United States Department of Agriculture

Forest Service

Southern Forest Experiment Station

Research Note

SO-351
December 1988

Growth Comparisons of Planted Sweetgum and Sycamore

Roger M. Krinard

SUMMARY

From age 18 through age 23, average annual growth of planted sweetgum *(Liquidambar styraciflua* L.) on Commerce silt loam exceeded growth of sweetgum on Sharkey clay by about 45 percent in diameter at breast height (d.b.h.) and height, 75 percent in basal area, and more than three times in cubic volume. At age 18 on the Commerce soil, sycamore *(Platanus occidentalis* L.) was smaller in average d.b.h. but had greater average height and 5 to 15 percent more cubic volume per acre than sweetgum.

Additional keywords: *Liquidambar styraciflua*, *Platanus occidentalis*, Sharkey clay, Commerce silt loam, volumes.

INTRODUCTION

Sweetgum *(Liquidambar styraciflua* L.) is widely distributed throughout the South on a number of different soils. Stands regenerate from both seeds and sprouts of stump and root origin. Planting of seedlings is also feasible where some form of weed control is maintained for at least a year or two. Growth of planted stands of pulpwood size, though, is not well documented. This paper compares 5 years' growth (age 18 through age 23) of two genetically similar planted stands in Mississippi, one on medium-textured soil and the other on fine-textured soil (fig. 1). Stand development to age 18 has been reported (Krinard and Johnson 1985). Also, the sweetgum on the medium-textured soil is compared with planted sycamore *(Platanus occidentalis* L.) (fig. 2).

METHODS

The sweetgum plantations were established on Commerce silt loam in the Mississippi River batture at Huntington Point (HP), Bolivar County, Mississippi, and on Sharkey clay in the Delta Experimental Forest (DEF), Washington County, Mississippi. Both soils developed from Mississippi River sediments, with Sharkey in depressions and slackwater areas and Commerce at high local elevations. Sweetgum is common to both soils and is rated as a species to be favored for management and as suitable for planting (Broadfoot 1976).

Planting was done in the dormant season of 1964-65 at 10- by 10-foot spacing. Each plantation consisted of 100 seedlings from each of 81 open pollinated families obtained from Arkansas, Tennessee, Alabama, and Mississippi.

Cultivation was used for weed control the first 2 years, and mowing was used thereafter. Alternate diagonal row thinning was done at HP on part of the plantation at age 6 and on the rest of the planting at age 8. The DEF was thinned similarly at age 12.

After the 18th year, all trees in two randomly selected rows at each area were measured for d.b.h. and height. The same rows were remeasured after the 23d year.

Cubic-foot volume estimations were obtained from dendrometer measurements, with 22 and 15 trees being measured after the 18th and 23d years at HP and 10 trees at each of the same ages at DEF. Regression equations were developed for stem volume outside bark from a 1-foot stump to the tip of the stem (VOB), for stem volume outside bark to a 4-inch top (VOB4), and for stem volume inside bark to a 3-inch diameter (VIB3) (table 1). A dry density of 28.7 pounds per cubic foot was used to obtain stem weights from cubic volume.

For comparison with the HP sweetgum, two rows of a nearby sycamore plantation, also planted at 10- by 10-foot spacing on Commerce soil and selectively thinned after the fifth year to leave half the planted trees, were measured at ages 16 and 19 (the latter year being the same time as the 23-year sweetgum measurement). Volume equations were developed from dendrometer measurements made on 16 and 10 trees at these ages. Weight yields were obtained using 30 pounds per cubic foot.

Southern Forest Experiment Station/T-10210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.
Serving Alabama, Arkansas, Louisiana, Mississippi, E. Oklahoma, Tennessee, E. Texas, Puerto Rico, U.S. Virgin Islands

Figure 1.— *General views of 23-year-old sweetgum plantings on Sharkey clay (left) and Commerce silt loam (right). Nearly all stumps from alternate diagonal row thinning after the 12th year on the clay site have sprouts, while no sprouts exist from 6th- and 8th-year thinning on the better site.*

RESULTS AND DISCUSSION

Whether compared at age 18 or age 23, production of the better sweetgum site on Commerce soil at HP was much greater than that of the poorer site on Sharkey soil at DEF, with essentially the same number of trees per acre on both areas (table 2). The better site had about 75 percent larger average d.b.h. and average height in 18 years and 69 percent in 23 years for both measurements. Basal area was slightly more than 3 times greater and slightly less than that amount at 18 and 23 years, respectively. Stem volumes, depending on whether outside or inside bark and top limits, were 5 to 7 times greater at age 18 and 4.3 to 5.5 times greater at age 23. Assuming 90 cubic feet per cord, volume mean annual increment (m.a.i.) varied from 1.4 to 1.9 cords per acre per year on the better site and from 0.2 to 0.4 cord per acre per year on the poorer site.

At age 18—obtained for the sycamore planting by using a linear relationship between 16- and 19-year measurements—the HP sweetgum was 13 percent larger in d.b.h. and had 25 percent more basal area than the sycamore. The sycamore was 14 percent taller and had 5 to 15 percent more volume, depending on whether inside or outside bark and top diameter used, and 10 percent more stem weight.

Site index at age 50, based on the 26 largest sweetgum trees per acre (five largest trees per row), was calculated as 75 at age 18 and 76 at age 23 on Sharkey clay using a formula developed for natural sweetgum stands in Alabama (Lyle and others 1975). By the same method, the site index on Commerce silt loam was 109 at age 18 and 110 at age 23. Broadfoot (1976) lists the site index of natural stands of sweetgum and sycamore at age 50 as the same for Commerce, with a range of 100 to 120, while sweetgum on Sharkey is listed as 80 to 100 feet.

Average annual growth in the 18- through 23-year

Roger M. Krinard is mensurationist 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.— *Cubic volume estimations for sweetgum and sycamore grown on medium-textured sites and sweetgum grown on fine-textured sites in Mississippi*[1]

Huntington Point (Commerce silt loam)

Sweetgum

VOB = $1.040 + 0.001958\ D^2H$
$r^2 = 0.96$, $S_{y.x} = 1.68$, CV = 8.6%, $\overline{V} = 19.5$

VOB4 = $-0.027 + 0.001986\ D^2H$
$r^2 = 0.96$, $S_{y.x} = 1.74$, CV = 9.3%, $\overline{V} = 18.7$

VIB3 = $0.193 + 0.001640\ D^2H$
$r^2 = 0.96$, $S_{y.x} = 1.47$, CV = 9.4%, $\overline{V} = 15.7$

Sycamore

VOB = $0.633 + 0.002221\ D^2H$
$r^2 = 0.99$, $S_{y.x} = 1.36$, CV = 5.8%, $\overline{V} = 23.3$

VOB4 = $-0.552 + 0.002250\ D^2H$
$r^2 = 0.99$, $S_{y.x} = 1.40$, CV = 6.3%, $\overline{V} = 22.4$

VIB3 = $-0.231 + 0.002048\ D^2H$
$r^2 = 0.99$, $S_{y.x} = 1.21$, CV = 5.9%, $\overline{V} = 20.7$

Delta Experimental Forest (Sharkey clay)

Sweetgum

VOB = $0.240 + 0.002186\ D^2H$
$r^2 = 0.95$, $S_{y.x} = 0.40$, CV = 8.3%, $\overline{V} = 4.8$

VOB4 = $-0.728 + 0.002271\ D^2H$
$r^2 = 0.94$, $S_{y.x} = 0.48$, CV = 12.0%, $\overline{V} = 4.0$

VIB3 = $-0.481 + 0.001708\ D^2H$
$r^2 = 0.94$, $S_{y.x} = 0.35$, CV = 11.4%, $\overline{V} = 3.1$

[1]VOB = stem volume outside bark from 1-foot stump to tip of stem; VOB4 = stem volume outside bark to 4-inch top diameter; VIB3 = stem volume inside bark to 3-inch top diameter; D = d.b.h.; H = total height.

Figure 2.— *Development of 19-year-old sycamore plantation established at 10- by 10-foot spacing on Commerce soil where half the trees were selectively thinned after the fifth year.*

period was about 45 percent greater in both average d.b.h. and height (0.32 vs. 0.22 inch per year and 2.3 vs. 1.6 feet per year) for the HP sweetgum compared to DEF sweetgum. Basal area growth was 75 percent greater and volume growth was 3 to 3.5 times greater (table 2).

Although the time periods differ, annual growth of HP sweetgum for the period 18 through 23 years of age (table 2) exceeded that of sycamore for the period 16 through 19 years (table 3) by 60 percent in average d.b.h. (0.32 vs. 0.20 inch), 12 percent in average height (2.3 vs. 2.1 feet), 60 percent in basal area (4.4 vs. 2.7 ft^2/acre), 26 percent in volume outside bark (214 vs. 169 ft^3/acre), 16 percent in volume inside bark to a 3-inch top (184 vs. 159 ft^3/acre), and 21 percent in dry weight (3.07 vs. 2.54 tons/acre).

The effect of tree size on annual growth from 18 through 23 years or 16 through 19 years (table 4) using 1-inch diameter classes (e.g., 6 = 6.0 to 6.9 inches), was tested at the 0.05 level in a completely random design. Both diameter and height growth were linearly related to diameter classes for both species at HP ($p<0.005$); the quadratic component was significant only for the height growth of sycamore ($p=0.02$).

Only four diameter classes occurred with DEF sweetgum—4 through 7 inches. Annual diameter growth was linearly related to diameter classes ($p=0.04$), but only varied between 0.19 inch (4- and 5-inch classes) and 0.25 inch (7-inch class). Annual height growth did not differ and ranged from 1.5 to 1.7 feet among diameter classes.

Differences in development of planted sycamore on Sharkey and Commerce soils may be made using m.a.i.'s for 15-year-old trees on the DEF and 16-year-old trees on the HP at 10- by 20-foot spacing (to be comparable to the number of trees per acre of sweetgum). Trees on the Commerce soil exceeded trees on the Sharkey soil by 56 percent in d.b.h., 70 percent in height, 2.8 times in basal area, and 4.7 times in cubic volume of bole wood.[1]

[1]Schlaegel, Bryce E. 1986. Plantation spacing of American sycamore. 80 p. Final Report FS-SO-4104-13. Unpublished; on file at Southern Hardwoods Laboratory, Stoneville, MS.

Table 2.— *Eighteen and 23-year values, and interim annual changes, for sweetgum grown at two sites in Mississippi.*

Variable	Huntington Point (Commerce soil)			Delta Experimental Forest (Sharkey soil)		
	18 years	Annual change	23 years	18 years	Annual change	23 years
Trees per acre	192	–3.2	176	194	–1.6	186
Diameter (in)						
Average	10.1	0.32	11.5	5.7	0.22	6.8
Range	5.5–14.7	...	6.1–17.4	4.6–7.3	...	5.3–8.7
Height (ft)						
Average	64.7	2.3	76.3	37.3	1.6	45.2
Range	48–75	...	59–89	30–46	...	34–54
Max[1]	71.5	2.5	84.2	42.9	1.6	51.0
Basal area (ft^2/acre)	110.7	4.4	132.6	34.5	2.5	47.0
Cubic volume (ft^3/acre)						
VOB	2,826	214	3,897	575	66	907
VOB4	2,658	221	3,762	408	70	760
VIB3	2,264	184	3,182	320	53	584
Dry weight (tons/acre)	40.55	3.07	55.92	8.25	0.95	13.02

[1]Max = 26 tallest trees/acre.

Table 3.— *Sixteen and 19-year values, and interim annual changes, for sycamore grown on Commerce soil at Huntington Point in Mississippi*

Variable	16 years	Annual change	19 years
Trees per acre	196	–3.0	187
Diameter (in)			
Average	8.5	0.20	9.1
Range	4.8–13.4	...	4.9–14.6
Height (ft)			
Average	69.9	2.1	76.1
Range	43–89	...	46–101
Max[1]	81.5	2.8	89.8
Basal area (ft^2/acre)	83.0	2.7	91.2
Cubic volume (ft^3/acre)			
VOB	2,644	169	3,152
VOB4	2,444	175	2,970
VIB3	2,278	159	2,754
Dry weight (tons/acre)	39.66	2.54	47.28

[1]Max = 24 tallest trees/acre.

Table 4.— *Average annual growth ± standard error of sweetgum from 18 through 23 years and of sycamore from 16 through 19 years by diameter class*

D.b.h. class	Sweetgum		Sycamore	
	Diameter	Height	Diameter	Height
in[1]	*in/yr*	*ft/yr*	*in/yr*	*ft/yr*
4	...	...	0.02 ± 0.02	0.7 ± 0.5
5	...	...	0.04 ± 0.01	0.3 ± 0.2
6	0.05 ± 0.02	1.8 ± 0.2	0.05 ± 0.01	1.0 ± 0.3
7	0.07 ± 0.03	0.7 ± 0.4	0.06 ± 0.01	1.3 ± 0.2
8	0.13 ± 0.06	1.6 ± 0.4	0.17 ± 0.02	1.8 ± 0.2
9	0.22 ± 0.02	2.3 ± 0.1	0.22 ± 0.01	2.5 ± 0.2
10	0.26 ± 0.02	2.1 ± 0.1	0.23 ± 0.01	2.0 ± 0.2
11	0.26 ± 0.03	2.5 ± 0.1	0.29 ± 0.03	2.8 ± 0.2
12	0.39 ± 0.03	2.6 ± 0.2	0.32 ± 0.04	2.6 ± 0.4
13	0.39 ± 0.02	2.5 ± 0.2	0.36 ± 0.04	2.7 ± 0.6
14	0.54	1.9	...	...

[1]Example: the 4-inch d.b.h. class represents trees whose d.b.h.'s range from 4.0 to 4.9 inches.

Figure 3.—*Example of various crown conditions within 23-year-old sweetgum, with left center crown illustrative of the best and bottom center crown among the worst.*

The data indicate faster early average height growth for planted sycamore compared to sweetgum on better sites through age 18 at the same stocking but slightly better average d.b.h. growth for sweetgum. Bole volumes were similar and averaged 0.1 to 0.2 cord per acre per year more for sycamore or 0.25 ton per acre per year more. For both species, medium-textured sites are capable of producing more than 4 times the stem volume in 16 through 23 years than are fine-textured sites. On poorer sites where both species were included in the same planting, sycamore outgrew sweetgum in total height by 27 percent in 15 years—38 vs. 30 feet (Krinard and Kennedy 1987).

Volume m.a.i. for sweetgum continued to increase in the 18- through 23-year period. However, the small crowns and slight diameter growth of the smaller diameter HP sweetgum trees indicate the need for thinning to forestall mortality (fig. 3). It is unlikely that removal of these trees would benefit the remaining trees. Thinning should probably have been done before age 18. One of the problems in thinning now is that some of the larger trees should also be removed because they are not future quality sawtimber trees due to low forking or crook. Thinning trees <11 inches d.b.h. would remove 38 percent of the trees and 25 percent of the basal area but still leave 99 ft^2/acre in 109 trees. Some of the better crowned 10-inch trees should probably be left and some of the less desirable larger trees removed to attain a basal area level of 75 to 80 ft^2/acre. No thinning is needed in the DEF sweetgum because the trees are of poor quality due to limbiness.

Thinning the sycamore from below would utilize the slow growing trees (d.b.h. <8 inches). This would remove 43 percent of the stems and 18 percent of the basal area, leaving 74 ft^2/acre in 107 trees.

LITERATURE CITED

Broadfoot, Walter M. 1976. Hardwood suitability for and properties of important Midsouth soils. Res. Pap. SO-127. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 84 p.

Krinard, Roger M.; Johnson, Robert L. 1985. Eighteen-year development of sweetgum *(Liquidambar styraciflua* L.) plantings on two sites. Tree Planters' Notes. 36(3): 6–8.

Krinard, Roger M.; Kennedy, Harvey E., Jr. 1987. Fifteen-year growth of six planted hardwood species on Sharkey clay soil. Res. Note SO-336. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 4 p.

Lyle, E. S., Jr.; Patterson, R. M.; Hicks, D. R.; Bradley, E. L. 1975. Polymorphic site index curves for natural sweetgum in Alabama. Circ. 220. Auburn, AL: Auburn University, Alabama Agricultural Experiment Station. 7 p.

* U. S. GOVERNMENT PRINTING OFFICE: 1988 -666-014/ 85024