Auburn University Southern Forest Nursery Management Cooperative

RESEARCH REPORT 02-6

GROWTH OF SWEETGUM THREE YEARS AFTER PLANTING MORPHOLOGICALLY DIFFERENT SEEDLINGS AND TWO PRUNING OPERATIONS

by
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INTRODUCTION

Sweetgum (Liquidambar syraciflua) is one of the most widely planted hardwoods in the Southeastern United States. Many growth and yield studies have been conducted for planted sweetgum (Buckner and Maki 1977, Ku et. al. 1981, Krinard and Johnson 1985, Nelson and Switzer 1992, Nelson et. al 1995, Zutter et. al. 1998) but few have looked at growth and yield of planted sweetgum in relation to initial root-collar diameter (RCD). Belanger and McAlpine (1975), Kaszkurewicz and Keister (1975), and McNabb (2001) found that RCD at time of planting has a large impact on future tree growth. Belanger and McAlpine (1975) found that height growth was 6.4 feet taller at age 7 for the largest grade seedlings and McNabb (2001) found that large seedling sizes increased plot volumes by up to 87% at age 2. No studies have been conducted, however, examining sweetgum growth in relation to the interacting affects of seedling size, top-pruning, root-pruning, and competing vegetation.

METHODOLOGY

The study was conducted near Atmore, Alabama on land owned by Kimberly-Clark (now Joshua Timberlands). Two separate sites, located within 1/2-mile of each another, were planted on January 29, 1999 with 1+0 seedlings grown at the KC nursery near Elberta, Alabama. Both sites (Site 1 and Site 2) are lower coastal plain, well-drained sandy loams and were bedded prior to planting. Site 2 had a higher weed pressure although neither site could be considered severe. Four replications of 12 plots were established at each site. Plot size was 40-feet long containing ten seedlings planted every

4 feet. A three-way factorial design was randomly assigned to each plot where SIZE – is seedling size, TOP – top-pruning, and ROOT – root pruning were the treatments. Prior to planting, seedlings were grouped into one of two categories based on root-collar diameter (RCD): large – RCD between 12 and 16 mm, or small – RCD between 4 and 8 mm. Height was not a factor in the seedling size grading process. Plots were randomly assigned one of the two seedling sizes and one of three top-pruning treatments - C – not top pruned, S – top pruned to a height of 5 cm, T – top pruned to 50% of its original height, and one of two root pruning treatments, either N – not root pruned, or R – all roots (laterals and taproot) were pruned to 15 cm, prior to planting. No further treatment was conducted to individual tree seedlings following planting. Oust® was applied the first year following planting to control competing vegetation.

The plots were measured on February 4 and 5 of 2002 (3 years after planting). Ground-line diameter (GLD) and total tree height (H) were determined for each surviving seedling. Percent survival was calculated by taking the total number of surviving seedlings per plot and dividing by 10. Cubic-foot volume was estimated using the conoid formula:

$$\text{Volume} = (1/3) * (GLD^2 * 0.00545415) * H \qquad (1)$$

Volume per plot was obtained by summing the individual tree volumes within each plot.

Statistical Design

The experiment was designed for using Analysis of Variance (ANOVA), and statistical comparisons between treatments were conducted using PROC GLM of the Statistical Analysis System (SAS Institute Inc. 1985). The three-way factorial of SIZE-TOP-ROOT was nested within SITE and BLOCKs within SITE. When F-values for treatment effects were significant (0.05 level), means were separated using Duncan's Multiple Range Test.

RESULTS

Survival and volume per plot were significantly greater at site 1 (Tables 1 and 2). Larger seedling sizes increased all variables (Tables 1 and 2) and produced 253% more volume per plot when all top and root pruning treatments were combined (Table 2). When no top or root pruning was conducted, larger seedlings produced 103% more volume at site 1 and 66% more volume at site 2 than smaller seedlings. Top pruning 50% of height and to the stump reduced all growth measures while only top pruning to the stump reduced survival (Tables 1 and 2). Root pruning did not increase or decrease any variable. No interactions between variables were observed for height and diameter and hence volume (Table 1). However, several interactions occurred for survival. The site*size and size*top interactions most likely occurred because of substantially more mortality for the small seedlings at site 2 (Table 3). This is especially true for the S top-pruning treatment, as survival in these treatment plots did not exceed 70%. One plot only had 10% survival and two plots had no survival. This probably resulted from height loss being so great that the weed competition had much more impact.

The site*top interaction was probably significant due to the high mortality rates in the S and T treatments at Site 2.

There has been much debate about whether to plant larger sized seedlings. Increases in growth can be seen in this study and have been documented in other studies (Belanger and McAlpine 1975, Kaszkurewicz and Keister 1975, McNabb 2001). The downside to planting larger seedlings are increased planting and seedling costs. Since equipment at nurseries are currently geared towards seedlings with smaller RCDs, they cannot harvest and ship large seedlings as inexpensively and timely as smaller seedlings. However, economic advantages can also result from planting larger seedlings, as fewer seedlings need to be planted per acre and survival will be increased (Belanger and McAlpine 1975).

There is much debate about whether top pruning seedlings prior to planting is desirable. One theory suggests that the decreased seedling height can never be recovered, while another theory suggests that in 2 or 3 years after planting the initial lost in height due to pruning will be recovered. Recovery occurs because of less transplant shock resulting from better root/shoot ratios. The T top pruning treatment appears to be close to recapturing the lost height growth due to top pruning (Table 2). The beneficial effects of top pruning can be confounded with moisture. It is usually assumed that top pruning will provide an increase in survival and growth when planting during drier years due to better root/shoot ratios. However, in this study top pruning was not beneficial. Perhaps, adequate moisture was provided. Root pruning may be conducted to facilitate easier planting. A decrease of only 0.7% was seen in volume per plot when root pruning was conducted (Table 2).

MANAGEMENT IMPLICATIONS

Planting larger seedlings can greatly increase the survival and volume production of sweetgum. These results show that top pruning 50% or greater of total seedling height of sweetgum prior to planting can reduce growth. Root pruning does not appear to reduce growth and can be used to help facilitate planting.

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Table 1. Results of the analysis of variance for several variables.

	Type	DF	SS	F	Prob
Survival	site	1	0.825	66.045	0.005
	block(site)	6	0.264	3.521	0.004
	size	1	0.440	35.228	0.000
	site*size	1	0.175	14.016	0.000
	top	2	0.807	32.293	0.000
	site*top	2	0.450	18.018	0.000
	size*top	2	0.253	10.114	0.000
	root	1	0.003	0.208	0.649
	site*root	1	0.003	0.208	0.649
	size*root	1	0.000	0.008	0.928
	top*root	2	0.000	0.008	0.992
	ERROR	75	0.937	.	.
RCD	site	1	0.001	0.010	0.982
	block(site)	6	5.284	16.665	0.000
	size	1	4.462	84.446	0.000
	site*size	1	0.003	0.049	0.825
	top	2	4.604	43.562	0.000
	site*top	2	0.038	0.356	0.701
	size*top	2	0.021	0.202	0.818
	root	1	0.000	0.009	0.925
	site*root	1	0.024	0.452	0.504
	size*root	1	0.172	3.257	0.075
	top*root	2	0.087	0.828	0.441
	ERROR	73	3.857	.	.
Height	site	1	0.359	0.560	0.874
	block(site)	6	78.185	20.304	0.000
	size	1	78.861	122.879	0.000
	site*size	1	0.315	0.491	0.486
	top	2	52.081	40.576	0.000
	site*top	2	0.537	0.418	0.660
	size*top	2	0.898	0.699	0.500
	root	1	0.356	0.555	0.459
	site*root	1	0.649	1.011	0.318
	size*root	1	0.650	1.014	0.317
	top*root	2	0.571	0.445	0.643
	ERROR	73	46.850	.	.

Table 1. (cont.)

	Type	DF	SS	F	Prob
Volume per tree	site	1	0.001	2.173	0.668
	block(site)	6	0.018	10.684	0.000
	size	1	0.011	40.709	0.000
	site*size	1	0.000	0.084	0.773
	top	2	0.011	20.526	0.000
	site*top	2	0.000	0.528	0.592
	size*top	2	0.001	1.954	0.149
	root	1	0.000	0.141	0.708
	site*root	1	0.000	1.447	0.233
	size*root	1	0.000	0.832	0.365
	top*root	2	0.000	0.857	0.429
	ERROR	73	0.020	.	.
Volume per plot	site	1	0.139	5.093	0.027
	block(site)	6	1.666	10.189	0.000
	size	1	1.165	42.756	0.000
	site*size	1	0.001	0.034	0.854
	top	2	1.243	22.801	0.000
	site*top	2	0.013	0.245	0.783
	size*top	2	0.104	1.916	0.154
	root	1	0.006	0.216	0.643
	site*root	1	0.025	0.906	0.344
	size*root	1	0.020	0.749	0.390
	top*root	2	0.039	0.712	0.494
	ERROR	75	2.043	.	.

Table 2. Duncan's multiple range test results for sweetgum seedlings outplanted on January 29 near Atmore, AL. C – no top-pruning, S – top-pruning to 5 cm, T – top-pruning 50% of height, N – no root pruning, and R – root pruning all roots (lateral and taproot) to 15 cm. All treatments were conducted prior to planting.

	Survival %	RCD (inches)	Height (feet)	Volume Ft^3/tree	Volume per plot ft^3
Site					
1	95.8%a	1.32	6.1	0.030	0.292a
2	77.3%b	1.33	6.1	0.026	0.216b
Size					
Large	93.3%a	1.53a	7.0a	0.038a	0.364a
Small	79.8%b	1.11b	5.2b	0.017b	0.144b
Top pruning					
C	94.7%a	1.56a	6.9a	0.041a	0.390a
T	91.3%a	1.36b	6.2b	0.028b	0.261b
S	73.8%b	1.03c	5.1c	0.014c	0.112c
Root pruning					
N	87.1%	1.30	6.15	0.028	0.262
R	86.0%	1.30	6.02	0.027	0.246

Table 3. Average sweetgum survival and morphological characteristics at time of planting (TOP) and at 3 years of age. Height at time of planting is prior to top-pruning treatments. Large seedlings had RCDs between 12 and 16 mm prior to planting, and small seedlings had RCDs between 4 and 8 mm. C – no top-pruning, S – top-pruning to 5 cm, T – top-pruning 50% of height, N – no root pruning, and R – root pruning all roots (lateral and taproot) to 15 cm. All treatments were conducted prior to planting.

			Site 1				Site 2			
			At time of planting		Year 3		At time of planting		Year 3	
	Top	Root	Large	Small	Large	Small	Large	Small	Large	Small
Survival (%)	C	N	-	-	95%	98%	-	-	98%	90%
	C	R	-	-	98%	100%	-	-	95%	85%
	S	N	-	-	100%	90%	-	-	75%	33%
	S	R	-	-	100%	80%	-	-	75%	38%
	T	N	-	-	98%	95%	-	-	98%	78%
	T	R	-	-	100%	98%	-	-	90%	75%
RCD (TOP - mm, 3 years - in)	C	N	13.13	6.66	1.90	1.43	12.96	6.39	1.67	1.35
	C	R	13.43	6.33	1.71	1.31	13.59	6.27	1.89	1.23
	S	N	13.19	6.61	1.13	0.81	12.53	6.43	1.05	0.95
	S	R	13.46	6.62	1.33	0.70	13.12	6.28	1.35	0.88
	T	N	12.94	6.73	1.58	1.16	12.78	6.58	1.62	1.18
	T	R	13.03	6.52	1.60	1.14	13.34	6.63	1.57	1.05
Height (feet)	C	N	2.69	2.04	8.21	6.47	2.65	1.96	7.35	6.05
	C	R	2.56	1.92	7.35	6.10	2.54	1.91	7.85	5.70
	S	N	2.64	2.03	6.16	4.04	2.58	1.95	5.61	4.40
	S	R	2.62	1.91	6.46	3.38	2.56	1.85	6.16	4.63
	T	N	2.59	2.05	7.12	5.45	2.63	1.88	7.16	5.35
	T	R	2.56	2.03	7.16	5.28	2.60	2.02	6.89	4.98
Volume/tree (ft^3)	C	N	-	-	0.074	0.036	-	-	0.041	0.026
	C	R	-	-	0.048	0.024	-	-	0.058	0.018
	S	N	-	-	0.018	0.009	-	-	0.013	0.008
	S	R	-	-	0.024	0.005	-	-	0.024	0.008
	T	N	-	-	0.041	0.018	-	-	0.037	0.017
	T	R	-	-	0.043	0.018	-	-	0.037	0.012
Volume per plot (ft^3)	C	N	-	-	0.710	0.349	-	-	0.399	0.240
	C	R	-	-	0.473	0.241	-	-	0.558	0.151
	S	N	-	-	0.177	0.083	-	-	0.100	0.038
	S	R	-	-	0.242	0.043	-	-	0.191	0.038
	T	N	-	-	0.399	0.179	-	-	0.360	0.120
	T	R	-	-	0.431	0.180	-	-	0.330	0.087