GROWTH FOLLOWING PRUNING OF YOUNG LOBLOLLY PINE TREES: SOME EARLY RESULTS

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Abstract—In the spring of 2000, a designed experiment was established to study the effects of pruning on juvenile loblolly pine (*Pinus taeda* L.) tree growth and the subsequent formation of mature wood. Trees were planted at a 3 m x 3 m square spacing in plots of 6 rows with 6 trees per row, with the inner 16 trees constituting the measurement plot. Among the treatments were an unpruned control and a treatment where half the live crown was removed at age 3 (live crown length was reduced by half). Measurements at the time of treatment and 1 year after treatment for each tree included d.b.h., total height, height to base of live crown, crown width within the row, and crown width between the rows. In addition, 1 and 2 years after treatment at ages 4 and 5, upper stem diameters at two positions in the crown were measured. Results are presented that show the initial impact of early pruning on tree growth. Additional measurements gathered over the life of the study, including wood samples, will provide a more complete understanding of the effects of pruning young loblolly pine trees.

INTRODUCTION

Pruning affects wood quality of trees harvested from loblolly pine plantations (Gibson and others 2002). Pruning future crop trees during stand development removes limbs (both living and dead) that produce knots in wood products merchandized from harvested logs. Removing live branches may also affect the onset of the production of mature wood and thus change the density and strength properties of wood obtained from pruned trees.

Pruning live limbs also affects tree growth and stand development. Valenti and Cao (1986) showed that pruning reduced stem taper resulting in more cylindrical trees with more volume per tree. Burton (1981), as well as others such as Labyak and Schumacher (1954) and Marts (1949), showed that pruning vigorous, live limbs causes a real and significant effect on stem form and subsequent diameter growth, at least for a period of time following pruning.

Past studies on the impact of pruning on tree form, growth, and wood quality characteristics have been conducted in stands without intensive silviculture. Today's plantations are being intensively managed using cultural practices that produce very rapid growth rates, thus allowing pruning treatments to be applied earlier in the rotation when trees are growing most rapidly. It is unclear what impact pruning will have on these intensively managed stands and how they will grow and develop following treatments.

In order to examine the impact of pruning on loblolly pine trees growing in intensively managed plantations, a pruning study was established with three overall objectives: to examine the effect of early pruning on (1) tree growth and stand development, (2) stem form and taper, and, (3) wood specific gravity. Objective (3) will be met at the close of the study when trees can be destructively sampled. In this paper, however, we present some early results that relate to objectives (1) and (2).

DATA

In the spring of 2000, two study sites in the Piedmont of Virginia (Appomattox and Patrick Counties) were identified as being suitable for establishment of the study. Both sites were cutover areas, one of which was burned following harvest. At each site, four replications containing five future treatment plots were laid out and planted using genetically improved 1-0 loblolly pine seedlings. The five future treatments included (1) control (unpruned), (2) removing half the live crown at age 3, (3) removing half the live crown at age 6, (4) removing half the live crown at age 9, and (5) removing half the live crown at ages 3, 6, and 9. Square treatment plots (6 rows with 6 trees per row) were established; the interior 16 trees were measurement trees.

Herbicides were applied during the first 2 years after planting to control competing vegetation. Twenty pounds per acre of elemental phosphorous and 200 pounds per acre of elemental nitrogen were applied at age 3 to all plots. Annual measurements from age 2 included d.b.h., height to live crown, total height, and two measures of crown width. The age 3 treatment was applied to one randomly selected plot in each replication. At ages 4 and 5, in addition to d.b.h., height and crown measurements, two measures of upper stem diameter (one-third and two-thirds of the distance from d.b.h. to the top of the tree) were collected. Table 1 presents summary statistics at time of treatment (age 3).

ANALYSES

A model was specified to examine five tree characteristics prior to treatment (age 3) using analysis of variance techniques:

$$C = b_0 + b_1 Loc_i + b_2 Rep_j + b_3 T_k + E_{ijk} \quad (1)$$

where

C = the characteristic of interest (d.b.h., total height, height to live crown, average crown width, or height to d.b.h. ratio),

Loc = the location effect (Appomattox or Patrick County, VA),

Rep = the Replication effect,

T = the treatment effect (pruned or control) and

E = the error term.

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Table 1—Before and after pruning statistics at time of pruning for the age three pruning plot treatment and the control plot

	Mean	Std. dev.	Minimum	Maximum
	control			
Dbh (*cm*)	1.85	0.83	0.51	4.06
Height to live crown (*m*)	0.19	0.08	0.10	0.40
Total height (*m*)	1.74	0.48	0.30	2.70
Crown width (*m*)[a]	1.19	0.36	0.10	2.25
	pruned			
Dbh (*cm*)	1.75	0.70	0.51	3.56
Height to live crown before pruning (*m*)	0.19	0.08	0.10	0.40
Height to live crown after pruning (*m*)	1.09	0.08	0.20	1.90
Total height (*m*)	1.83	0.46	0.30	2.80
Crown width before pruning (*m*)[a]	1.23	0.34	0.20	2.00
Crown width after pruning (*m*)[a]	0.73	0.27	0.10	1.35

[a]Average of within and between row crown widths.

Results from applying Model (1) to the pre-treatment data indicated that only the location and, in some cases, the replication effect were significant (α=0.05). That is, immediately prior to treatment, there were no significant differences in tree characteristics between the pruned and the control treatment plots.

To examine the effect of the pruning treatments at ages 4 and 5 (1 and 2 years after treatment), Model (1) was again employed. In this case, the characteristics examined were periodic annual growth (PAI) of d.b.h., total height, and average crown width. In addition, two form quotients, defined as the ratio of upper stem diameter (at 0.33 and 0.66 percent of the distance from breast height to tip) to d.b.h., and the height over diameter ratio were examined:

$$FQ_{33} = D_{33}/dbh;\ FQ_{66} = D_{66}/dbh;\ HD = H/dbh$$

where FQ_{33} and FQ_{66} are the specified form quotients, D_{33} and D_{66} are the upper stem diameters just described, and H is total height.

D.b.h., total height, and mean crown width PAI from age 3 to age 4 were significantly different between treatments (table 2). From age 4 to age 5, only d.b.h. and total height PAI were significantly different. Neither of the form quotients was significantly different at year 4, and only FQ_{33} was significantly different at year 5. HD was not significantly different between treatments at either age 4 or age 5.

DISCUSSION AND CONCLUSIONS

In the pruned plots, removal of 50 percent of the live crown length appeared to reduce crown mass, or volume, by considerably more than 50 percent (perhaps on the order of 60 to 70 percent), leaving many of the trees with only 1 whorl of live branches with which to begin the next growing season. This severe reduction in photosynthetic capacity resulted in a significant reduction of d.b.h. and total height PAI for the 2 years following treatment. The difference between the control and pruned treatments was, however, less significant the second year after treatment than it was the first year after treatment. This suggests that the pruned trees are recovering rapidly from the effects of the treatment.

Table 2—Periodic annual increment (standard deviation in parentheses) for d.b.h., total height, and mean crown width; mean form quotient at one-third (FQ_{33}) and two-thirds (FQ_{66}) distance from breast height to tip and the height over d.b.h. ratio for the control and pruned plot (P value for F-test between treatment means)

	Control	Pruned	P value
		d.b.h. (cm)	
Year 4	2.80(0.59)	2.29(0.68)	< 0.0001
Year 5	2.52(0.64)	2.37(0.57)	0.0482
		total height (m)	
Year 4	1.22(0.38)	1.04(0.41)	< 0.0001
Year 5	1.22(0.28)	1.13(0.31)	0.0070
		mean crown width (m)	
Year 4	1.53(0.39)	1.27(0.37)	< 0.0001
Year 5	2.11(0.47)	1.87(0.39)	0.6007
		FQ_{33}	
Year 4	0.68(0.13)	0.69(0.11)	0.6944
Year 5	0.65(0.09)	0.68(0.11)	0.0150
		FQ_{66}	
Year 4	0.42(0.13)	0.40(0.10)	0.1925
Year 5	0.36(0.07)	0.36(0.09)	0.8485
		height over d.b.h. ratio	
Year 4	0.31(0.09)	0.32(0.08)	0.5921
Year 5	0.27(0.07)	0.27(0.05)	0.9735

The difference in mean crown width PAI was also highly significant for the first growing season after treatment. During the second growing season, however, there was no difference in mean crown width expansion between the pruned and control treatments. This suggests that young trees initially respond to pruning by rebuilding crown before allocating resources to height and diameter growth.

The effect of the pruning treatment on stem form and taper appears to be negligible for these young trees. Both measures of stem form were taken well within the live crown at these early ages, and while FQ_{33} was significantly different at age 5 (2 years following treatment), no discernable trends in stem form could be discerned. No significant difference between treatments for the height to d.b.h. ratio supported this finding.

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