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Fertilizer and Mulch Improves Yellow-Poplar Growth on Exposed Hartsells Subsoils

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SUMMARY

Fertilizing and mulching of eroded Hartsells soil increased height and diameter of yellow-poplars. To see if chemical infertility of exposed Hartsells subsoils limits yellow-poplar growth and to test fertilizer and mulch as remedial agents, seedlings were planted on undisturbed soil, soil with the topsoil removed, and soil with the topsoil removed but mulched with leaf litter. After one growing season, 9 of the 18 plots were fertilized.

Topsoil removal with no remedial treatment reduced growth through four growing seasons. Mulching did not improve growth the first year but did in subsequent years. The first year after application, fertilizer greatly increased growth; thereafter growth on fertilized plots was about the same as growth on unfertilized mulched and undisturbed plots. Fertilizer with mulch provided no added growth. Mineral deficiencies and rapid drying apparently limit growth on exposed subsoils, but physical structure does not.

Additional Keywords: *Liriodendron tulipifera,* forest fertilization, erosion.

PLANTING ON ERODED SITES

Abundant rainfall and decay of forest vegetation have formed nutrient-rich topsoils in the Cumberland Plateau of Tennessee, but on thousands of acres, the topsoil has eroded. When the rich topsoil is removed — as it often is by farming, logging, construction of forest roads and trails, and site preparations exposing mineral soil — the loss of nutrients limits tree growth. And once a site loses its topsoil, it continues to erode and loses moisture rapidly, making it suitable for only "poor site" trees like upland oak and Virginia pine. Yellow-poplar, which needs moist, fertile soil, grows slowly on exposed subsoils (Loftus 1971).

The objectives of this study were to determine the extent that infertility of exposed Hartsells subsoils limits yellow-poplar growth, and to test fertilization and mulching treatments for trees in eroded areas.

METHODS

A typical Cumberland Plateau hollow near Sewanee, Tennessee was chosen for study. Soils are Hartsells, an extensive Typic Hapludult. The area was cleared of a mixed oak stand, all other vegetation was removed, and stumps were treated to prevent sprouting. Plots were arranged in a randomized block design in six blocks containing one 12 x 12 foot plot of each of three initial treatments.

Treatments were: (1) undisturbed (2) organic and A horizons removed (3) organic and A horizons removed and a litter layer returned. The topsoil was removed with a shovel. The litter layer in the third treatment was raked up and spread again by hand after the topsoil had been removed. In the spring of 1970, nine yellow-poplar seedlings graded 1-0 with roots and tops clipped uniformly were planted in each plot at a 4 x 4 foot spacing.

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At the end of the first growing season (fall, 1970) height and root-collar diameter of all seedlings were measured. Four seedlings per plot were excavated, oven dried, and weighed. Two tons per acre of dolomitic limestone were hoed into the surface of 9 of the 18 plots. In the spring of 1971, fertilized plots received 150 lbs N/acre as NH_4NO_3 and 100 lbs P/acre as triple super phosphate topdressed.

Tree heights and root-collar diameters were measured each succeeding fall for three seasons. After the last measurement, one seedling per plot was excavated, oven dried, and weighed. The results were evaluated by analysis of variance supplemented by Tukey's ω procedure.

RESULTS AND DISCUSSION

During the first growing season, growth was significantly depressed by removal of topsoil (table 1). Leaf mulch added to the subsoil did not increase growth the first year. During the second through the fourth years, however, seedling growth on unfertilized mulched plots equalled that on the undisturbed control plots (table 2). Seedlings on exposed subsoil that was not mulched or fertilized grew slowly throughout the experiment (fig. 1). Mulching apparently improves the intake of water, protects the soil from drying, and may speed mineralization of nutrients.

Table 1. — First year response of planted yellow-poplar to topsoil removal with and without mulching.[1]

	Undisturbed	Exposed B	Mulched B
Height growth (cm)	27.5 a[2]	16.9 b	19.2 b
Root collar diameter (mm)	9.8 a	8.2 b	8.2 b
Top dry weight (gms)	6.4 a	4.1 b	3.9 b
Root dry weight (gms)	9.6 a	7.4 ab	6.0 b

[1]Each entry for height growth and root collar diameter is the average of 54 seedlings and each entry for top and root dry weight is the average of 24 seedlings.

[2]Means in each line followed by the same letter are not significantly different at the .05 level of probability.

In the first year after fertilization, fertilized trees increased significantly in height and diameter (table 2). In the following years, fertilized seedlings grew at about the same rate as those on unfertilized mulched and undisturbed plots. Fertilizer and mulch each helped seedlings overcome the growth depression caused by topsoil removal, but mulching combined with fertilizer produced little additional growth. Fertilized plots quickly built up a light natural mulch created by weed growth in the year of fertilization.

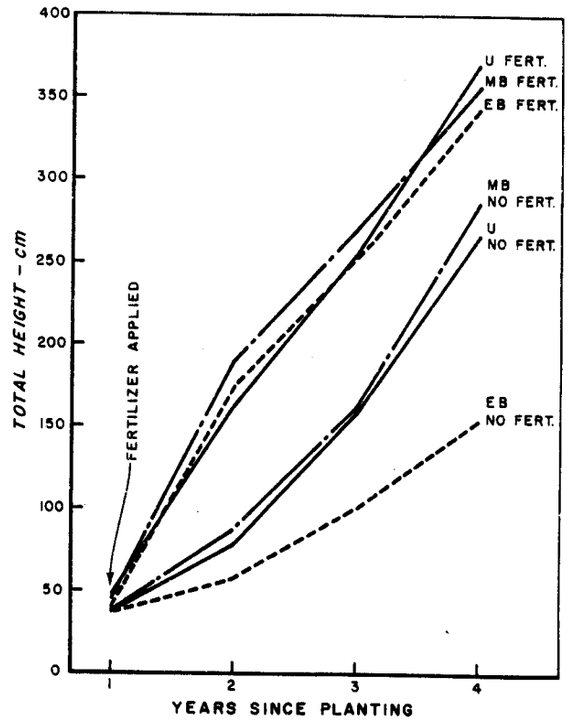

Figure 1.—*Total height of yellow-poplar on fertilized and unfertilized plots that were undisturbed (U), had B horizon exposed (EB), or had B horizon exposed and were mulched (MB).*

At the end of the experiment, root weight was significantly increased by fertilization (table 2). Root weight was depressed by removal of topsoil, but not significantly so.

The experiment indicates that the chemical infertility of Hartsells subsoil severely limits yellow-poplar growth on exposed subsoil. Because improving the nutrient or moisture levels of the exposed subsoil makes growth equal to or greater than that found where the topsoil is still present, physical properties of the subsoil are apparently not the reason for poor growth. Where loss of topsoil has been extensive enough to warrant treatment, ease of application and promotion of growth and litter accumulation make fertilization a valuable aid to establishment and early growth of yellow-poplar.

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LITERATURE CITED

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Table 2. — Yellow-poplar height growth, root-collar diameter growth, and root weight on fertilized and unfertilized soil that was undisturbed (U), had B horizon exposed (EB) or had B horizon exposed and was mulched (MB). Times shown indicate time since fertilizer application.[1]

	No Fertilizer			Fertilizer		
	U	EB	MB	U	EB	MB
Height growth yr. 1 (cm)	42 a[2]	22 a	49 a	116 b	135 b	153 b
Height growth yr. 2 (cm)	79 b	42 a	72 b	92 b	76 b	79 b
Height growth yr. 3 (cm)	111 b	47 a	124 b	118 b	92 b	90 b
Diam. growth yr. 1 (mm)	4.6 a	4.0 a	6.4 ab	13.4 bc	18.4 c	17.0 c
Diam. growth yr. 2 (mm)	11.8 bc	5.8 a	9.6 ab	15.9 c	12.2 bc	14.2 bc
Diam. growth yr. 3 (mm)	10.6 bc	5.7 a	9.5 bc	11.7 c	8.6 ab	10.1 bc
Root weight yr. 3 (gms)	424 abc	125 a	278 ab	986 d	608 bcd	718 cd

[1]Each figure is the average of 15 seedlings except for root weight which is the average of 3 seedlings.

[2]Means in each line followed by the same letter are not significantly different at the .05 level of probability.