EARLY PRUNING OF LOBLOLLY PINE: EFFECTS ON WEEKLY GROWTH AT VARIOUS LOCATIONS ON THE STEM

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ABSTRACT. — Loblolly pine was pruned to 20, 40, and 60 percent and the weekly radial growth was determined at various locations on the stem.

Results the first year following pruning showed that trees varied considerably in their rates of stem growth; pruning delayed growth initiation and reduced growth rate with the most drastic pruning having the greatest effect; growth was greatest in the crown and decreased as distance below the live crown increased; height growth was not affected by intensity of pruning.

Lower branches of trees eventually die and are shed by natural processes, commonly resulting in large knots that degrade the wood and reduce pulp and veneer yields. This is especially true for trees growing at wide spacings where crown closure is very slow. Thus, artificial pruning is practiced to increase the ultimate value of the tree.

When live branches are removed, growth of the tree may be affected. Numerous researchers (Staebler, 1963) have reported that a substantial reduction (35 to 70 percent) of the living crown results in decreased height and stem growth. Only a few pruning studies have considered growth of the bole above breast height (Young and Kramer 1952, Heidmann 1963, Staebler 1963) and with the exception of Young and Kramer, these studies have dealt with growth only on a yearly basis.

The effect of artificially pruning loblolly pine (*Pinus taeda* L.) on weekly radial growth at various locations on the stem are reported in this paper. The study was conducted on a 10-year-old plantation at the Dixon Springs Agricultural Center in southern Illinois.

METHODS

Sixty-six trees used in the study averaged 4.1 inches in diameter at breast height (4.5 feet) and 23 feet in total height. The live crown on all trees extended down to at least breast height. Trees within 15 feet of each study tree were removed prior to the initiation of the experiment to reduce competition for soil moisture and sunlight. Limbs on the study trees below breast height were removed to eliminate any possible effect that they might have on the experiment. Dial-gauge dendrometer stations as described by Brown et al. (1947) were established at 4.5 feet, 8.5 feet and 12.5 feet above the ground if the bole was large enough to accommodate them; otherwise two or one dendrometer stations per tree were installed (hereafter referred to as either three station trees, two station trees or one station trees). Weekly radial measurements were taken at all dendrometer stations for one growing season before and after the trees were pruned.

Pruning treatments consisted of removing all limbs from the lowest

0 (control), 20, 40, and 60 percent of the stem, as measured between breast height and top of the tree. The origin of the limb on the stem determined if a limb was to be included in a pruning group.

Growth was computed as percent of control, percent decrease of actual to expected, and percent of previous year.

Results

Trees varied considerably in their rates of growth (Table 1). Growth before pruning varied from a low of 74 percent in the three station trees to a high of 124 percent in the two station trees. At the 8.5 foot station, growth varied from 75 to 115 percent. Variation in growth was also considerable at the 12.5 foot station. After pruning, growth varied to a lesser extent.

Decrease in the growth rate as a percent of the difference between expected growth and actual growth to expected growth is shown in Table 1. Reduction in growth occurred at all locations on the stem except in the 20 percent pruned trees at 4.5 feet for the one station trees. Although reduction in growth was not always statistically significant, it could be attributed to pruning. Treatment comparisons were highly significantly different with the following exceptions: 0-20 percent pruning treatments at all locations; 40-60 percent treatments of the two station trees; 0-40 and 20-40 percent treatments of the three station trees. There were significant differences in growth rate between the lower and upper station of the three station trees pruned to 60 percent and between the 8.5 and 12.5 foot locations of the three station trees pruned to 40 and 60 percent.

Accumulative growth after pruning is shown in Figures 1, 2 and 3 as a percentage of the previous year's total growth before pruning. There were no statistical differences in growth between the 0-20, 0-40, and 20-40 percent treatments of the three station trees. Neither were there differences between the 0-20 and 40-60 percent treatments of the one and two station trees. Growth was consistently greater on the control and 20 percent pruned trees than on the 40 and 60 percent pruned trees. Growth was reduced most by 60 percent pruning. Growth of the 40 percent pruned trees was less than the trees pruned 20 percent except at the 12.5 foot station in the three station trees.

Pruning affected growth early in the season with most drastic pruning having the greatest effects. Trees pruned 60 percent did not begin growing at any location on the stem to any appreciable extent until nearly 40 days after the controls and 20 percent pruned trees. Trees pruned 40 percent were also slow in starting growth but less so than trees pruned 60 percent.

On all trees, the rate of growth was slow in the spring increasing rapidly before reaching a maximum in early summer and then diminishing. Growth was erratic and no weekly growth pattern was detected in any group of trees. Growth was always greatest at the top station and in the crown, decreasing as distance below the live crown increased with more pronounced differences as more of the live crown was removed.

TABLE 1.—Cross-Sectional Area Growth Before and After Pruning and Decrease in Growth Rate Due to Pruning.

Percent crown pruned	No. Trees	Before		After		Expected growth in 0.010 Sq. ft.[1]	Difference between expected and actual	Percent decrease in growth rate
		0.010 Sq. ft.	As percent of control	0.010 Sq. ft.	As percent of control			
				ONE STATION TREES				
				4.5 Feet Location				
0	5	361	100	356	100	356	0	0
20	3	380	105	414	116	374	40	-11[2]
40	4	296	82	173	49	292	119	41
60	3	353	98	94	26	349	255	73
				TWO STATION TREES				
				4.5 Feet Location				
0	8	463	100	471	100	471	0	0
20	7	506	109	474	101	513	39	8
40	8	574	124	298	63	584	286	49
60	6	526	114	113	24	537	424	79
				8.5 Feet Location				
0	8	398	100	456	100	456	0	0
20	7	454	114	451	99	520	69	13
40	8	456	115	251	55	524	273	52
60	6	427	107	143	31	488	345	71
				THREE STATION TREES				
				4.5 Feet Location				
0	6	668	100	628	100	628	0	0
20	6	731	109	601	96	685	84	12
40	5	491	74	328	52	465	137	29
60	5	661	99	176	28	622	446	72
				8.5 Feet Location				
0	6	610	100	557	100	557	0	0
20	6	639	105	582	104	585	3	0
40	5	457	75	331	59	418	87	21
60	5	654	107	193	35	596	403	68
				12.5 Feet Location				
0	6	549	100	599	100	599	0	0
20	6	463	84	453	76	503	50	10
40	5	394	72	420	70	431	11	3
60	5	438	80	278	46	479	201	42

[1] Based upon pre-treatment; for example, 105 percent of 356 = 374.
[2] A negative (—) sign indicates an increase.

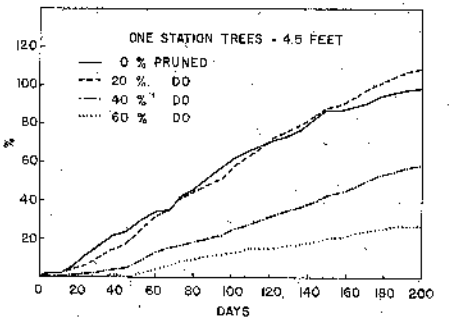

Figure 1.—Accumulative growth according to percent crown pruned and location on stem—one station trees.

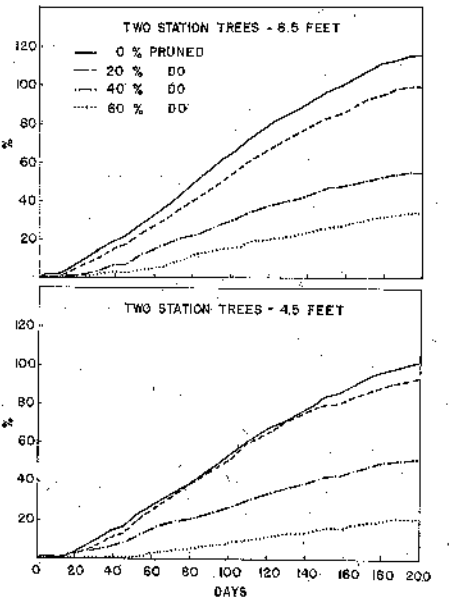

Figure 2.—Accumulative growth according to percent crown pruned and location on stem—two station trees.

Discussion

The method used to compute growth in this study assumes that an increase or decrease in growth according to the potential of the trees, as indicated by growth before treatment, is a satisfactory method

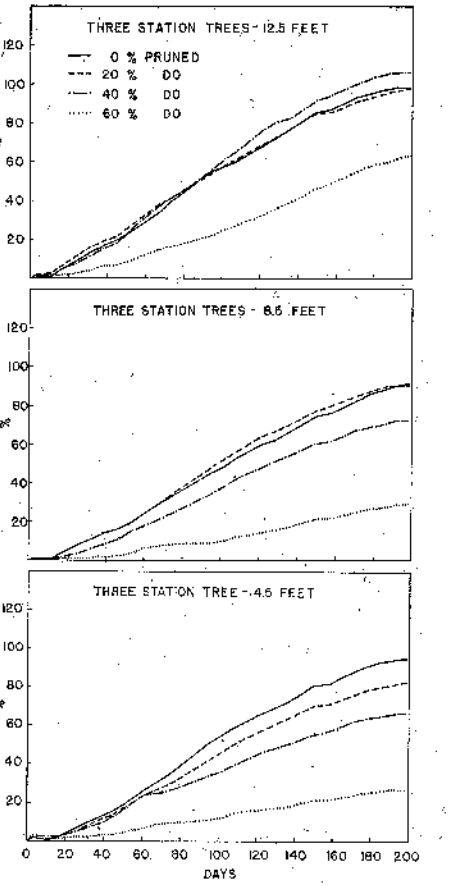

Figure 3.—Accumulative growth according to percent crown pruned and location on stem—three station trees.

of expressing growth. A tree may for some unknown reason(s) change its yearly growth pattern. But by using a number of trees per treatment, the effects of changeable yearly growth rate (if it exists in this study) should be eliminated or at least relegated to a minor status.

The method used in this paper to compute the percent of crown to remove is slightly different from most reported studies and should be re-

membered when trying to compare pruning as reported here with pruning reported elsewhere. Never-theless, these results demonstrate that removing about 40 percent of the live crown usually results in a reduction of stem diameter growth.

Stem growth is not affected by the removal of less than 40 percent of the live crown because water is used more efficiently. Unthrifty lower branches of a tree lose more carbohydrate through respiration than they add from photosynthesis (Takahara, 1954). When these branches are removed, more moisture is available to the remaining thrifty branches without a loss in photosynthate. Labyak and Schumacker (1954) demonstrated that the typical branch located at 15 percent of tree length below the free tip contributes maximum volume to the stem.

A probable reason why no significant growth difference occurred between the 40 and 60 percent pruned trees of the two station trees, is that some of the trees supposedly pruned 40 percent were actually pruned more. As stated in the methods, the origin of the limb on the stem determined whether a limb was to be pruned. Because of this rule it is possible to over-prune. As an example, a thirty foot tree to be pruned 40 percent will have all limbs below 14.7 feet removed. If there should be no limbs between 14.7 feet and the point that represents the 60 percent pruning (19.8 feet), then 60 percent and 40 percent pruning of the live crown are the same. This may explain why growth of one tree of the two station trees pruned 40 percent was very small in comparison with the other trees similarly treated. If this tree is disregarded in the analysis of variance, there is a significant difference between the 40 and 60 percent pruned trees at the 4.5 foot location but not at the 8.5 foot location.

A probable reason that stem growth was slow in starting in trees that had been pruned 60 percent (Fig. 3), is that there was not enough growth substance (auxin and/or vitamin) or carbohydrates produced by the remaining small crown. However, the different rate of growth at all three stations for the 60 percent pruned trees indicates that this limiting factor might be carbohydrates and not an auxin or a vitamin. Trees pruned 40 percent tend to bear this out in that they began growth later than the control trees, but not as late as the severely pruned trees. It is conceivable that growth had commenced at this early date but was proceeding too slowly to be detected by the method used in the study.

The tendency for trees to be erratic in their growth has been shown by a number of workers. But pine trees do not exhibit this erratic growth on an individual stem, as Young and Kramer (1952) observed that when growth at any location on the main stem either increased or decreased, all locations on the main stem grew in a like manner.

The fact that height growth was not affected by pruning does not conform with Slabaugh's (1957) report with red pine. He found that a light pruning (30 percent) had little effect, but more than this amount reduced height growth the first year. It was expected that height growth would be affected since four trees

died the first year from excessive pruning. If height of the trees had been measured for a number of years after being pruned, it is logical to expect that height growth would be found to be reduced.

The use of a dendrometer to measure growth of a tree has certain disadvantages as stem growth is not uniform (Bormann and Kozlowski, 1962) but it permits the results of cultural operations to be followed immediately and to detect trends. This study has been conducted for only one year but a trend has been established. Reported pruning studies (Stein 1955, Blockman and Roe 1958, Staebler 1964) indicate that this trend should continue for a number of years in the most drastic pruning treatment but not necessarily in the lighter pruning treatments.

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