Southern Forest Experiment Station

Research Note

SO-271

1981

Growth and Yields of 5-Year-Old Planted Hardwoods On Sharkey Clay Soil

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SUMMARY

Yields of five hardwood species at age 5, planted at 10- by 10-foot spacing on Sharkey clay soil, were ranked cottonwood>sycamore>green ash>sweetgum≃Nuttall oak. By species, per acre volume of stemwood ranged from 29 to 446 cubic feet and total above-ground dry tree weight ranged from 1.08 to 7.68 tons.

Additional keywords: Cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), green ash (*Fraxinus pennsylvanica*), sweetgum (*Liquidambar styraciflua*), Nuttall oak (*Quercus nuttallii*).

INTRODUCTION

Growth and yield information pertaining to planted hardwoods on slackwater sites in the Midsouth have been generally confined to cottonwood (*Populus deltoides* Bartr. ex Marsh.). Such sites are less productive than medium-textured soils and offer poorer economic returns. Most forested areas remaining on clay soils are cut-over and depleted. Clearing and planting should provide the quickest economic returns, although demanding the highest initial investment. The actual production values possible from several hardwood species are needed by the forest manager. Volume and weight data of 5-year-old trees of five hardwood species planted on Sharkey clay soil are provided in this note.

SPECIES AND METHODS

The study area was planted in a split-plot design with six replications. Mowing or disking for weed control were major plot effects, and species were minor plot effects. Species measured were cottonwood, sycamore (*Platanus occidentalis* L.), green ash (*Fraxinus pennsylvanica* Marsh.), sweetgum (*Liquidambar styraciflua* L.), and Nuttall oak (*Quercus nuttallii* Palmer). Species subplots consisted of 4 rows by 6 rows of planting spots on 10×10 feet spacing. Plots were cross-disked or mowed three to five times a year for the five growing seasons. Mowed plots of sweetgum and Nuttall oak were not considered because of survival ≤50 percent.

In March 1976, before the sixth growing season, height and diameter of all trees were measured. Two trees from each species on each of the six disked plots were felled and weighed with and without branches in the field. For five of the weighed trees of each species, samples of bole and branches were obtained for later determination of moisture content and dry weight. Weighed trees were also measured for bole volume by taking diameters at 2-foot intervals along the main stem to the tip. An additional 18 to 25 felled trees per species were measured for volume in both the disked and mowed plots. Stem cubic volume was obtained by Newton's prismoidal formula.

Regression equations were developed for total stem volume, using D^2H as the independent variable

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Table 1.—*Survival, diameters, heights, stem volumes per acre and total tree weights per acre by species and weed control treatments at age 5*

Species	Treatment	Survival	$\overline{Dbh}$	$\overline{Ht}$	Stem volume $\overline{V}$	Stem volume $S_{\overline{V}}$	Total tree wt. $\overline{W}$	Total tree wt. $S_{\overline{W}}$
		percent	*in*	*ft*	----*ft³/A*----		----*tons/A*----	
Cottonwood	Disk	91	4.0	25.8	446	52	7.68	0.92
Cottonwood	Mow	81	2.5	18.0	151	32	2.67	0.58
Sycamore	Disk	99	2.8	19.9	238	19	5.45	0.41
Sycamore	Mow	95	1.2	11.8	40	6	2.10	0.11
Green ash	Disk	96	2.2	16.3	131	7	4.33	0.22
Green ash	Mow	95	1.5	13.4	65	11	2.38	0.32
Sweetgum	Disk	85	1.1	9.8	36	6	1.08	0.14
Nuttall oak	Disk	86	1.0	8.6	29	6	1.27	0.24

where D=dbh and H=total height, and for total tree green weight, using powers and cross products of D and H as independent variables. For each plot, volume and green weight per tree were predicted using these regressions and tree values summed to give a total plot value. Plot values for dry weight were obtained by applying average moisture content values to plot values for green weight.

RESULTS AND DISCUSSION

Survival, at 5 years, ranged from 81 percent for mowed cottonwood to 99 percent for disked sycamore (table 1). Whether mowed or disked, sycamore and green ash had 95 percent or better survival.

Average dbh ranged from 1.0 inch for Nuttall oak to 4.0 inches for disked cottonwood. Disking increased average dbh over mowing from 47 percent for green ash to 133 percent for sycamore. Average height ranged from 9 feet for Nuttall oaks to 26 feet for disked cottonwood. Disking increased average height over mowing from 22 percent (green ash) to 69 percent (sycamore).

Regression equations for predicting total stem volume outside bark in cubic feet from D^2H had r^2 values ranging from 0.85 for sweetgum to 0.99 for mowed cottonwood (table 2). Standard errors of estimate, expressed as a percentage of mean volume, ranged from 6 percent for mowed cottonwood to 21 percent for mowed green ash and Nuttall oak.

For total tree green weight D^2H, compared to D^2, provided equivalent fit for cottonwood and sycamore, slightly poorer fit with green ash and sweetgum, and slightly better fit with Nuttall oak. Using

Table 2.—*Total stem volume* (V) *outside bark, where* $V=b_0+b_1 D^2H$

Species	b_0	b_1	r^2	$S_{y.x}$	$\overline{V}$
					ft³
Disked plots					
Cottonwood	0.110800	0.002266	0.99	0.08	1.16
Sycamore	0.138971	0.002486	0.96	0.05	0.59
Green ash	0.073700	0.002742	0.88	0.06	0.36
Sweetgum	0.052089	0.003924	0.85	0.01	0.10
Nuttall oak	0.038432	0.003916	0.90	0.02	0.09
Mowed plots					
Cottonwood	0.080677	0.002237	0.99	0.03	0.54
Sycamore	0.029682	0.003241	0.98	0.01	0.12
Green ash	0.047868	0.003060	0.93	0.03	0.16

D^2H, r^2 values ranged from 0.80 for Nuttall oak to 0.99 for cottonwood with ratios of standard error of estimate to mean weight ranging from 10 percent for cottonwood to 24 percent for Nuttall oak (table 3).

Average tree stem volume, according to regression equations and average tree values for dbh and height, ranged from 0.07 cubic feet for Nuttall oak to 1.05 cubic feet for disked cottonwood. Average tree total dry weight ranged from 5.8 pounds for sweetgum to 35.9 pounds for disked cottonwood.

Average moisture content of cut trees was 52 percent for green ash, 67 percent for Nuttall oak, 104 percent for both sweetgum and sycamore, and 123 percent for cottonwood.

In dry weight, the average ratio of stem weight to total weight ranged from 54 to 57 percent for sweetgum, green ash, and Nuttall oak, and was 67 percent for cottonwood and 69 percent for sycamore.

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Table 3.—*Total tree weight* (W) *green basis, where* $W=b_0+b_1 D^2H$

Species	b_0	b_1	r^2	$S_{y.x}$	$\overline{W}$
					lbs
Cottonwood	5.944333	0.178922	0.99	7.7	78.6
Sycamore	16.314908	0.211899	0.90	6.0	52.1
Green ash	7.903848	0.269740	0.86	7.1	33.9
Sweetgum	7.771218	0.355748	0.82	2.2	13.1
Nuttall oak	6.237939	0.495070	0.80	3.5	14.6

The regression equations and ΣD^2H per plot allow per acre estimates with standard errors of estimate (table 1). Maximum total stem volume outside bark was 446 cubic feet per acre for disked cottonwood, nearly 90 percent more than disked sycamore, the next best growing species. Disked cottonwood yielded 1.535 tons dry weight per acre per year, 40 percent more than disked sycamore (1.091 tons per acre per year). The other three species yielded only 14 (sweetgum) to 56 (disked green ash) percent as much dry weight as disked cottonwood.

Statistically, at the 5 percent level, all disked cottonwood values (average dbh and height, stem volume per acre and total tree dry weight per acre) were greater than other species. Disked sycamore dbh, height, and stem volume per acre was greater than disked green ash, but no difference showed in total tree dry weight between the two species. No differences occurred between sweetgum and Nuttall oak. Within a species, disked values were greater than mowed values except for green ash stem volumes per acre.

The value of disking over mowing for weed control with hardwood plantings on clay sites is well illustrated. Besides controlling vegetative competition, disking enhances nutrient availability, particularly N, because of periodic incorporation of green herbaceous matter (accompanied by its release of N during decomposition) and its effect on mineralization in the soil. Additionally, disking improves water infiltration, gas exchange between the soil and atmosphere, and root proliferation by causing branching when roots near the surface are cut.[1]

[1]Kennedy, Harvey E., Jr. Foliar nutrient concentrations and hardwood growth influenced by cultural treatments. (Manuscript in preparation by U.S. Dep. Agric. For. Serv., South. For. Exp. Stn., New Orleans, La.)

Cottonwood growth on fine textured soils compares poorly to growth on medium textured soils—57 feet vs. 32 feet in height in 5 years when averaged over 14 select clones.[2] Yet, no species in this study approached cottonwood growth and yield, although all five are rated as species to favor in management on Sharkey and as suitable for planting on those sites.[3]

The four species other than cottonwood were planted on a Coastal Plain minor stream bottom at the same spacing and with cross disking.[4] Soils were Arkabutla silt loam in the bottoms and Dulac silt loam on adjoining lower slopes. Estimated site indices at age 50 are 10 feet taller for ash and sweetgum, 15 feet taller for sycamore, and 20 feet taller for Nuttall oak on Arkabutla soil as compared to Sharkey soil.[3] Site comparison at age 5 can be made by using the average of the tallest tree per plot for each species on Sharkey and the tallest six trees measured per species on the Coastal Plain site. On Sharkey, sycamore was 2 feet shorter, green ash had the same height, sweetgum was 8 feet shorter, and Nuttall oak was 3 feet shorter.

A yield comparison at age 5 may be made by assuming that the weight sample trees are representative of tree development on the two sites (on Sharkey clay, the average weight sampled trees by species were within 0.2 inches dbh and 1 foot in height of overall stand averages). Based on the average tree per site, total tree dry weight on the Coastal Plain site was 56 percent greater for sycamore, 3 percent greater for green ash, 314 percent greater for sweetgum, and 86 percent greater for Nuttall oak. Total stem volume on the Coastal Plain site was greater by 9 percent for sycamore, equal for green ash, 255 percent greater for sweetgum, and 91 percent greater for Nuttall oak. The stem dry weight to stem cubic volume (green basis) ratio (pounds per cubic foot) varied between Arkabutla silt loam and Sharkey clay soils, and was 39 and 31 for sycamore, 41 and 35 for green ash, 40 and 32 for sweetgum, and 43 and 44 for Nuttall oak.

[2]Mohn, C. A., W. K. Randall, and J. S. McKnight. 1970. Fourteen cottonwood clones selected for Midsouth timber production. U.S. Dep. Agric. For. Res. Pap. SO-62, 17 p. South. For. Exp. Stn., New Orleans, La.

[3]Broadfoot, Walter M. 1976. Hardwood suitability for and properties of important Midsouth soils. U.S. Dep. Agric. For. Res. Pap. SO-127, 84 p. South. For. Exp. Stn., New Orleans, La.

[4]Krinard, R. M., H. E. Kennedy, Jr., and R. L. Johnson. 1979. Volume, weight, and pulping properties of 5-year-old hardwoods. For. Prod. J. 29(8):52–55.