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Research Note

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Growth of Planted Yellow-Poplar After Vertical Mulching and Fertilization on Eroded Soils[1]

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SUMMARY

Fertilization and vertical mulching improved height growth of yellow-poplars planted on eroded soils. A growing demand for hardwood timber accompanied by a diminishing land base has prompted land managers to consider planting hardwoods on marginal sites such as the eroded soils in the Silty Uplands of Arkansas, Louisiana, and Mississippi. Many of these areas were well suited for pine but lack the moisture and nutrients necessary for fast-growing hardwoods. If soil moisture and nutrient content were improved, hardwood management would be feasible on these sites. In two field experiments to improve moisture and nutrient content of eroded Memphis soils, vertical mulching with sawdust plus fertilizer improved height growth by 40 percent on severely eroded soils and by 25 percent on moderately eroded ones. Total height growth during the 5-year study period averaged 12.2 and 14.4 feet for treated trees on severely and moderately eroded sites, respectively, compared to 8.5 and 11.5 feet for untreated controls. Greatest response occurred during the second through fourth years after application. Broadcast fertilization followed by disking also improved height growth, but the response lasted only 2 years. Total height growth of trees ranged from 11.7 feet for controls to 13.3 feet for the fertilizer treatment.

Additional keywords: Liriodendron tulipifera, forest fertilization, Memphis soils, soil erosion.

PLANTING ON ERODED SITES

A growing demand for hardwood timber, accompanied by a diminishing land base, has prompted land managers to consider planting hardwoods on marginal sites such as the eroded soils in the Silty Uplands of Arkansas, Louisiana, and Mississippi. Many of these areas are well suited for pine but lack the moisture and nutrients necessary for fast-growing hardwoods. During its first decade, for example, yellow-poplar (Liriodendron tulipifera L.), averages only about 1.5 feet in height growth per year, when planted on severely eroded Memphis soils (Typic Hapludalfs) in the Silty Uplands of Mississippi. When planted on noneroded soils of the same series, however, yellow-poplar averages about 5 feet per year during the same growth period. If soil moisture and nutrient content were improved, hardwood management would be feasible on these sites. This note describes two field experiments to improve moisture and nutrient content of eroded Memphis soils.

METHODS

The first experiment was installed in two plantations near Vicksburg, Mississippi, in spring 1967. Noneroded Memphis soils in the area commonly have 8 to 12 inches of topsoil. One of the plantations represented a severely eroded site, as it had 1 inch or less of topsoil; the other site, which had 4 to 5 inches of topsoil, was considered moderately eroded. Both sites had become eroded several years earlier while under agronomic use. At the time of treatment, trees on the severely eroded site were 2 years old and averaged 2.6 feet in height; trees on the moderately eroded site were 3 years old when treated and averaged 8.4 feet in height.

Treatments consisted of a vertical mulch with sawdust, a vertical mulch with sawdust plus fertilizer, and an untreated control. All treatments were replicated four times in a completely random design at each site. Each treatment plot consisted of four trees; there was at least one row of trees between each plot.

The vertical mulch consisted of filling two holes per tree with partially decomposed sawdust. The holes, which were 7 inches in diameter and 20 inches deep, were placed on opposite sides of each tree at a distance of 12 inches. For the fertilizer treatment, 0.6 pounds per tree (equivalent to 1,000 pounds per acre) of 13-13-13 was placed in a horizontal layer at the midpoint of the sawdust column. This provided 130 pounds per acre of N, 57 pounds per acre of P, and 108 pounds per acre of K. There were no holes on the control plots.

During the first year after establishment, both plantations were clean cultivated with a disk harrow; a cross-cultivation technique was used.

Tree heights were measured at the beginning of the study and at the end of each growing season for 5 consecutive years. Diameters (DBH) were measured at the end of the fifth year.

The second study was established near the first one in spring 1969; sample trees were 2 years old and had been clean cultivated during the first year. The experiment tested growth responses after a broadcast application of 1,000 pounds per acre of 13-13-13 fertilizer, which was applied and disked into the soil early in the second growing season. At the time of treatment, the trees averaged 3.1 feet in height. There were four replications installed in a randomized complete block design. Each plot was 100 feet square (0.23 acres) and contained approximately 80 trees. For 28 trees in the interior of each plot, height was measured at the time of

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[1] A cooperative study with Greif Bros. Corporation and Anderson-Tully Company.

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treatment and after the second through the fifth growing seasons; diameters were measured at the end of the third through the fifth seasons.

Differences were tested at the 0.05 level by analyses of variance.

RESULTS AND DISCUSSION

For severely eroded sites, mulching and fertilization significantly improved total height growth of trees during the 5-year study period (experiment 1) (table 1). Total height growth of trees on the poor site ranged from 8.5 feet for the controls to 12.2 feet for the sawdust plus fertilizer treatment. The sawdust mulch alone did not significantly influence growth.

Significant responses to fertilizer occurred on the severely eroded site during the second, third, and fourth years after treatment, when annual height growth increased by 43, 125, and 69 percent over the controls. No growth responses occurred during the first and fifth years. During the first year, the roots had probably not penetrated the sawdust- fertilizer columns sufficiently; by the fifth year, the fertilizer had apparently been depleted, immobilized, or leached. Farmer, Snow, and Curlin (1970) reported that NP fertilization of yellow-poplar on a severely eroded, silty clay loam soil in eastern Tennessee produced significant growth responses during the first 2 years after planting. However, by age 5, only the N effect was significant; trees on the most effective N treatment plots were 80 percent taller than controls.

On the moderately eroded site, mulching plus fertilization appeared to increase height growth by 25 percent, and mulching alone apparently decreased height growth by 29 percent; however the differences were not significant. The only significant finding for moderately eroded sites was increased height growth during the second year after mulching plus fertilization.

A comparison of total height growth by treatment on the two sites indicated that mulching plus fertilizer on the severely

Table 1.--*Annual height growth of yellow-poplar after vertical mulching with sawdust and fertilizer (experiment 1)*

Site and treatment	Annual height growth after treatment [1]					Total
	1st year	2nd year	3rd year	4th year	5th year	
	- - - - - - - - - - - - *Feet* - - - - - - - - - - - -					
Severely eroded site						
Control	2.3 a	2.8 a	1.2 a	1.3 a	0.9 a	8.5 a
Sawdust only	1.8 a	2.9 a	1.4 a	1.3 a	1.3 a	8.7 a
Sawdust plus fertilizer	2.1 a	4.0 b	2.7 b	2.2 b	1.2 a	12.2 b
Moderately eroded site						
Control	1.7 a	3.1 a	2.5 a	1.9 a	2.3 a	11.5 a
Sawdust only	1.3 a	2.1 a	1.9 a	1.1 a	1.8 a	8.2 a
Sawdust plus fertilizer	1.8 a	5.0 b	3.7 a	1.3 a	2.6 a	14.4 a

[1] Separate analyses of variance were used for each site-year. Means in the same column and for each site followed by the same letter are not significantly different (0.05 level).

eroded soil produced growth comparable to that of the untreated trees on the moderately eroded site. Thus, 5 years after treatment, the productivity of the poor site was similar to that of the intermediate site.

Mulching and fertilization did not significantly influence diameter growth, although an increase of 25 percent over controls was observed on the severely eroded sites, and a 32 percent increase was recorded on the moderately eroded one.

Because of the early responses to the sawdust plus fertilizer treatment, it was thought that a similar response might be obtained with a simple broadcast application of 13-13-13 fertilizer followed by disking (experiment 2). Fertilization significantly improved height growth for 2 years after treatment (table 2), when total height growth was 11.7 feet for the controls and 13.3 feet for fertilized trees. There was no response to fertilizer during the third or fourth years, but at the end of 4 years, the fertilized trees were 2 feet taller than the controls, though the difference was not significant.

Trees on individual blocks responded differently (table 2). Blocks 1, 2, and 3, which were located on a flat portion of a ridge, were only moderately eroded (4- to 5-inch topsoil depth); block 4 was located on the side slope of the ridge and was severely eroded (topsoil depth of 1 inch or less). Improvements in height growth were greater for trees on the severely eroded block than for those on the three moderately eroded blocks. By the end of the experiment, fertilization had increased block 4 tree heights by 4.5 feet, while tree heights on blocks 1, 2, and 3 were increased by only 0.5 to 1.2 feet. These results are comparable to the findings in experiment 1, where eroded sites showed the best responses to soil improvement. As in the first experiment, fertilization failed to affect diameter growth significantly.

CONCLUSIONS

Both experiments indicated that height growth of yellow-poplar planted on eroded Memphis soils is improved by adding fertilizer. Results were more pronounced on severely eroded than on moderately eroded

Table 2.--*Annual height growth of yellow-poplar after broadcast fertilization (experiment 2)*

Treatment	Block	Annual height growth after treatment[1] 1st year	2nd year	3rd year	4th year	Total
		- - - - - - - *Feet* - - - - - - -				
Fertilized	1	5.3	8.9	8.5	7.6	30.3
	2	5.4	7.9	10.4	6.1	29.8
	3	5.8	9.1	9.5	3.8	28.2
	4	4.8	6.2	5.3	3.9	20.2
	Mean	5.3 a	8.0 a	8.4 a	5.4 a	27.1 a
Control	1	5.1	7.5	10.1	6.4	29.1
	2	5.1	7.5	11.0	5.7	29.3
	3	5.4	7.5	10.1	4.2	27.2
	4	4.2	4.8	4.6	2.1	15.7
	Mean	4.9 b	6.8 b	9.0 a	4.6 a	25.3 a

[1] Separate analyses of variance were used for each site-year. Means in each column followed by the same letter are not significantly different (0.05 level).

sites, although growth responses in both tests were moderate and of brief duration when compared to growth on noneroded sites. After fertilization, productivity of the severely eroded sites was similar to that of moderately eroded ones; however, the treatments did not raise productivity of eroded soils to the high levels typical of noneroded ones.

Responses to fertilization were only temporary but might be enhanced by periodic fertilizer applications during the early plantation development; however, only severely eroded soils should be fertilized.

LITERATURE CITED

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