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Fertilization To Accelerate Loblolly Pine Foliage Growth For Erosion Control

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SUMMARY

On the southern Coastal Plain, loblolly pine (*Pinus* taeda L.) can be used to help control erosion because it produces abundant soil-protecting litter. The species requires several years to produce enough litter for adequate soil protection, but on loamy soils fertilization can reduce the time by a year or more.

When five fertilizer combinations were tested, one application of N at 150 lb/acre together with P at 33 lb/acre, and K at 62 lb/acre was best. Seedlings fertilized with this combination produced 1.6 times the foliage weight of unfertilized seedlings through the first 2 years without decreased survival. Additions of N up to 300 lb/acre in several small applications may further stimulate foliage growth.

Additional keywords: Nitrogen, ureaform, phosphorus, potassium, ammonium nitrate, litter, *Pinus taeda* L.

INTRODUCTION

Loblolly pine (*Pinus taeda* L.) is considered the most satisfactory tree species for erosion control on most upper Coastal Plain sites because it produces abundant soil-protecting litter (McClurkin 1967, Ursic 1963). Several years, however, are necessary for loblolly to produce enough litter to control erosion. Fertilization to increase the amount of foliage per seedling and shorten the time required to obtain enough litter for site protection was studied in field tests in northern Mississippi, and results are presented here.

METHODS

After preliminary pot tests were used to determine the best combinations and methods of application of nitrogen (N), phosphorus (P), and potassium (K), four fertilizer combinations and one untreated control were tested in two trials with field-planted year-old loblolly pine.

The treatments tested were:

1. $N_{50}P_{33}K_{62}$ in one application with N as ammonium nitrate.
2. $N_{150}P_{33}K_{62}$ in one application with N as ammonium nitrate.
3. $N_{300}P_{87}K_{62}$ in 10 small applications at 10-day intervals with N as ammonium nitrate.
4. $N_{300}P_{87}K_{62}$ in one application with N as ureaform.

Subscripts denote the application of the elements in lb/acre. Multiple small applications equaling a total of $N_{300}P_{87}K_{62}$ were tested because pot tests showed this combination improves growth but reduces survival unless applied in small increments over several weeks. Ureaform was tried to determine if its slow release of N would produce a response similar to that of several small applications of ammonium nitrate. Potassium was applied as muriate of potash and P as normal superphosphate. Fertilizers were broadcast and worked into the soil surface with fire rakes and hoes 6 weeks after planting.

In both tests, two eroded but naturally revegetated sites near ridgetops were cleared of vegetation, litter, and of At horizon to simulate bare, eroded, relatively dry soils. For each test, one site had a sandy surface soil (upper 9 inches), and the other had a loamy surface soil. At each site, 15 plots, each 10 x 15 feet, were planted with 50 seedlings. The 1.5- x 2.0-foot spacing on the plots provided enough seedlings to evaluate growth and survival on a small area with almost completely uniform soil. Each of the four fertilizer treatments and an unfertilized control were randomly assigned to three plots per site. Soil on the sandy site in test I was the Troup series (loamy, siliceous, thermic. Grossarenic Paleudult); on the loamy site, the soil was a Mayben (fine, mixed, thermic, Ultic Hapludalf). In test II, the soil on the sandy site was Smithdale (fine-loamy, siliceous, thermic, Typic Paleudult) and the soil on the loamy site was a Tippah (fine-silty, mixed, thermic, Aquic Paleudalf). Particle size distribution was:

	Test I			Test II		
Site	Sand	Silt	Clay	Sand	Silt	Clay
	Percent			*Percent*		
Loamy	30	44	26	23	50	27
Sandy	80	14	6	59	34	7

In test I, all current-year foliage on randomly selected seedlings was clipped, dried, and weighed after each of three consecutive growing seasons. Test II observations were limited to two consecutive growing seasons since, on many plots, clipping and mortality left too few seedlings for third-year sampling. In each test only current-year foliage was used for measurements because, as was shown in the pot tests, needles grew only in their first year. Number of fascicles were counted after the first season in test I. In both tests, height growth of the seedlingswas measured at 2-week intervals throughout each growing season. Variation caused by site, fertilization, and site-fertilization interaction was tested at the 0.05 probability level. Rainfall was measured in a recording gage located on the Experimental Forest about a mile from all plots.

RESULTS AND DISCUSSION

Test I seedlings planted on loamy soils and fertilized with $N_{150}P_{33}K_{62}$ produced 1.6 times the foliage weight of unfertilized seedlings through their first 2 years (table 1) because, as the counts showed, the fertilized seedlings produced more fascicles, at least in the first year. The pot tests also showed that fertilization increases number of needles per seedling and needle length. Seedlings receiving $N_{50}P_{33}K_{62}$ produced no more foliage weight than the unfertilized seedlings. Because of their second-year response when multiple ammonium nitrate applications were used, seedlings receiving $N_{300}P_{87}K_{62}$ on the loamy site yielded even more foliage weight than those receiving $N_{150}P_{33}K_{62}$. Third-year response to $N_{300}P_{87}K_{62}$ in both ammonium nitrate and ureaform applications also seemed to exceed response to $N_{150}P_{87}K_{62}$, but clipping in the first 2 years limited third-year observations to few trees, and results were not statistically tested. Perhaps ureaform released N unusually slowly on these rather poor soils and did not supply N in amounts supplied by ammonium nitrate until the third year. Height growth response to fertilization was similar to the response in foliage growth (table 1).

In test I, seedlings on the sandy site responded to fertilization, but the low level was as effective as the other levels. Periodic height growth and rainfall measurements within the growing season suggested that soil moisture availability probably limited response to fertilizer on the sandy site. In their first year, test I seedlings on the two sites grew in height at similar rates through early June as rainfall replenished soil moisture. On the loamy site seedlings continued growing at the same rate into September. However, growth on the sandy site slowed greatly in June, a dry month, and although it increased in late July and August with above normal rainfall, growth for the year was significantly less than on the loamy site. Available moisture also influenced response the second year. On the loamy site, growth, which was rapid and greatest on fertilized plots, continued into August although June, July, and August rainfall was below normal. On the sandy site growth was rapid through June and was greatest on fertilized plots, but it practically ceased for the year on all plots by early July.

Seedlings on the loamy site of test II responded to fertilization, but total foliage weights were less than in test I (table 1). Weight differences seemed related to differences in rainfall and soil moisture availability, particularly during the first year. In both tests, first-year rainfall was above normal through April and May, and height growth of seedlings on the loamy sites was about the same. Though June rainfall in the first year of each test was below normal, test I seedlings continued growing at a constant rate into September because July-August rainfall was above normal. In test

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Table 1 .-*Total pine foliage production and height growth during 2 years following planting.*

Site	Fertilization [1]	Foliage weight2		Height growth*	
		Test I	Test II	Test I	Test II
		Ounce/seedling		*Feet*	
Loamy	$N_0P_0K_0$	4.30_{c}	1.59_{b}	3.37,	1.55,
	$N_{50}P_{33}K_{62}$	4.34_{c}	2.36_{b}	3.24,	1.69,
	$N_{150}P_{33}K_{62}$	6.88,	3.00_{ab}	4.15,	2.28_{ab}
	$N_{300}P_{87}K_{62}$ 10 small applications	8.11_{a}	4.20,	4.28,	2.54,
	$N_{300}P_{87}K_{62}$ with ureaform	6.60_{b}	2.47,	4.19,	1.95_{bc}
Sandy	$N_0P_0K_0$	1.20,	0.46,	1.454	0.73_{d}
	$N_{50}P_{33}K_{62}$	1.76,	$.46_{c}$	1.81_{c}	$.88_{d}$
	$N_{150}P_{33}K_{62}$	1.87_{d}	$.56_{c}$	1.73_{c}	$.84_{d}$
	$N_{300}P_{87}K_{62}$ 10 small applications	1.55_{de}	$.71_{c}$	1.69,	1.02_{d}
	$N_{300}P_{87}K_{62}$ with ureaform	1.83_{d}	$.60_{c}$	1.80,	$.77_{d}$

[1] Subscripts denote elemental N, P, and K in lb/acre.

*Mean weights or height growth in the same column with different subscripts differ significantly.

II, summer growth was much slower as rainfall continued below normal through July and August.

No statistical differences existed between foliage weights of fertilized and unfertilized seedlings on the sandy site in test II. First-year height growth of the seedlings indicated that there was a response while moisture was available, but growth nearly ceased by late June, so seedlings did not fully- use the fertilizers.

Fertilization did not reduce survival in either test I or test II; surviva!. like growth, appeared related to first-year rainfall. Test I first-year and second-year survival ranged from 93 to 96 percent for the fertilized treatments on the loamy soil and was 97 percent for the control; on sandy soil, survival ranged from 86 to 92 percent for the fertilizer treatments and was 94 percent for the control,. In test II, survival ranged from 72 to 82 percent for the fertilizer treatments on loamy soil and was 83 percent for the control. On sandy sites, survival was 68 to 83 percent for the fertilizer treatments and was 78 percent for the control. Survival on fertilized plots might have been substantially reduced if large amounts of competing vegetation had been present and responded to fertilization (McClurkin 1958 and 1961). However, on sites where such vegetation is present, fertilization to increase foliage production would not be needed since the competing vegetation already would protect the site.

CONCLUSIONS

The time needed by loblolly pines to cover eroding sites with protective litter may be reduced by a year, perhaps more, by accelerating foliage production with fertilization. A plantation with a 6- x 6-foot spacing on a loamy soil receiving near-normal rainfall and moderate fertilization ($N_{150}P_{33}K_{62}$) should produce about 510 pounds of foliage per acre in the first 2 years, An unfertilized plantation would produce only about 315 pounds, and would require 3, perhaps 4, years to produce as much foliage as the fertilized plantation would in 2 years. This greater amount of foliage on fertilized plants also intercepts 'more rainfall and reduces impact on the soil. Response to fertilization can be expected when moisture is available for a large part of the growing season, but may not occur if soil moisture is limited. Fertilization of loblolly pine appears useful where accelerated formation of permanent cover is needed to protect unattractive eroding soils or on any site yielding large amounts of sediment that is filling ditches, channels, or ponds that require costly cleaning or rebuilding.

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