United States Department of Agriculture
Forest Service
Southern Forest Experiment Station

Research Note

SO-302
December 1983

Growth, Thinning Treatments, and Soil Properties in a 10-Year-Old Cottonwood Plantation on a Clay Site

Roger M. Krinard and Harvey E. Kennedy, Jr.

SUMMARY

Two of four Stoneville select cottonwood (*Populus deltoides* Bartr. ex Marsh.) clones planted at 12- by 12-foot spacing on old field clay soils had 80+ percent survival at age 5 and were subjected to three stocking levels. Plots were left unthinned (approximately 266 trees/acre) and thinned to half the number of trees (about 126 trees/acre) and to 60 trees per acre at age 5. Dbh growth the next 5 years differed significantly but amounted to only 0.3, 0.4, and 0.5 inch annually by treatments. Thinned plots had 23 and 35 percent less total volume (5th-year cut plus 10th-year standing) than unthinned plots. Tenth-year soil N, P, K, Ca and Mg values were greater than 5th-year values, but only Ca equalled and Mg exceeded plantation establishment measurements.

Additional keywords: *Populus deltoides.*

INTRODUCTION

Cottonwood plantation establishment costs, estimated at $255 per acre in 1980 (Dutrow 1980) where land clearing was involved, represent a considerable expense. Consequently, most cottonwood plantations in the Midsouth have been established on medium-textured soils, where cottonwood grows best, rather than on clay soils, where growth is considered marginal. The difference in height of 5-year-old trees of the same select clonal material was 25 feet between cleared Sharkey clay and Commerce silt loam soils (Mohn et al. 1970). In an attempt to improve growth, select cottonwood clones, planted on an old field clay soil, were thinned after the 5th year. This note presents stand and soil characteristics of the plantation 5 years later for both the thinned and unthinned areas.

METHODS

The study was planted on clay soils of a Sharkey (clay extends >36 inches)-Tunica (clay cap 20 to 36 inches thick) complex in Issaquena County, Mississippi, on the Mahannah Plantation of the Anderson-Tully Company. The site had been cleared and planted to soybeans for 6 years, then summer-fallowed prior to planting cottonwood. Three tons of lime per acre had been applied to the area before the last soybean crop in 1970.

Four clones-Stoneville (ST) 66, 67, 92, and 124—were randomly selected as representative of above-average material (Mohn et al. 1970), and cuttings were planted in December 1971 at 12- by 12-foot spacing. Each clone was planted as a unit, with 9 plots per clone except for ST-92 with only 8 plots. Overall plot size was 17 rows (east-west) by 17 columns (north-south) with measurement plots 10 rows by 10 columns.

ST-66 and ST-67 were thinned in March and April 1977 at the start of the sixth growing season; ST-92 and ST-124 were not thinned because of poor survival. Thinning treatments were: (1) control or check (CK), equiva-

lent to approximately 266 trees per acre; (2) thin every other column, leaving half the trees (TH) or about 126 trees per acre; and (3) thin every other column, then thin remaining columns to four trees each (20 trees per plot) or 60 trees per acre (T6).

A randomized complete block design was used to test thinning treatments at the 0.05 level. Where clonal means were compared, a t-test at the 0.05 level was used.

Diameters of all measurement plot trees were taken every year while a sample of heights was taken, using two columns in CK and TH plots and all trees in T6 plots. Ten-year standing-tree volumes from Barr and Stroud dendrometer measurements were combined with 5-year cut-tree volumes for volume determinations in the form:

$$V = 1.445848 + 0.002063\ D^2H - 6.117578(1/A);$$

$$r^2 = 0.992,\ S_{y\ x} = 0.330$$

where

V = total stem volume (cubic feet) outside bark from 1-foot stump to the top of the tree,

D=dbh,

H = total height, and

A = age (years).

In the 10th year, samples of height to live crown, maximum crown diameter, and, for ST-66 and ST-67, number of limbs and limb stubs in the first 17 feet of height were taken. As trees had been pruned to about 5 feet in the third year, the limb count generally indicated number of limbs from 5 to 17 feet.

Soil moisture determinations at the surface and 1-, 2-, 3-, and 4-foot depths were made several times during each growing season using a neutron probe and nine soil moisture tubes. Measurements taken nearest the middle of each month from May through September were used to characterize growing season moisture.

Bulk soil samples from 0 to 6 inches deep were collected at the start of the first growing season and in September of the 5th and 10th year from all plots. Soil chemical analyses, using standard laboratory procedures (Krinard and Kennedy 1980), were made for N, P, K, Ca, Mg, organic matter (OM), and pH.

RESULTS

Unthinned Plots

After 5 years, considering all 35 plots, survival was 75 percent. Average dbh and height were 5.4 inches and 43 feet. Basal area and volume per acre were 38 square feet and 681 cubic feet. The mean annual increment (mai) of volume, 136 cubic feet per acre per year, was equivalent to 1.5 cords (90 cubic feet = 1 cord).

At age 10, based on clonal averages of unthinned plots, average dbh and height increased to 6.9 inches and 60 feet while basal area and volume per acre reached 60 square feet and 1,594 cubic feet. Volume mai was 1.8 cords.

At age 5 (and also age 10), ST-66 and ST-67, compared to ST-92 and ST-124, had a third more trees with approximately 40 percent more basal area and about 60 percent more volume (table 1). Differences were significant by t-tests; thus, ST-66 and ST-67 were regarded as representative of better surviving select clones and considered separately from the poorer surviving clones.

Thinned Plots

Thinning after the 5th year increased the average dbh of T6 plots to 5.8 inches compared to 5.5 inches for the CK and TH plots. After 10 years, average dbh for CK, TH and T6 plots were 6.9, 7.5, and 8.4 inches, all significantly different from each other. The 5 years' diameter growth of 1.3, 2.0, and 2.6 inches were also significantly different.

Comparing the 20 largest trees per plot after 10 years' (so that CK and TH plots had the same type "thinning" as T6 plots, i.e., favor largest trees from alternate columns and no two trees adjacent in the same "leave" column) showed no difference at age 5: all treatments averaged 5.8 inches dbh. At age 10, TH and T6 trees were larger than CK trees. Diameter growth was different between all treatments. Thinning increased diameter growth, and larger trees tended to respond slightly more than smaller trees.

There were no significant differences in total height between treatments after the 5th or 10th year. Average 5 and 10 years' heights were 46 and 65 feet.

After 10 years, crown ratios of CK trees were significantly less than the other two thinning treatments-39 (CK) vs. 57 (TH) and 62 (T6) percent-while crown widths of T6 trees were significantly greater-l 0.6 (CK) and 12.0 (TH) vs. 14.3 (T6) feet. Diameter was more closely related to crown width (r^2 range by treatment from 0.42 to 0.59) than to crown ratio (r^2 range from 0.02 to 0.29).

Number of branches and stubs on the first 17 feet of stem did not differ by thinning treatments within clones, but did differ between clones. Mean number by clones over all thinning treatments was 28 for ST-66 and 17 for ST-67. Live branches in the first 17 feet were found on 21 of the 26 observed trees of ST-66, while only 2 of the 23 ST-67 trees had live branches.

Soil Moisture

By months, the general trend was for soil moisture to decline from May through August, then increase in September. By years, the eighth growing season (1979) was

Roger M. Krinard is Mensurationist and Harvey E. Kennedy, Jr. is Principal Silviculturist at the Southern Hardwoods Laboratory, maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, Forest Service-USDA, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

Table 1.-Average *tree and stand values at age 5 after thinning treatments applied and at age 10, by clones*

Clones	Treatment	Age 5 Trees/A	Age 5 Dbh	Age 5 Ht	Age 5 Basal area	Age 5 Volume	Age 10 Dbh	Age 10 Ht	Age 10 Basal area	Age 10 Volume	Age 10 Crown ratio	Age 10 Crown width
			in	*ft*	*ft²/A*	*ft³/A*	*in*	*ft*	*ft²/A*	*ft³/A*	%	*ft*
ST-66	CK[1]	282	5.5	45.3	46.9	871	6.9	65.0	73.2	2052	40.0	10.8
	TH[2]	133	5.5	43.4	22.3	405	7.5	61.7	41.0	1091	55.6	11.8
	T6[3]	60	5.7	45.4	10.8	200	8.3	66.3	22.9	628	63.4	13.7
ST67	CK	250	5.5	48.8	42.1	842	6.9	66.0	64.8	1851	38.7	10.5
	TH	119	5.6	49.2	21.0	431	7.7	65.6	38.9	1079	54.3	12.0
	T6	60	5.8	50.0	11.3	228	8.5	65.6	24.2	656	59.6	15.3
ST-92	CK	209	5.2	38.0	32.4	535	6.4	52.5	47.8	1147	34.0	10.2
ST-124	CK	184	5.4	37.9	30.3	489	7.3	55.8	53.7	1315	53.7	11.6

[1]CK: Check (no thinning).
[2]TH: Thin half of trees.
[3]T6: Thin to 60 trees/acre.

the wettest year at all depths, having both the most rainfall and backwater flooding from the Mississippi River in April and May that reached 6½ feet deep. The driest year differed by depths. Regardless, yearly dbh growth showed little response to soil moisture differences.

Soil Properties

There was a significant increase in soil N, P, K, Ca, and Mg contents and a significant reduction in soil OM and pH in the 10th year compared to the 5th year (table 2). Only Mg exceeded and Ca equalled soil values measured prior to planting cottonwood.

Table 2.—*Soil property values before the first growing season (year 0) and after year 5 and year 10*

Year	N	P	K	Ca	Mg	pH	OM
	%	*ppm*	*ppm*	*ppm*	*ppm*		%
0	0.188a[1]	81a	465a	5489a	1225b	6.76b	3.84a
5	0.162c	55c	350c	3882b	997c	7.15a	3.27b
10	0.174b	58b	415b	5439a	1330a	6.01c	2.94c

[1]Values in columns not followed by same letter significantly different at 0.05 level by Duncan's multiple range test.

DISCUSSION

The main intent of this study was to determine growth of select cottonwood stock. Indications are that ST-66 and ST-67, with better survival and growth, would be preferred pulpwood clones for clay sites compared to ST-92 and ST-124. At this time, ST-67 appears to have better sawtimber potential than ST-66 because of fewer limbs in the first log.

Thinning has improved dbh growth, but the difference is small. Yearly growth rates for years 6 through 10 were only 0.3, 0.4, and 0.5 inch from least to heaviest thinning.

Site comparisons of volume production of unthinned cottonwood at 12- by 12-foot spacing may be made between select clones on clay soils and random, run-of-the-bar planting stock on medium-textured soils by using the Mahannah data and Fitler, Mississippi, data (Krinard and Johnson 1980). The Fitler planting, on old-field and pasture Commerce silt loam soil, averaged 1,260 cubic feet per acre after 5 years and 3,052 cubic feet after 10 years. In a best case comparison; with better surviving clones, medium-textured soils produced 1½ times more volume after the 5th and 10th years and 2½ times more volume in a worst case comparison, with poorer surviving clones. These volume differences represent 4.6 and 8.3 fewer cords on clay sites after 5 years and 12.2 and 20.2 fewer cords after 10 years.

In considering select clones on clay sites for pulpwood production, total harvesting could start at about age 8 or 9 or the volume could be stored on the stump for several years, with little difference in yield in a continuous plantation system. Thinning decreased total yields at age 10 by one-fourth to one-third. For thinned plots to be equivalent to unthinned plots at age 10, the dollar value of volumes cut at age 5 would need to appreciate at a 16 percent compound interest rate.

The measured soil elements appear to be in a continuing state of change. Others have also shown soil property variation and changes over time where agronomic fields were planted to trees (Gilmore and Boggess 1976, Ovington 1956).

This is a continuing study of the survival and growth of cottonwood on clay sites cleared for soybeans and replanted to trees. Cottonwood was not a major component of the cleared stand. However, cottonwood can grow on these marginal sites to at least pulpwood size, although yields may be only 40 to 60 percent of those obtainable from medium-textured soils.

LITERATURE CITED

Dutrow, George F. Economic consideration in, artificial and natural regeneration of hardwoods. In: Proceedings, Hardwood Regeneration Symposium; 1980 January 29; Atlanta, GA. Forest Park, GA: Southeastern Lumber Manufacturers Assoc.; 1980: 48 – 57.

Gilmore, A. R.; Boggess, W. R. Changes in a reforested soil associated with tree species and time. I. Soil organic matter and pH in pine relationships. For. Res. Note, Urbana-Champaign, IL: University of Illinois, Department of Forestry: 1976. 5 p.

Krinard, R. M.; Johnson, R. L. Fifteen years of cottonwood plantation growth and yield. South. J. Appl. For. 4(4): 180 – 185; 1980.

Krinard, R. M.; Kennedy, H. E., Jr. Five-year-old cottonwood plantation on a clay site: growth, yield, and soil properties. South. J. Appl. For. 4(2): 80 – 83; 1980.

Mohn, C. A.; Randall, W. K.; McKnight, J. S. Fourteen cottonwood clones selected for Midsouth timber production. Res. Pap. SO-62, New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station; 1970. 17 p.

Ovington, J. D. Studies of the development of woodland conditions under different trees. IV. The ignition loss, water, carbon, and nitrogen content of the mineral soil. J. Ecol. 44(1): 171 – 179. 1956.

Soil Test Work Group. Procedures used by state soil testing laboratories in the southern region of the United States. South. Coop. Serv. Bull. 190; 1974.23 p.

*U.S. GOVERNMENT PRINTING OFFICE: 1983-769-089:5