1960

Further Results of Bud and Twig Pruning of Loblolly Pine

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Notes and Observations

Academy-Research Council to Investigate Insecticide-Wildlife Relationships

The National Academy of Sciences-National Research Council has announced formation of a new committee to investigate the relationship between chemical control of agricultural and forest pests and conservation of America's wildlife populations.

In a letter of appointment to members of the new Committee on Pest Control-Wildlife Relationships, Dr. Detlev W. Bronk, president of the Academy, notes: "This committee is being established to undertake the task of encouraging cooperation and harmonious relations in this increasingly important and somewhat controversial field of agriculture."

The creation of the committee, which will function within the Division of Biology and Agriculture, is the most recent of several steps taken by the Academy-Research Council during the past few years in response to concern expressed in several quarters over use of chemicals to control agricultural pests.

The over-all problem of pesticide use was set forth in mid-1959 by an *ad hoc* committee appointed by the Academy-Research Council. The committee reported that expanded use of newly discovered chemical controls had resulted in significant gains in agricultural production and in public health. At the same time, however, numbers of some desirable wildlife may have been reduced.

In January, 1960, the Academy-Research Council sponsored a conference to explore the challenge further. Noted then was a grievous lack of objective data; some persons responsible for pest-control programs tended to minimize the injurious effects of the chemicals they use, while some conservationists tended to maximize such damage. It was further noted that "In every case there may be a happy medium in which effective plant protection can be obtained without lasting damage to useful animals."

The new committee, in search of an optimum, will

1. provide technical advice and guidance to bring about maximum control of crop pests with minimum damage to wildlife;
2. provide critical evaluation of both the direct and indirect effects of various pest control operations on plants and animals;
3. stimulate new research where gaps exist, and encourage investigations in progress to obtain factual information as a basis for sound guiding principles and policy determinations; and
4. foster cooperation among various agencies, organizations, industries, and individuals interested in pest control and those concerned with its effects on fish and wildlife.

The members of the new committee are: Chairman, Dr. Ira L. Baldwin, special assistant to the president of the University of Wisconsin; also Dr. Ira N. Gabrielson, president of the Wildlife Management Institute; Dr. Tom Gill, executive director of the Charles Lathrop Pack Forestry Foundation; Dr. George L. McNew, managing director of Boyce Thompson Institute; Dr. E. C. Young, professor of economics and dean of the graduate school, Purdue University; and Dr. G. C. Decker, entomologist, Illinois Natural History Survey. Dr. W. H. Larrimer of the Academy-Research Council will serve as the executive secretary of the committee.

An Efficient Method of Taking Large Increment Cores

A joint research project between North Carolina State College and Southlands Experiment Forest of International Paper Company has been initiated to investigate heritability patterns in loblolly pine. The project involves the controlled pollination and complete description of 320 randomly chosen trees. One of the important phases of this project includes the study of wood characteristics which requires that two 8 mm. and one 10 mm. diameter increment cores be taken from each parent tree.

Because of the time and effort required for extracting the many cores needed for the study, it was necessary to devise some method that would be less time-consuming and easier than the conventional procedure. Use of the ratchet-equipped handle as designed by Duffield[1] and the borer starter described by Echols[2] was helpful, but the process was still exceedingly laborious.

Southlands Experiment Forest had a trailer-mounted electric generator (Fig. 1) which was originally designed for electric welding in the field. A one-inch AC-DC electric drill was found to have a "no-load" speed of 370 rpm, which did not seem excessive. A $\frac{9}{16}$ inch, 8-point socket was brazed to a drill shank to hold the 8 mm. diameter borer bit. The shoulder of the bit was filed slightly to fit the $\frac{9}{16}$ inch socket.

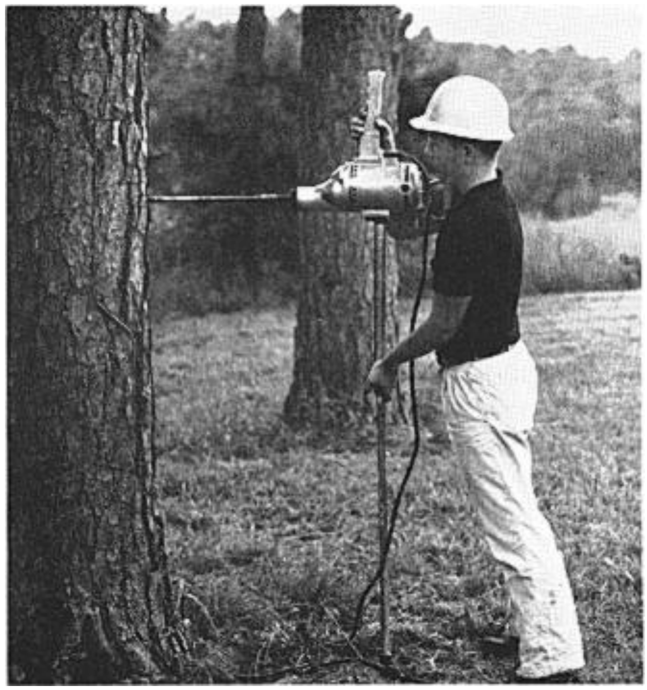
This set of equipment was tested and found to drive the bit into

[1]Duffield, John W. A ratchet wrench for over-size increment borers. For. Science 3:21. 1957.

[2]Echols, Robert M. Variation in tracheid length and wood density in geographic races of scotch pine. Yale University: School of Forestry Bull. No. 64, 16. 1958.

Above

Fig. 1.—Equipment for taking increment cores mechanically. Drill and stand ride between generator and fender when changing positions.



Right

Fig. 2.—Position for starting increment borer.

the tree effortlessly. A 5/8 inch, 8-point socket was then welded to a second drill shank and the drill tested with the 10 mm. increment borer bit. This larger bit penetrated as easily as the 8 mm. bit.

An adjustable stand was constructed, using lightweight pipe and a flat steel base which made it possible to take all cores at the 4½ foot level regardless of slope.

In operation, the bit of the increment borer was placed in the drill chuck and started into the tree by applying pressure to the handle of the drill (Fig. 2). After a full day's work it was found that the bit was somewhat difficult to start. Apparently, this was due to the fact that the bits of the increment borers became dull after a number of cores were taken. This difficulty was eliminated by honing the bits after each day's use.

Once the bit was started into the tree, it was necessary to push the stand toward the tree in order to keep the socket on the bit. The bits were backed out of the tree by hand using the ratchet-equipped handle.

A good ground was maintained at all times while the drill was in operation. To accomplish this, a $\frac{3}{16}$ inch brass welding rod was soldered to an insulated wire which was attached to the drill frame. Prior to starting the generator, the rod was forced into the ground.

This operation was fairly efficient. Two men averaged taking three cores from approximately 40 trees in about six hours' working time. This included moving from tree to tree, and in some cases the trees were quite scattered. Taking cores with the drill approximately halved the time required to take the same number of cores by hand labor. The efficiency of this method could no doubt be speeded up by using a reversible drill to back the bits out. The quality of the cores taken, using the drill, was excellent and no damage to the bits of the increment borers was noted.

In the particular situation at Southlands Experiment Forest, the drill and portable generator were available, and the trees to be studied were fairly accessible. This equipment can readily be used in cases where a large number of cores must be taken in a fairly well-localized area. However, the use of a jeep or tractor-mounted portable generator would make the method more adaptable for work in more inaccessible areas.

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Seasonal Rooting Responses of Slash and Loblolly Pine Cuttings

Plant men have long recognized that season of collection influences rooting response of cuttings of many species. It has been suggested by Mergen[1] that late October to early November is the best period to collect slash pine cuttings for maximum rooting. His air-layering work and that of Hoekstra[2] with the same species have amply demonstrated that time of preparation markedly affects rooting.

A study was initiated to determine the effect of season on the rooting response of cuttings of loblolly pine (*Pinus taeda* L.) and slash pine (*P. elliottii var. elliottii* Little and Dorman) and to ascertain the best time of year to collect material. Subsequent studies designed to investigate the physiology related to this phenomenon are necessary and have been begun. This report is confined to the rooting of cuttings collected throughout an entire year.

As previous studies of aging have shown that cuttings from old trees of the species considered do not root,[3] trees two to three years old were used as sources. At each collection date all source trees were the same age.

Cuttings from leaders of these trees were collected monthly starting in January, 1958, and ending January, 1959. They were trimmed to uniform size, approximately eight inches long, and wounded at the base by slicing two inches of bark from one side of the cutting. Three treatments—talc formulations of 0.3 percent indole-butyric acid (IBA), Rootone, and a control—were employed in each of three replications. Forty-five cuttings of each species were planted each month.

Fermate was dusted on the surface of a sand medium which was then soaked with water in advance of planting. Cuttings were planted in flats and placed in the greenhouse without shading. No attempt was made to control either duration or quality of light or temperature. However, ventilation without benefit of fan or other mechanical device was enhanced where possible to reduce high midday temperatures. Heating cables in the benches compensated for the relatively low temperatures of water used in misting. A misting schedule of one minute "on" and five minutes "off" was employed.

Examination of cuttings and final collection was made five months after planting. Two categories were recognized, namely those which had produced roots and those which had not.

Statistical analysis reveals that month, species, and treatment were highly significant in accounting for the variation in rooting re-

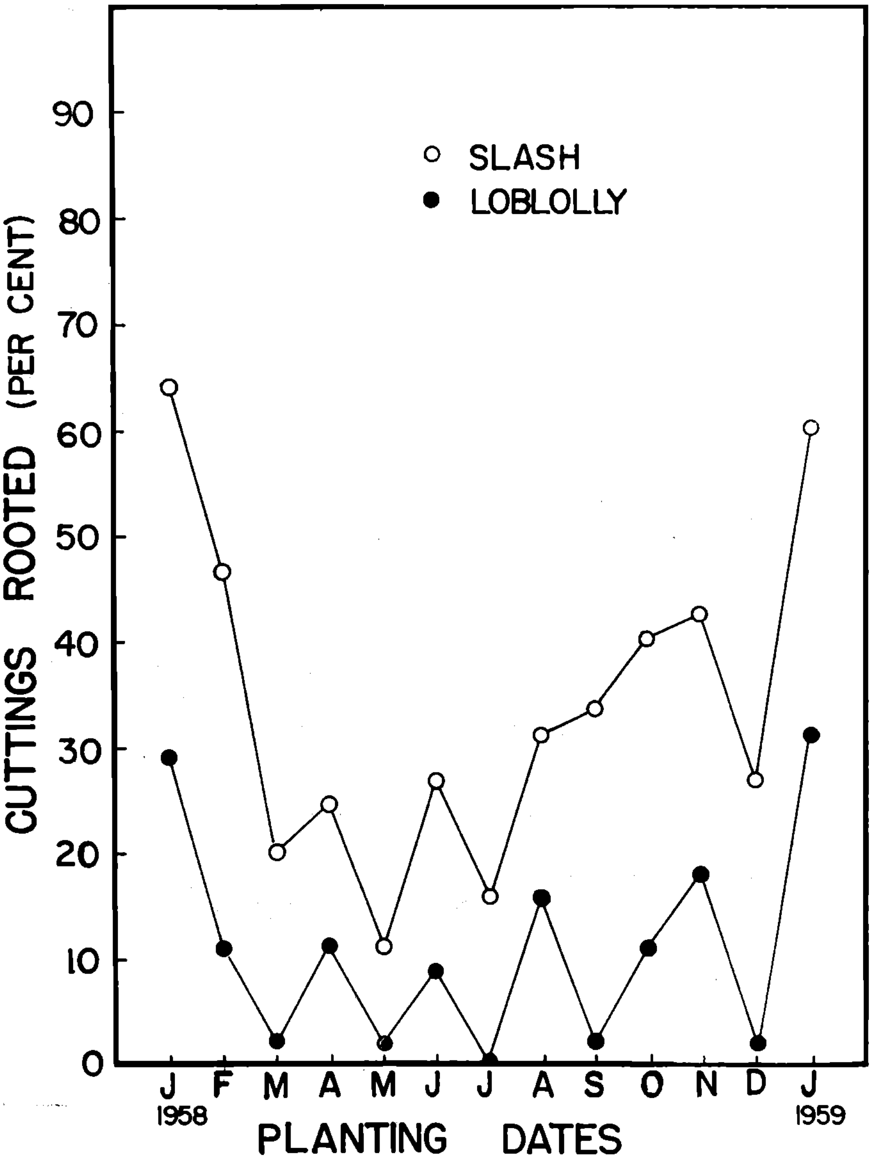

FIG. 1.—Rooting (percent) of slash and loblolly pine cuttings for each month over an entire year (all treatments).

[1]Mergen, F. Vegetative propagation of slash pine. Southeastern Forest Expt. Sta. Station Paper 54. 1955.

[2]Hoekstra, P. E. Air-layering of slash pine. Forest Sci. 3:344-349. 1957.

[3]Reines, M., and J. T. Greene. Forest genetics at the George Foster Peabody School of Forestry, University of Georgia. Progress Report 1956-1957. Report No. 5, Georgia Forest Research Council. 1958.

TABLE 1.—RANGE OF MONTHS IN ORDER OF SIGNIFICANCE

Month	Significance
May[1]	
July	None
March	None
December	None
September	None
June	Significant
April	Significant
August	Highly significant
October	Highly significant
February	Highly significant
November	Highly significant
January (1958)	Highly significant
January (1959)	Highly significant

[1]Base month

sponse. The peak response in rooting took place in January, falling off to a low in May, after which the trend was upward (Fig. 1). Similar peaks have been observed in previous unrelated studies. The drop in the December, 1958, planting cannot be accounted for, and on the basis of previous observation represents aberrant behavior. Further analysis using the Duncan Range Test shows the range of months in order of significance (Table 1).

Species differences were obvious. Slash cuttings at all times rooted more readily than those of loblolly pine. The analysis shows that differences between species were highly significant.

Treatment differences were significant. The Duncan Range Test for testing between means reveals that rooting responses to Rootone and IBA were better than that of the untreated control. Rootone was better than IBA.

None of the interactions computed were significant.

The seasonal results suggest to us that a relationship to some annual cyclic sequence of events may exist. Food storage and consumption during the dormant and growing seasons respectively may be involved and rooting may be best when the food supply is highest. Differences in species performance would not necessarily reflect differences in food reserves but rather an innately diverse intermediary metabolism affecting the capacities of their living cells to reproduce mitotically. This, of course, requires verification.

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This work was done as part of a project of the University of Georgia College of Agriculture Experiment Station in cooperation with the Georgia Forest Research Council and the Georgia Forestry Commission.

The European Pine Shoot Moth: Relationship Between Proportion of Trees Infested and Number of Insects Per Tree

Where trees are uniform in size and distribution, as they usually are in plantations, one might suppose that the density of a pine-feeding insect would be reflected by the proportion of trees affected, or vice versa. During several recent studies of the European pine shoot moth (*Rhyacionia buoliana* [Schiff.]) carried on by the author and his co-workers in Michigan, much information was collected which can be brought to bear on this question.

The data were obtained between 1956 and 1958 from 69 sampling areas in 20 plantations in Lower Michigan. The trees in these plantations ranged between 3 and 7 feet tall; all were spaced at 6×6 feet, and none had reached crown closure. Most of the samples (85 percent) were taken in red pine (*Pinus resinosa* Ait.). Other species sampled included Scotch pine (*Pinus silvestris* L.) (5 percent), Eastern white (*P. strobus* L.) (3 percent), jack (*P. banksiana* Lamb.) (3 percent), Austrian (*P. nigra* Arn.) (2 percent), and ponderosa (*P. ponderosa* Laws.) (2 percent).

Insect population counts were made between April and June during late larval and pupal stages. From 10 to 60 trees were taken in each sampling area for proportion of trees infested and from 3 to 30 infested trees for number of insects per tree. Several sampling methods were used: trees were taken successively in a row; alternately in a row; every fifth in every fifth row; or every tenth in every tenth row. Final values for number of insects per tree were computed by multiplying the proportion of trees infested by the mean number of insects per infested tree. A plantation with 50 percent of trees infested and a mean of 2 insects per infested tree would thus have an over-all average of 1 insect per tree.

Values for number of insects per tree were graphically plotted on proportion of trees infested. It was clear at once that, where all trees in the sample were infested, infestation intensities generally exceeded 7 insects per tree (33 sampling points with 8 to 38 insects per tree). At less than 100 percent of trees infested, the relationship between proportion of trees infested and number of insects per tree was exponential (Fig. 1).

Weighted averages were used in making Figure 1 so that each point represented about 10 trees. Thus an area where 30 trees had been sampled for both proportion of trees infested and intensity of infestation became three 10-tree samples. The larger samples were not always in multiples of 10, however; sample sizes for points in Figure 1 actually average out to 15 for proportion of trees infested and 9 for number of insects per tree.

The formula $y = ab^x$ reduced to logarithmic form was used to fit the regression line in Figure 1. Since the standard error of log b (.002) is small in comparison to log b (.01868), the regression of y on x is statistically significant.

In shoot moth infestations, determining proportion of trees infested is easier and quicker than counting number of insects per tree. Therefore, the relationship suggests a rapid method for estimating shoot moth population levels when the proportion of trees infested is known. In 6×6-foot plantations with trees between 3 feet tall and crown closure, a sample of as few as 15 trees should provide the necessary index for obtaining a number-of-insects-per-tree reading from Figure 1. Coordinates obtained with each of the sampling methods used were about equally scattered on the diagram, so it seems likely that any of these methods could be used in practice. However, every fifth tree in every fifth row would probably give the most representative sample with the least effort.

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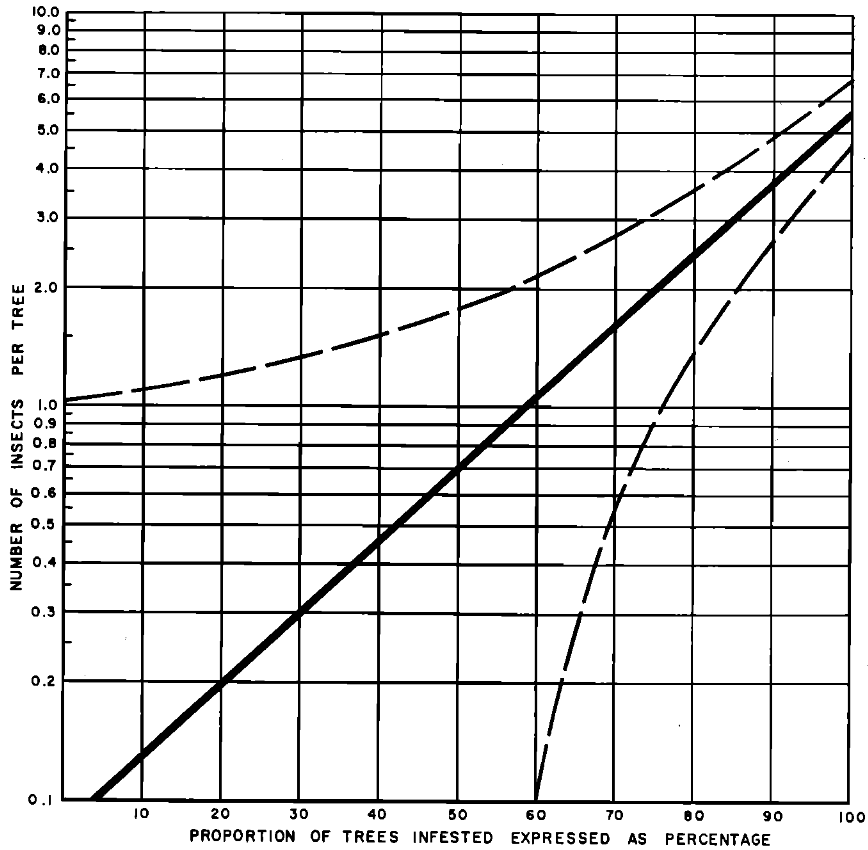

FIG. 1.—Regression of number of insects per tree on proportion of trees infested. The trend line is a graphic presentation of the equation $\log y = -1.0884 + 0.01868 x$. The standard error of y is 0.58. Broken lines indicate the 95-percent confidence band.

Further Results of Bud and Twig Pruning of Loblolly Pine[1]

Following the appearance of papers by Bickerstaff (*1*), Curtis (*3*), and Paul (*5*) on the method of pruning advocated by Krotkevich (*4*) known variously as debudding, finger budding or bud and twig pruning, an experiment was planned to test the applicability of the method to loblolly pine in the Duke Forest located in the lower Piedmont of North Carolina.

The objects of the experiments were to determine the effect of this treatment on (1) rate of height and diameter growth, (2) change in form, (3) relative value of the final product, and (4) whether the results might be influenced by spacing.

The experiment was initiated in a six-year-old loblolly pine plantation on Orange silt loam soil having a soil site index of 69 for loblolly pine. This plantation followed the clearcutting of a mature, even-aged stand of shortleaf pine during the winter of 1943-1944.

The experiment was set up with four replications of the following six treatment-spacing combinations:

1. Complete lateral bud and twig pruning with 7×7 foot spacing.
2. Lateral buds and all twigs pruned, except that the lowest complete whorl was left, with 7×7 foot spacing.
3. Control (no pruning) with 7×7 foot spacing.
4. Complete lateral bud and twig pruning with 14×14 foot spacing.
5. Lateral buds and twigs pruned, except that the lowest complete whorl was left, with 14×14 foot spacing.
6. Control (no pruning) with 14×14 foot spacing.

The required 24 plots were laid out in the field and all hardwoods within seven feet of the plots were cut and their stumps were "am-

[1]Prof. Kenneth L. Carvell, Division of Forestry, West Virginia University, assisted materially in the early work on the project while a part-time assistant in the Duke School of Forestry and offered constructive suggestions on the manuscript.

TABLE 1.—AVERAGE DIAMETER AND HEIGHT GROWTH OF THE TREES USED IN THE BUD AND TWIG PRUNING EXPERIMENT

	Trees spaced 7 × 7 feet			Trees spaced 14 × 14 feet		
	Control (no treatment)	Pruned, leaving basal whorl	Pruned completely	Control (no treatment)	Pruned, leaving basal whorl	Pruned completely
D.b.h. (inches)						
1951	1.08	1.17	0.85	0.84	1.07	0.79
1955	2.80	1.76	1.08	2.98	1.84	1.19
Growth 1951-1955	1.72	0.59	0.23	2.14	0.77	0.40
Adjusted d.b.h. growth	1.84	0.58	0.23	2.14	0.87	0.52
Height (feet)						
1951	6.96	7.69	6.02	5.99	6.98	5.96
1955	16.57	15.80	11.97	14.14	14.68	12.44
Growth 1951-1955	9.61	8.11	5.95	8.15	7.70	6.48
Adjusted height growth 1951-1955[1]	9.3	8.3	7.5	8.7	7.7	6.9

[1]The actual diameter and height growth adjusted for the difference in the heights of the trees at the beginning of the experiment in 1951.

mated" to prevent sprouting. In addition all shortleaf pines, eastern red cedars, and all loblolly pines not needed in the experiment were removed. Also overtopping pines and hardwoods, left as remnants of the previous stand, were cut or frilled and "ammated."[2]

The treatments were then applied to plots randomly selected in the office. Each plot contained nine trees arranged in three rows with three numbered trees in each row. Pruning shears or clippers were used to remove the twigs. Each twig was cut as close as possible to the stem. The first pruning was made in the spring of 1952 just after the buds began to swell which facilitated their location and removal. The same treatments were repeated each of the three following springs just before appreciable terminal growth occurred. The diameters at breast-height and total heights were measured each autumn until 1955 when the experiment was terminated earlier than originally planned because of epicormic branching and the development of excessive crookedness in most of the pruned trees.

Incidental observations deemed worthy of record were made on the pruned trees as follows:

1. Leaving the basal whorl on some of the trees did not reduce the quality of the wood in the knot-free portion of the stem from which the first log would be cut since the knots from this whorl are below stump heights. This modification resulted in a marked reduction in feathering out from adventitious buds along the bole and reduced the amount and cost of the necessary follow-up work.

2. The bud and twig pruned trees retained old needles for several years after they would normally be shed. These needles were longer than the average on the unpruned trees and were denser than those on branches of the unpruned trees.

The results of analyses of the growth data, as summarized in Table 1, show that:

1. For the 7-foot as well as for the 14-foot spacing the height and diameter growth of trees subjected to both types of pruning was significantly less (1 percent level) than that of the control trees.

2. For both spacings the complete bud and twig pruning was inferior to that with the basal whorl left unpruned. The difference in height growth was significant at the 5-percent level, while the difference in diameter growth was significant at the 1-percent level.

3. For all three types of pruning the height growth of trees with the 14-foot spacing was significantly less (5-percent level) than that of the trees with the 7-foot spacing.

4. Regardless of type of pruning the trees spaced 14 feet apart showed significantly greater (1 percent level) diameter growth than did the trees spaced 7 feet apart.

Furthermore the severely pruned trees not only developed very crooked stems but also an excessive number of epicormic branches rendering them very undesirable components of a possible future stand. Their development was very similar to that shown by Brender (*2*) in his Figures 1 and 2.

Because of the undesirable results obtained the authors agree with Brender that loblolly pine is definitely not suited for bud and twig pruning. These severe prunings reduce very drastically the photosynthetic capacity of the treated trees and consequent assimilation of the foods, thus resulting in the decreased growth in height as well as diameter.

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[2]Treated with an aqueous solution of ammonium sulfamate.