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Ten-Year Growth of Five Planted Hardwood Species With Mechanical Weed Control on Sharkey Clay Soil

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SUMMARY

Five hardwood species planted on Sharkey clay soil showed little practical difference in growth whether plots were mowed or disked for weed control in years 6 to 10, although disking had given better growth in the first 5 years. After 10 years, cottonwood (*Populus deltoides* Bartr. ex Marsh.) stem volume was at least three times greater than other species. Changes in soil nutrient properties were similar for mowing and disking.

Additional keywords: *Fraxinus pennsylvanica, Liquidambar styraciflua, Platanus occidentalis, Populus deltoides, Quercus nuttallii.*

INTRODUCTION

Clearing and planting hardwoods on slackwater sites in the Midsouth, though high in initial cost, is an alternative for rejuvenating cutover and depleted stands and for introducing desired species on given sites. As production on these sites is less than on medium-textured sites and offers poorer economic returns, practices leading to improvement in tree growth are desirable. Weed control, along with tree release by thinning, has been suggested. This note provides growth data on planted hardwood trees through 10 years where original planting spacing was doubled after 5 years by selective thinning and where some competition control was given yearly. Soil properties before planting were also compared with those after 5 and 10 years.

METHODS

The study area was a flat site on the Delta Experimental Forest, a slackwater area near Stoneville, Mississippi. The site had been forested before clearing and planting in 1971. Soil is Sharkey clay.

Species planted were cottonwood (CW—*Populus deltoides* Bartr. ex Marsh.), sycamore (SY—*Platanus occidentalis* L.), green ash (GA—*Fraxinus pennsylvanica* Marsh.), sweetgum (SG-*Liquidambar styraciflua* L.), and Nuttall oak (NO-*Quercus nuttallii* Palmer). Estimated mid-range site index values for these species on Sharkey clay are 9.5 feet for CW (30 years), 90 feet for SY, SG, and NO, and 8.5 feet for GA (all 50 years) (Broadfoot 1976).

Trees were planted in a split-plot design with six blocks (replications). Species subplots consisted of a 6- by 4-row planting (24 trees) on a IO-foot spacing. Plots were mowed (M5) or disked (D5) three to five times annually the first 5 years.

After the 5th year, species subplots with 80 percent or more survival for trees more than 4.5 feet tall were thinned to six trees each, or an equivalent 20- by 20-foot spacing. Sweetgum and Nuttall oak were not considered in analysis of M5 plots as 5th-year survival was 50 percent or less. For thinning, subplots were subdivided into squares of four trees each and one tree per square was selected to maintain spacing over a subplot. Mowing (M10) or disking (D10) treatments, one to three times annually, for the next 5 years were randomly assigned to whole blocks. Diagrammatically, treatment and species for the first two blocks were as follows:

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Block 1:	M10	D5	SG	GA	CW	SY	NO
		M5	~~NO~~	SY	~~SG~~	GA	CW
Block 2:	D10	M5	SY	~~SG~~	GA	CW	~~NO~~
		D5	CW	NO	GA	SG	SY

Thus, there were three replications of mowing or disking for years 6 through 10 for five species disked the first 5 years and for three species mowed the first 5 years.

Yearly height and dbh measurements were made. Soil moisture readings were taken several times each growing season from 12 soil moisture tubes-two per block or one per mowing/disking combination. A cornposited soil sample was also taken across each mowing/disking combination before planting and after the 5th and 10th years. Content of nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), organic matter (OM), and pH were determined.

Tree volumes were calculated from measurements of samples of cut trees after the 5th year-30 to 37 trees per species-and from standing trees with a Barr and Stroud dendrometer' after the 10th year-20 trees each for CW, SY, and GA, and 10 trees each for SG and NO. Total stem volume outside bark (V) equations, based on dbh (D) and total height(H), were:

CW: $V = 0.1856 + 0.002074\,D^2H,\ r^2 = 0.997,$
$S_{y.x} = 0.203,\ \bar{V} = 2.91$

SY: $V = 0.1046 + 0.002435\,D^2H,\ r^2 = 0.989,$
$S_{y.x} = 0.100,\ \bar{V} = 0.92$

GA: $V = 0.1120 + 0.002180\,D^2H,\ r^2 = 0.993,$
$S_{y.x} = 0.073,\ \bar{V} = 0.75$

SG: $V = 0.0791 + 0.002247\,D^2H,\ r^2 = 0.993,$
$S_{y.x} = 0.037,\ \bar{V} = 0.29$

NO: $V = 0.0616 + 0.002452\,D^2H,\ r^2 = 0.987,$
$S_{y.x} = 0.045,\ \bar{V} = 0.28$

Analyses of variance were tested at the 0.05 level. Duncan's multiple range test was used to compare means.

RESULTS

Tree Growth

At age 5, disked CW was significantly larger in height, dbh, and volume than all other species-treatment combinations Mowed CW and disked SY and GA were similar, as were mowed SY and GA and disked SG and NO.

For the 6th- through 1 Oth-year period, height and dbh growth was greatest with CW-M5, (table 1). Averaged over all species, disking in years 6 through 10 provided significant though very slight increases in height and diameter growth but did not affect volume growth.

At age 10, CW did not differ in height, dbh, or volume regardless of weed control treatment, and was greater than all other species. Generally, SY was equal to GA and SG to NO in height and dbh.

Overall height growth through 10 years was from 1.7 to 4.9 feet per year, depending on species-treatment combination. The annual height growth values are comparable to or slightly greater than the mean annual height increment obtained from the estimated site index values.

For volume production, CW is still far ahead of the other species. After 5 years, whether mowed or disked, CW produced two to three times the volume of the next fastest growing species, and this difference increased to three to four times after 10 years.

Soil Moisture

Moisture tube readings nearest the middle of each month from May to September of each year were used to characterize growing season moisture conditions. Yearly rainfall, as a factor in tree growth, was considered from January through September.

Cultural treatments from the 6th through 10th years had no effects on soil moisture; the same trend in years 1 through 4 was reported earlier (Kennedy 1981). Averaged over years, moisture was highest in May and became progressively lower, with lowest measurements usually recorded in September. From May to September, average moisture values decreased from 41 to 32 percent on the surface, 51 to 41 percent at 1- and 2-foot depths, and 50 to 44 percent at 3- and 4-foot depths. Yearly rainfall was above average 4 of the first 5 years and 3 of the second 5 years.

Soil Properties

After 5 years there was no difference in N, K, and Ca levels, compared to values before planting, whether plots were mowed or disked (table 2). Both treatments significantly reduced Mg and lowered pH, whereas disking increased P but lessened OM.

The only significant difference between 5- and 1 O-year soil values was an increase in Mg, but there was no difference within 5-year values and no difference within 10-year values by treatments.

[1]Mention of a trade name does not constitute a warranty of the product by the U.S. Department of Agriculture or an endorsement by the Department over other products not mentioned.

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Table 1.—*Growth of five species in 6th through 10th year compared with 5th-year average, by cultural treatment*

Species and treatment[1]	Fifth year			Sixth/tenth year growth		
	Height	Dbh	Volume	Height	Dbh	Volume
	ft	*in*	*ft³*	*ft*	*in*	*ft³*
All species, avg.						
D5 and M5, D10	16.6	2.3	0.4	15.2a[2]	3.4a	2.6
D5 and M5, MI0	16.8	2.2	0.4	13.9b	2.8b	2.1
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Cottonwood						
D5				22.1 b	4.2b	6.5a
D5, D10	26.9a	4.3a	1.2a			
D5, MI0				21.5b	4.0bc	6.1a
Sycamore						
D5				10.6cd	2.8efg	2.1b
D5, D10	20.6b	2.9b	0.5bc			
D5, MI0				9.0d	2.0gh	1.4b
Green ash						
D5				13.0cd	3.2cde	2.1b
D5, D10	17.9b	2.5b	0.4cd			
D5, M10				10.5cd	2.2fgh	1.1b
Sweetgum						
D5				11.6cd	2.6efgh	0.7b
D5, D10	10.4d	1.2d	O.le			
D5, MI0				11.0cd	2.2fgh	0.5b
Nuttall oak						
D5				9.4cd	2.5efgh	0.8b
D5, D10	8.9d	1.1d	0.1e			
D5, MI0				8.4d	1.9h	0.3b
Cottonwood						
M5				27.8a	5.1a	5.9a
M5, D10	19.9b	2.9b	0.6b			
M5, MI0				25.2ab	4.3b	5.1a
Sycamore						
M5				13.0cd	3.3cde	1.4b
M5, D10	13.1c	1.4cd	0.2de			
M5, MI0				13.0cd	2.8efg	1.0b
Green ash						
M5				13.8c	3.6bcd	1.6b
M5, D10	14.7c	1.8c	0.2de			
M5, M10				12.5cd	3.0def	1.4b

[1]Treatments were disk or mow in years 1 to 5 (D5 or M5) and years 6 to 10 (D10 or MI 0).

[2]Means in same part of same column (that is, above or below dashed line) followed by same letter are not significantly different from each other (P = 0.05) by Duncan's multiple range test.

Table 2.—*Preplant, 5th-year and 10th-year soil chemical levels, pH, and organic matter (OM) by cultural treatment*

Year and Treatment[1]	N	P	K	Ca	Mg	pH	OM
	%	*ppm*	*ppm*	*ppm*	*ppm*		%
Preplant	0 172	46	439	5697	1316	6.0	3.6
5th year							
M5	.188	53	412	5642	1079	5.6	3.2
D5	.162	61	432	5692	1120	5.6	2.7
10th year							
M5-M10	.179	43	404	5857	1213	5.4	3.4
M5-D10	.203	47	433	5920	1280	55	3.1
D5-M10	.153	46	420	5963	1322	5.5	3.0
D5-D10	,173	53	423	5949	1244	5.5	2.9

[1]Treatments were disk or mow in years 1 to 5 (D5 or M5) and years 6 to 10 (D10 or M10).

DISCUSSION AND CONCLUSIONS

Height and diameter growth differences between mowing and disking for weed control in the 6th through 10th year were minimal. Growth of species in years 6 to 10, with disking or mowing, suggested that disking neither injured tree roots in a fashion to hinder growth nor was especially beneficial in increasing growth. As mowing showed no advantage over no weed control for the first 4 years (Kennedy 1981), and there was so little difference between mowing and disking the second 5 years, weed control beyond the 5th year does not seem warranted on these soils.

If weed control is not needed beyond 5 years, how long should it be maintained for individual species, and what are the differences between disking and mowing? Answers are not readily discernible in this study. Elsewhere, for CW plantations, intensive first-year cultivation on good sites is recommended (McKnight 1970), while on old-field clay soils disking gave better survival and growth than mowing (Krinard 1964). Also for CW plantings, summer fallowing before planting on medium-textured, old-field sites-which reduced the johnsongrass (Sorghum *halepense* (L.) Pers.) component-increased 1st-year survival, but 2nd-year cultivation provided no long-term benefits (Francis 1982). Sycamore plantations with high survival have been established without weed control measures, but clean cultivation gave most consistent high survival and best height growth (Briscoe 1969).

A cultural treatment guideline inferred from this study for hardwood plantation establishment on clay sites would be to expend the greatest effort in the 1 st year for weed control by disking for greatest survival and to give the plantation the best possible start. Second- and 3rd-year disking would tend to optimize early growth, but, practically, would obtain only another 1 to 1½ feet a year in height. Growing conditions and weed competition would be influencing factors.

Considering costs of plantation establishment and the growth obtained, hardwood planting on heavy clay soils may be a disappointing investment if timber growth is the only consideration. Expenditures on better sites are a much better investment, as the lo-year-old CW and SY are only about 55 to 60 percent as tall as plantings on medium-textured sites (Krinard and Johnson 1975, Schlaegel 1981). Even dominant trees in a nearby 1 1-year-old natural stand on clay soil (Krinard and Johnson 1981) were 70 percent (GA) to 90 percent (NO) as tall as the planted trees.

The main benefit from planting on Sharkey clay soils may well be in putting given species where they are wanted. An alternative to planting other than natural regeneration would be direct seeding, but only NO of the five species in this study is a likely candidate (Johnson 1981).

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