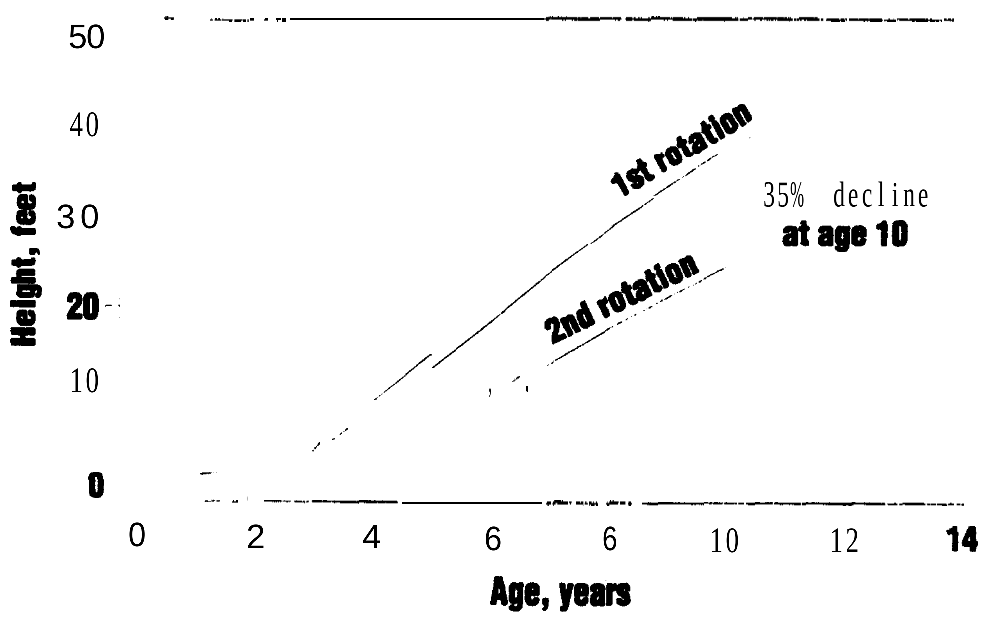

Figure 3. Height growth of two rotations of loblolly pine growing on the same site which was very low in phosphorus.

corrected by using a species that is less sensitive to low fertility or by adding fertilizer to replace the nutrients removed by harvesting. The heights at age 10 of the loblolly from Figure 3 are shown again in Table 1 as well as slash pine at the same site and slash pine from another site. Slash pine is less sensitive to phosphorus deficiencies so the decline between rotations was much less than for loblolly. In the second location, the productivity of unfertilized slash pine was the same for two rotations. Fertilization increased the height by the same amount in both rotations. These comparisons between rotations indicate that the primary cause of the decline in loblolly was a nutrient deficiency that was exacerbated by harvesting. However, the problem is easily and economically corrected by applying phosphorus fertilizer to the site.

Table 1. Heights of loblolly and slash. pine at age 10 of two rotations grown on two sites. Phosphorus fertilizer was applied at the beginning of each rotation on part of site 2.

Variable	First rotation	Second Rotation
	———feet---	
	Site 1	
Unfertilized loblolly pine	35	25
Unfertilized slash pine	32	30
	Site 2	
Unfertilized slash pine	28	28
Fertilized slash pine	31	31

DISPLACEMENT OF ORGANIC MATTER

Organic matter and associated nutrients' can be displaced or removed from a site as logging slash or by harvesting pine straw. When trees are harvested for timber products, the amount of nutrients removed is small because of the low concentrations of nutrients in wood, The other above ground parts of the tree contain higher levels of nutrients, so the fate of the logging residue may have an important effect on the productivity of the next rotation. In a 37 year-old-stand loblolly stand, the wood and bark in the merchantable stem contained 46 pounds of nitrogen per acre. The needles and branches from the pines contained 61 pounds of nitrogen and another 32 pounds was in the understory. Thus, removing the nonmerchantable materials from the site during harvest and site preparation would be much more detrimental to the nitrogen left on the site that the harvest itself. If the logging residues are piled up near landing or in windrows, the effect is the same as if the nutrients were removed from the site.

In soils of low fertility, keeping the residue near the stump can be important for pine growth and survival. In East Texas, we have an experiment where we left different amounts of the logging slash on the plots. On some plots we removed only the main stem of the pines including the bark but none of the slash. On other plots we removed the entire pine tree excluding the stump but including the branches and needles. Finally, on a third set of plots we removed all of the above ground slash, litter and understory. Two years after planting the amount of residue retained on the plots had an important effect on the survival of the seedlings. The summer of 1998 was an extremely dry year, but on plots were some of the logging slash was retained, we have an acceptable level of survival. On the plots where we removed all of the organic matter the survival is only 34% which is too low for a fully stocked stand. Also, the trees were tallest on the plots where we left all of the logging slash. Based on similar but older studies in Louisiana and Mississippi, we expect the negative effect of removing the logging slash to continue.

Table 2. The amount of logging residue removed during harvest affected both the survival and growth of two-year-old loblolly pine in East Texas, near Groveton.

Residue removed	Survival	Height
	%	feet
None	64	3.4
Pine branches	57	3.1
All above ground	34	2.9

When pine straw is harvested, nutrients are also lost from the site. In a study on longleaf pine, raking the stand decreased the growth of the trees by more than 10%. Burning the straw had a similar effect. Fertilizer did not increase growth on the plots where the straw was left, but did prevent a ‘growth loss on the raked plots. These results must be interpreted with caution because measuring differences in growth of large trees is difficult and the response shown here is not statistically significant. However, the results indicate that any negative effect of pine straw harvesting can be overcome by adding fertilizer. The cost of the fertilizer would have to come from the returns of the pine straw sales.

Table 3. Effect of burning, straw raking, and fertilization on the volume growth of longleaf pine from age 34 to 39 years-old.

Treatment	No fertilizer	Fertilized	Response
	———cu ft/acre (ib)———		
None	4638	4674	36
Straw Burned	4048	4630	582
Straw Raked	4030	4665	635

SUMMARY

Coastal plain soils are naturally low in fertility and many pine stands will give an economic response to fertilization, especially phosphorus. Maintaining the nutrients that are on the site by limiting displacement of logging slash during and after the harvest can be important in maintaining the productivity of the site and reducing the amount of fertilizer required. Because of the low reserves in the soil, even well managed harvests may remove sufficient nutrients to lower productivity of the site. Soil testing should be included in the planning of a harvest. After the harvest, application of fertilizer as indicated by the soil test will prevent losses in productivity.

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