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Stand Parameters of a 27-Year-Old Water Oak Plantation on Old Field Loessial Soils

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SUMMARY

At age 27, water oak (Quercus nigra L.) plantings on Macon Ridge old field loessial soil near Winnsboro, Louisiana, had per-acre stand values as follows: number of trees, 356; average d.b.h., 6.6 inches; basal area, 86 ft^2; total volume from the stump to the tip (of trees with d.b.h. 25.0 in), 2,017 ft^3; average height of the 50 tallest trees, **61 ft.**

Additional keywords: *Pinus elliottii,* plantation costs, *Quercus nigra.*

INTRODUCTION

Growth and yield data for oak plantations 20 years of age and older in the Midsouth are very limited. Although plantations represent only a fraction of the hardwood resource, planting is one way to establish a desired species on a given site. Information on development of plantations is desirable so that some idea of returns can be obtained on the high cost of establishment and to make comparisons with natural regeneration on similar sites. In the case reported here, 27-year-old water oak *(Quercus nigra* L.) plantations on two fields were made available for measurements by the landowner, who had originally planted the trees on land that produced below average crops (fig. 1).

STUDY AREA

The plantations were established the first 2 weeks in February 1960 on old fields of loessial soil on Macon Ridge near Winnsboro, Louisiana. The fields had been under cultivation for decades prior to planting trees, as had the neighboring fields that still remain in crops. The water oak plantings consisted of a 14 l/2-acre tract on a larger field and a 6 1/2-acre tract on a smaller field.

Records show that 20,000 oaks were planted on the 21 acres, approximately 950 trees per acre-about 46 square feet per tree. Original spacing between rows appears to have been mainly about 9 to 10 feet, although spacing varied to as close as 6 feet. In some instances parts of rows were completely missing, but whether from mortality or not being planted is unknown. Within-row spacing was variable. After planting, no cultivation or weed control was done.

METHODS

In the fall of 1986, thirty-six O.l-acre measurement plots were systematically established in the water oak plantings on a 150-foot by 15-row grid, with 27 of the plots in the larger field. On the plots all trees were measured for d.b.h. and assigned to a crown class. Five dominant-codominant trees were measured for total height, as were two to three intermediate or suppressed trees. Near each plot center, soil samples were taken from the surface O-to 1 O-inch level and from the 10- to 20-inch level. Additional samples at the 20- to 30-inch level and 30- to 40-inch level were planned, but afragipan at about 20 inches prevented deeper sampling on all but four plots. For comparison, soil samples were taken from two locations in an adjacent field.

Twenty water oak trees were felled and diameters of the bole measured at 4-foot intervals to the tip, starting at a 1 -foot stump, in order to develop a main stem outside bark volume equation. Four codominant trees were

Figure *1. — General view of a 27-year-old water oak plantation on old field loessial soil*

measured for height to live crown and maximum crown spread in cardinal directions, then felled and sectioned at 5-foot intervals. Ring counts were made to determine height development over time.

RESULTS AND DISCUSSION

Texture of all soil samples was either silt loam or silty clay loam. The plantation soil pH of most samples was very strongly acid (4.5 to 5.0). An adjacent agricultural field had surface pH's of 5.3 and 5.9 and a hardpan at 20 inches, as did most samples taken from the woods. Because of the pan conditions encountered in soil sampling the soils could probably be best described as a Calhoun-Calloway complex and Calhoun-Loring complex. All three soils developed from loess with Calloway and Loring having fragipans.

Broadfoot (1976) listed Calloway as having an estimated site index range for water oak of 65 to 85 feet at 50 years. In an earlier publication, Broadfoot and McKnight (1961) did not recommend favoring water oak as a future stand component on either Loring or Calhoun, and Broadfoot (1963) estimated a water oak site index for medium textured soils with a pan within 30 inches of the surface as 75 to 84 feet. From extrapolated curves (Broadfoot 1963) individual plot site indices varied from 68 to 100 feet and averaged 86 feet.

Because of height variations within the oak plantation, a total height over d.b.h. curve of the form $\ln(\text{height}) = b_0 + b_1 (1/\text{d.b.h.})$ was calculated for each plot using the seven to eight trees measured for height on the plot. Total stem volume outside bark (V) from a 1-foot stump to the tip was determined from:

$$V = 0.000718 D^{1.677282} H^{1.450080}$$

n = 20, fit index = 0.92, S_e = 1.12, CV = 14.5%.

Plot volumes were determined using 1-inch diameter classes and height over diameter curves, where D = d.b.h. class midpoint (e.g., 10.45 inches) and H = total height in feet as calculated from D.

The per-acre stand parameters of the 27-year-old water oak plantation based on the 36 plots for total trees and dominant/codominant trees are shown in table 1. The dominant/codominant component comprised 74 percent of the trees, 87 percent of the basal area, and 88 percent of the volume. The average respective diameters, in inches, of the dominant, codominant, intermediate, and suppressed trees were 9.0, 6.7, 5.1, and 4.0; average respective basal areas, in ft^2/acre, were 14.7, 60.4, 6.7, and 4.3. Height and diameter distributions are shown in figures 2 and 3.

Live crown ratios averaged 48 percent for the four codominant trees sampled, which averaged 7.4 inches in d.b.h. and 59.2 feet tall. Average respective heights at 5, 10, 15, 20, and 25 years, from ring counts, were 7, 20, 34,

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Table 1 .-*Per-acre stand parameters for total trees and dominant/codominant trees of a 27-year-old water oak plantation, based on 36 plots*

Stand parameter	Total trees	Dominant/codominant trees
	Mean ± standard error (range)	
Number of trees	356 ± 16 (130-530)	264 ± 12 (90-400)
Avg. d.b.h. (in)	6.6 ± 0.2 (4.9-9.2)	7.2 ± 0.2 (5.3-10.1)
Basal area (ft^2)	86.1 ± 2.8 (50.6–125.8)	75.0 ± 2.4 (41.1–109.7)
Volume (ft^3)	2166 ± 102 (11353831)	1908 ± 89 (1044-3390)
Volume (ft^3, d.b.h. ≥ 5.0 in)	2017 ± 106 (1080-3756)	1862 ± 93 (1044-3390)
10 tallest trees (ft)	64.4 ± 1.0 (49-77)	
Avg. 50 tallest trees (ft)	60.6 ± 0.9 (47.4-71.8)	

46, and 56 feet, with corresponding mean annual height increments of 1.4, 2.0, 2.3, 2.3, and 2.2 feet per year and 5-year periodic annual increments of 1.4, 2.6, 2.8, 2.4, and 2.1 feet per year. Thus maximum height growth occurred in the 11 th- through 15th-year period. Eighty percent of the 27-year diameter growth at a height of 5 feet took place during the first 15 years, after which a fairly uniform slow down in diameter growth occurred.

The 28-foot difference in the tallest tree per plot or 24-foot difference in the average of the five tallest trees per plot could not be related to various soil nutrients (N, P, K, Ca and Mg), soil texture, pH, or organic matter. Microsite moisture relationships and fragipan development were probably the main influencing factors, together with possible genetic differences in planting stock. Differences between the woodland soil and soil in the adjacent agricultural field were: in the surface 0 to 10 inches, greater amounts of Cain the field (1,064 vs. 392 ppm, $p < 0.010$) and a higher percentage of organic matter in the woods (1.19 vs. 0.48 percent, $p = 0.013$); in the 10- to 20-inch depth there was more K in the field (136 vs. 101 ppm, $p = 0.041$).

The development of the water oak can be compared with slash pine (*Pinus elliottii* Engelm.), which was

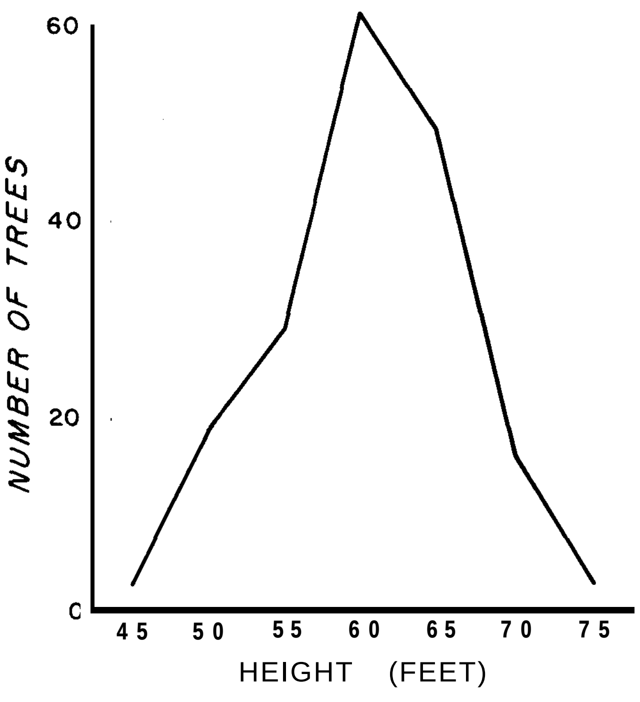

Figure 2. — *Height distribution of 180 dominant/codominant trees.*

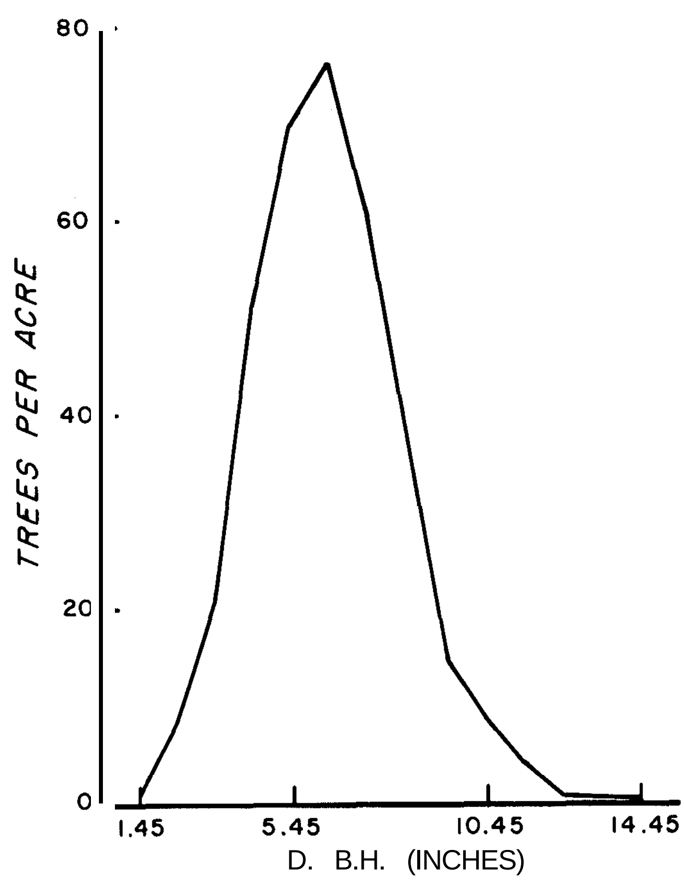

Figure 3. — *Diameter distribution per acre for frees ≥ 1.0 inches d.b.h.*

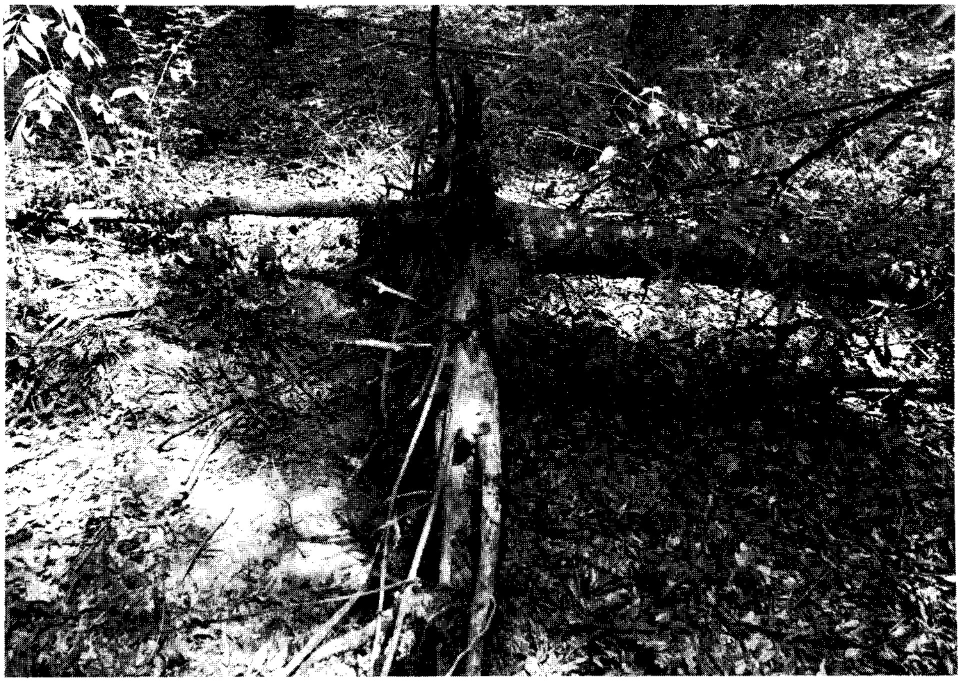

Figure 4. — *Shallow root development of windthrown water oak tree that had been growing in the 27-year-old plantation.*

planted at the same time on fields adjacent to the oak plantings. Based on five random 0.1 -acre plots in the pine plantings, the 27-year-old pine values exceeded the oak values with 16 percent more trees, 30 percent larger average d.b.h., 20 percent taller heights, 105 percent more basal area, and 192 percent more cubic volume in trees 25.0 inches d.b.h.

This planting has provided information on old field water oak plantation development on loessial soil with a fragipan, a less than ideal site that limits root growth and is subject to growing season drought. These pure oak stands have continued to develop through 27 years with crown class differentiation and 20 to 25 feet of limb-free boles among larger trees. Site differences may be partly responsible for the different growth patterns between the oaks, though. A slowing of both diameter and height growth may be partly due to stagnation of the pure oak stand but is mostly due to the fragipan soil. An intermediate thinning for the purpose of increasing growth of crop trees and for utilizing low vigor and poor quality trees is probably desirable, but because of size, cut trees would be more for firewood than pulpwood. Because rooting of the oak trees is shallow due to a pan (see fig. 4), any thinning to open the stand should probably be light.

Per-acre cost of planting, including labor, supervision, seedlings, and other expenses was $11.74. Price of seedlings in 1960 was $4.25 per thousand.

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