U.S.D.A. Forest Service Research Note SE-106 February 1969

INFLUENCE OF SOIL TYPE AND DRAINAGE ON GROWTH OF SWAMP CHESTNUT OAK (*QUERCUS MICHAUXII* NUTT.) SEEDLINGS

Abstract.—Swamp chestnut oak (*Quercus michauxii* Nutt.) seedlings were grown for 2 years in five soil types in drained and undrained pots. First-year height growth was related to soil type and pot drainage, but second-year height growth was related only to soil type. Results suggest that swamp chestnut oak is site-sensitive. But slow growth, a maximum of 2 inches the first year and 4 inches the second, indicates that factors other than the composite effect of soil type and drainage are important to early growth of this species.

Growth of planted oak seedlings is slow and erratic in coastal South Carolina. In a 5-year-old plantation, Stubbs[1] found extreme variability in the height growth of cherrybark oak (*Quercus falcata* var. *pagodaefolia* Ell.) and Shumard oak (*Q. shumardii* Buckl.) and only slightly better growth with swamp chestnut oak (*Q. michauxii* Nutt.). DeBell and Langdon[2] reported that average diameter of 11-year-old volunteer species, in the same plantation, was three, four, and five times larger than the average diameter of planted swamp chestnut oak, cherrybark oak, and Shumard oak, respectively.

Putnam and Bull[3] reported swamp chestnut as widely distributed throughout the Mississippi Delta, but local and irregular in occurrence within its range. Comparison of the number of soils on which swamp chestnut oak and sweetgum (*Liquidambar styraciflua* L.) grow and on which they can be successfully managed illustrates the differential in site requirements of the two species. For coastal plains, Broadfoot[4] lists two of nine soil types on which swamp chestnut oak occurs frequently and should be favored in management. In contrast, he lists eight of nine soil types on which sweetgum occurs frequently and should be favored.

Is the capricious growth of planted oak an inherent variability of the species, or is this response caused by sensitivity to site factors? This paper reports the results of a shadehouse study of swamp chestnut oak seedlings grown for 2 years in five soil types in drained and undrained plots.

Methods

Soil used in the experiment was collected from five soil types common to the Santee Experimental Forest, Berkeley County, South Carolina. In all types the litter layer was removed and 6 inches of soil surface were taken. Texture ranged from coarse sand to clay loam. The soils sampled were Lakeland loamy fine sand, Wagram loamy coarse sand, Dunbar sandy loam, Meggett silt loam, and Meggett clay loam.[5]

All the soils except Meggett clay loam were sieved through a ¼-inch mesh before being put into pots. Meggett clay loam formed irreversible clods upon drying and therefore was lifted undisturbed and placed directly into pots.

[1]Stubbs, Jack. Planting hardwoods on the Santee Experimental Forest. South. Lumberman 207 (2585): 135-136, 138. 1963.

[2]DeBell, Dean S., and Langdon, O. Gordon. A look at an 11-year-old hardwood plantation. South. Lumberman 215 (2680): 156-158. 1967.

[3]Putnam, J. A., and Bull, Henry. The trees at the bottomlands of the Mississippi River Delta region. U. S. Dep. Agr. Handbook 271, pp. 622-624. 1932.

[4]Broadfoot, Walter M. Soil suitability for hardwoods in the midsouth. South. Forest Exp. Sta., U. S. Forest Serv. Res. Note SO-10, 10 pp. 1964.

[5]Four of these soils have been reclassified since the study was completed. Wagram loamy coarse sand was formerly called Fort Meade loamy coarse sand; Dunbar sandy loam was Coxville loam; Meggett silt loam was Chastain silt loam; and Meggett clay loam was Bayboro clay loam. Lakeland loamy fine sand was not reclassified.

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Four metal pots (9 inches in diameter and 10 inches tall) were used for each soil type. Two pots were provided with bottom drainage and two were lined with plastic to prevent drainage, for each soil type. The pots were randomly arranged in two blocks, with each block containing one drained and one undrained pot of each soil type. Three seedlings with roots pruned to 3 inches were planted in each pot. The seedlings were 5 months old and fully leafed out when planted. Pots were kept in a shadehouse (50 percent shade) and watered weekly to saturation. Drained pots were brought to saturation with drains open.

During the first growing season the seedlings showed some evidence of shock, probably because of being planted while leafed out, so the experiment was carried another year. After final 2-year height measurements were taken, the seedlings were removed from the pots and ovendried for leaf, stem, and root weights.

At the end of the experiment, the Meggett clay loam with its seedlings was submerged in 1½ percent hydrogen peroxide (H_2O_2) solution for 24 hours. Seedlings were then easily removed with intact root systems. This scheme allows observations of physical development of seedling root systems in a heavy clay soil.

Although seven seedlings died during the 2-year experiment, each pot had two or more surviving seedlings. Pot averages were used in the analysis of variance, and Duncan's multiple range test was used to test differences among means.

Results

First-year height growth appeared to be affected by pot drainage and soil type, although differences were small. Surprisingly, there was no interaction between soil type and pot drainage. Seedlings in drained pots grew taller than those in undrained pots in all soil types.

Second-year and total height growth was not significantly affected by pot drainage, but soil type did show a definite effect (table 1 and fig. 1). Meggett silt loam (labeled Chastain silt loam in figure 1) had consistently better growth than the other soil types.

Second-year height growth completely masked the first-year effects of pot drainage. Consequently, the pattern of total height growth for the 2-year period was similar to second-year growth patterns (table 1).

Table 1.—Second-year and total 2-year height growth of swamp chestnut oak seedlings by soil type

Soil type	Average height growth[1]	
	Second-year	2-year total
	Inches	
Lakeland loamy fine sand	0.9	1.9
Wagram loamy coarse sand	1.3	2.1
Meggett clay loam	1.4	1.9
Dunbar sandy loam	2.0	3.5
Meggett silt loam	4.0	6.3

[1]Values within the brackets are not significantly different at the 5-percent level (Duncan's multiple range test).

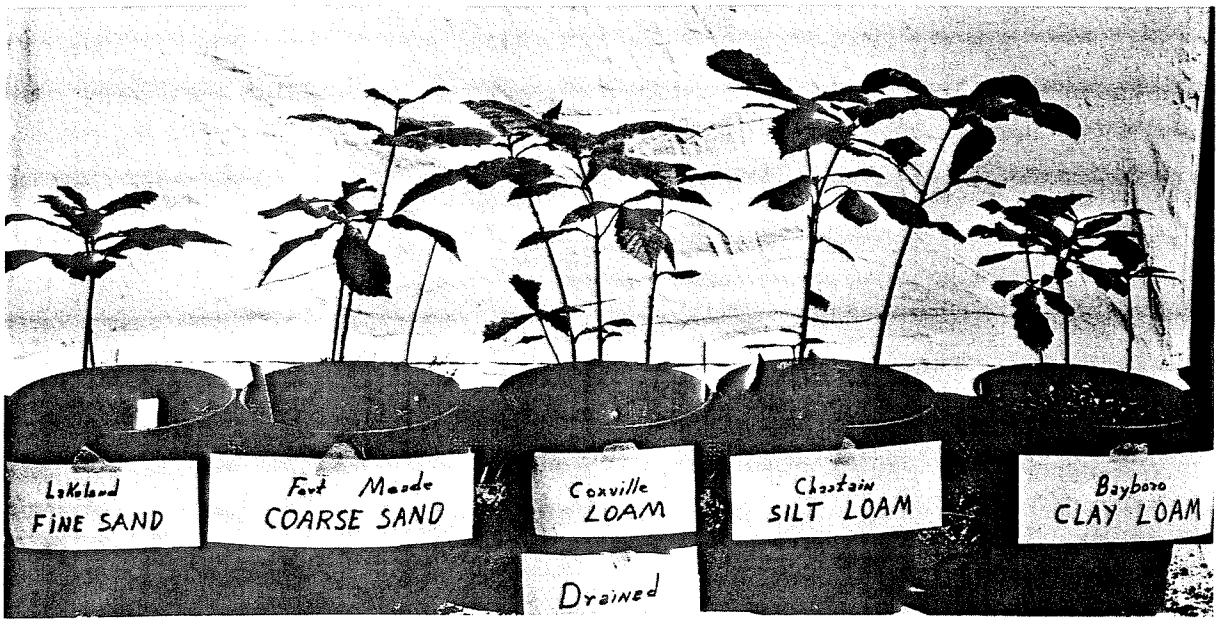

Figure 1.—Height growth of swamp chestnut oak seedlings in five soil types at the end of 2 years in drained pots. Since this study was completed, four of these soils have been reclassified (see footnote 5).

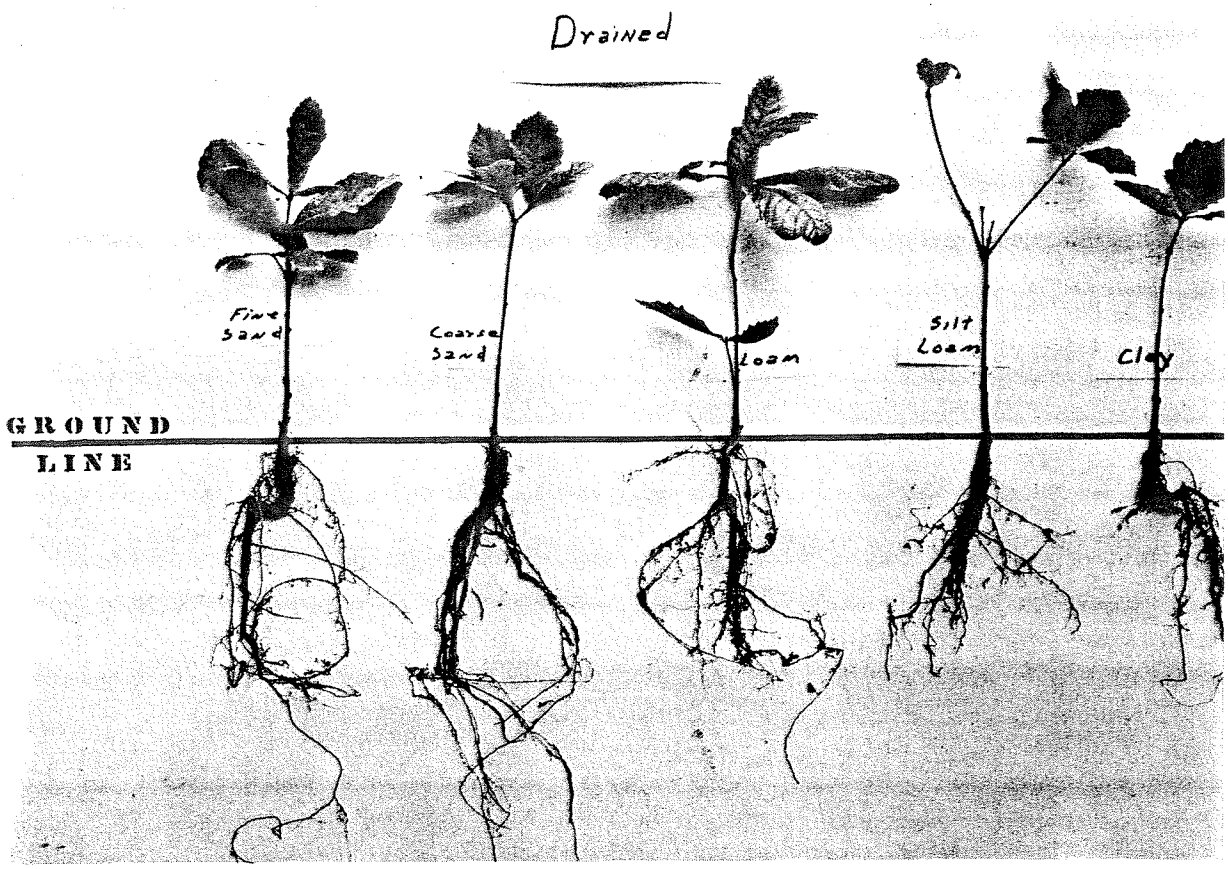

Figure 2.—Root development of swamp chestnut oak seedlings in five soil types at the end of 2 years in drained pots.

Dry weight top-root ratios were significantly affected by soil type at the 6-percent level. Undrained pots had larger top-root ratios, regardless of soil type. It appears that root system structure was only slightly affected by soil type (fig. 2). In the sandy soils, root systems were long and stringy; there were shorter and slightly more fibrous root systems in the heavier silt and clay loam soils.

Discussion

Results from this exploratory study are tentative and indicate areas for more intensive future research with swamp chestnut oak.

The significant response of height growth to drainage and soil type the first year, and only to soil type the second year, suggests that drainage may be more important to establishment than to subsequent growth.

Of the five soils tested, only Meggett silt loam appears to afford the proper composite of edaphic factors (structure, texture, nutrients, and other physical and chemical properties) necessary for best growth of swamp chestnut oak. This suggests the species is site-sensitive.

The best height growth in any treatment was 2 inches the first year and 4 inches the second—poor by any standards. This suggests that factors other than soil type and drainage are critical to the early growth of planted swamp chestnut oak seedlings. Until more is learned about the capricious growth of this oak, planting the species should be only a last resort in regeneration.

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