EFFECTS OF CROWN PRUNING ON HEIGHT AND CONE PRODUCTION BY LOBLOLLY PINE AFTER 6 YEARS

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Abstract.--The effects of several different types of crown pruning, begun at different tree heights, on flowering by grafted loblolly pine seed orchard trees were evaluated periodically for 6 years. Some of the pruning methods were based on those commonly used on fruit trees, where bowl-shaped crowns result from removal of vertically growing shoots. Unfortunately, even pruning twice a year for several years did not often result in a fruit tree type crown because loblolly pine has extremely strong apical control. Even when horizontal growth by several vigorous lateral branches was encouraged, one of them usually became vertical and suppressed the growth of the more horizontal branches. The overall result of our treatments was a significant decrease in height growth and a correspondingly greater decrease in cone production. Even on those few trees that developed bowl-shaped crowns, the width of the crown made harvest of interior cones difficult. We conclude that the benefits of height control, even if begun early, are more than offset by decreases in cone production.

Key Words: Loblolly pine, seed orchards, crown management, cone harvest, seed orchard management.

OBJECTIVE

The objective of this study was to determine whether the height and shape of the crowns of trees in a loblolly pine (Pious taeda L.) seed orchard could be managed by pruning, to reduce cone harvest costs. Lift trucks with 60-fort blooms have been required for most of this decade to harvest cones in Weyerhaeuser's North Carolina first generation seed orchard which was established in 1959. Our hypothesis was that we could duplicate the results of pruning in fruit tree orchards, where tree height is limited by forcing the crown into a bowl-shaped habit, so that cone harvest would be possible with smaller and less expensive man lifts. Crown management has been attempted for a number of conifers with mixed success (see literature review by Gerwig 1987). Studies on Southern pines have shown that pruning reduces cone production (e.g., van Buijtenen and Brown 1962; Varnell 1969), and led to a recommendation from the

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North Carolina State Tree Improvement Cooperative that crown training be avoided (Jett 1978). However, pruning was not repeated in several successive years, nor was it begun early in the life of the tree. Our rationale was that pruning, begun early, would significantly limit tree height without affecting cone production. Gerwig (1987) has reported on a similar study, also carried out on loblolly pine, which was begun in 1982. The study reported on here was begun in 1980, and our results will be compared with those of Gerwig (198').

METHODS

The study area is located in Weyerhaeuser's Lyons, NC loblolly pine seed orchard near Vidalia, Georgia, where 10 clones were established in rows during 1977 and 1978, at 15-x 30-foot spacing. The area was divided into 6 blocks across clonal rows so that each block represented 3 rows of 10 clones each. Three treatments were randomly assigned to each of these rows, which included (1) an unpruned control, (2) pruning begun when the trees reached a height of meters (m) or more, and (3) pruning begun when the trees reached a height of 3m or more. A total of 180 trees were treated.

Pruning was begun in February, 1980, starting with removal of the entire terminal long shoot, down to the first branch whorl from the previous year's growth. Since almost no trees were >3m in 1980, only treatment 2 was applied; reatment 3 began in 1981. More elaborate pruning treatments, which included isbuding of vigorous lateral branches as well as terminal shoot removal, had 'den evaluated in a previous study (Bramlett and Greenwood 1982, unpublished data, Weyerhaeuser Co., Hot Springs, AR 71901), but did not significantly augment the effects of leader removal on crown shape or tree height. Consequently, disbuding wa; abandoned after 1981. In the years following the first pruning, dominant terminal shoots were removed from any lateral branches that had become vertical. practically all the trees, the pruned terminal shoot was rapidly replaced by or more lateral shoots from the first whorl of branches, which became vertical in the growing season after pruning and effectively replaced the terminal shoot. Consequently, pruning in 1981, 1982 and 1983 involved removing those shoots, which were often as large as those removed at the first pruning. Since lateral shoots became dominant so quickly, pruning removed as much as 1/3 of the total crown in the first 2 years of the study, and drastically (but temporarily) altered the appearance of the trees. Height and diameter were measured immediately after pruning in 1982 and 1983, and female flower buds were counted, if present, on any branches removed. Total counts of female flowers were made in late March, before needle elongation occurred. After pruning in February, 1983, the trees were allowed to recover for several years, and the effects of the treatments on height, diameter and flowering were evaluated in March, 1986. All results were analyzed using analysis of variance. The model used included replication, clone and treatment as main effects, and all two-way interactions. Three-way interactions were not possible since within each replication, each clone-treatment combination was represented by only 1 tree.

RESULTS AND DISCUSSION

Prior to pruning in 1980, ANOVA showed no significant difference in tree heights or diameters among the trees selected for the 3 treatments. In 1982,

1983 and 1986, the effects of clone and treatment on height and female flowering were highly significant (p <.008 for both clone and treatment). In 1986 only, replication did have a significant effect on tree height (p <.01) but not on female production (p <.20). The interactions between clone, treatment and replication for height and flowering were not consistently significant across years but significance was occasionally observed (see Table 1). Therefore, we can conclude that pruning significantly decreased height growth and flowering in i982, 1983 and 1986 (see Table 2). Although the expected differences in flowering among clones were observed, the effect of pruning on flowering was the same on poor and good flowering clones (see Table 3), which is reflected in the absence of significant clone x treatment interactions (p <.63) in 1986.

Table 1. ANOVA table for height growth and female cone production in 1983 and 1986.

		Height (1983)		Height (1986)		Cones (1983)		Cones (1986)	
Effects	dF	MS	F-ratio	MS	F-ratio	MS	F-ratio	MS	F-ratio
Rep	5	22787	1.07	54385	3.23	26655	1.47	44569	1.55
Clone	9	146266	3.80	444237	14.68	844587	25.83	1700528	32.78
Trt	2	581373	67.97	315833	46.95	64817	8.92	59536	5.16
Rep*Clone	44	245680	1.31	173337	1.17	154719	0.97	454146	1.79
Rep*Trt	10	41826	0.98	33598	1.00	24017	0.66	29170	0.45
Clone*Trt	18	90847	1.18	60573	1.00	137742	2.11	89016	0.86

Table 2. Overall effects of pruning on height, diameter and cone production by grafted loblolly pine seed orchard trees in 1982, 1983 and 1986.

		Treatment			% Reduction from control	
		1	2	3		
		(control)	(prune >2m)	(prune >3m)	2 vs. 1	3 vs. 1
Ht+cm)	'82	392	254	262	35%	33%
	'83	545	390	412	28%	24%
	'86	775	665	680	13%	12%
Dia+(mm)	'82	100	88	94	12%	6%
	'83	142	116	119	18%	16%
	'86	219	198	197	10%	10%
Cones(#)	'82*	41	20	42	51%	0%
	'83*	107	51	50	52%	53%
	'86	145	94	98	39%	36%
# Times Pruned		0	4	2-3		

+Measured immediately after pruning.
*Includes # cones on branches pruned off.

Table 3. Clonal response to pruning treatments for height and number of female flowers in 1)86, 3 year after pruning was discontinued. Different letters indicated means differ at p <.05.

	Height (cm)			# Female Flowers		
	1	2	3	1	2	3
Clone	Control	Prune >2m	Prune >3m	Control	Prune >2m	Prune >3m
1	710	656	663	183	95	119
2	775	720	753	113	30	44
3	756	668	653	20	0	5
4	712	579	583	400	398	377
5	740	633	634	72	107	54
6	821	721	678	259	162	191
7	780	491	606	32	22	5
8	856	766	768	141	6	37
9	773	682	688	27	14	26
10	823	728	724	202	108	119
	775a	664b	676b	145a	94b	98b

Thus, overall, pruning decreased height growth by 12 to 13%, and female flowering by 36 to 39% in 1986 (see Table 1), even though the trees had 3 growing seasons to recover from the final pruning. Unfortunately, the residual inhibitory effects of pruning were about 3 times greater on flowering than on height growth, which was just the opposite of the desired effect. Gerwig (1987) also reports no residual inhibition of height growth, noting that pruned trees put on just as much height growth as the unpruned control in the growing season following pruning. He concludes that pruning only limits height growth in the year that it is applied, and that flowering is reduced in proportion to the amount height is decreased. Our results support this conclusion, but show that pruning has a more lasting inhibitory effect on flowering than on height growth. Since the trees in Gerwig's study were still being pruned, the differential effect reported here on height and flowering several years after pruning stopped awaits confirmation.

In addition to a slight reduction in height, we were successful in forcing the horizontal development of 1 or more large lateral branches between 1 and 3m off the ground. However, the terminal shoots of these branches are now growing upwards, and observations in December, 1987, indicate that it is more difficult to work around the pruned trees than the controls. The large, low lateral branches make approach to the main stem difficult, and the crowns of the pruned trees appear to cover more area than the controls. Thus, more movement around the crown would be required for cone harvest, and reaching the interior of the pruned crowns is more difficult. Also, the large lateral branches may be more susceptible to ice damage.

RECOMMENDATIONS

Based on the results reported here, we do not recommend pruning of loblolly pine seed orchard trees during early development. Loblolly pine has a very strong tendency to restore apical control following removal of terminal shoots, so the effects of even repeated pruning on height growth are temporary. This, plus the apparently greater inhibitory effect on flowering, do not justify the effort and cost needed to control height. We would, therefore, only recommend that top pruning be applied when the trees outgrow the vertical capacity of available manlifts. When that occurs, removal of cone-bearing branches just above reach during cone harvest is advised. A single top pruning (pollarding) of relatively large radiata pine seed orchard trees resulted in increases in flowering several years after pruning. Young trees, however, did not show increases in flower production from a single pruning (Pederick and Brown, 1976).

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