the level of acceptable kill with stand characteristics, the appropriate herbicide may be determined to maximize hardwood control, avoid over-injection of easy-to-kill species and small stems of hard-to-kill species, eliminate guesswork when deciding how much herbicide to buy, and increase productivity of applicators. □

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A Comparison of the Effects of One-Step and Two-Step Pruning on Loblolly Pine Stem Form[1]

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*ABSTRACT. The effects of one-step and two-step pruning treatments on tree taper of loblolly pine (*Pinus taeda L.*) were compared in this study. Girard form class and a segmented taper equation were used as two measures of stem form. There was a significant difference in stem form between trees subjected to one-step and two-step pruning treatments at the 5% probability level. Trees pruned at ages 6 and 11 tapered less and yielded about 4% more cubic-foot volume and 9% more board-foot volume than trees pruned at age 11 of comparable diameters and heights.*

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Effects of pruning on tree form are well documented in the forestry literature. Pruning reduces growth at the base of the tree and increases growth near the base of the crown (Young and Kramer 1952, Labyak and Schumacher 1954), which causes an upward redistribution of growth and an increase in the cyclindricity of pine stems (Larson 1963, Burton 1981). For any given dbh and height combination, pruning a tree at an early age should result in reduced tree taper and thus increased volume. The objective of this study was to compare the effects of one-step and two-step pruning on stem form of planted loblolly pine.

DATA

This study was conducted in a loblolly pine plantation established in an abandoned cotton field at the Hill Farm Research Station, Homer, LA. Site index at 25 yr ranged from 65 to 78 ft. In February 1950 two 1-ac blocks were planted with 1-0 stock at each of the following spacings; 4 × 4, 6 × 6, 6 × 8, 8 × 8, and 10 × 10 ft. Interplanting was conducted the following year where necessary. At age 6 (1955), each 1-ac block was divided into four 0.25-ac plots, and four treatments were randomly assigned and applied to the four plots in each of the ten 1-ac blocks;

1. thinned to 400 trees/ac(TPA),
2. crop trees pruned to 8 ft or up to one-half total height,
3. thinned and pruned as above, and,
4. control.

At age 11, the three culturally treated plots were randomly thinned to 100, 200, or 300 TPA, and all trees, except those in the control plots, were pruned to 17 ft. In 1978 (age 29), the plots of 100, 200, and 300 TPA were thinned again. Measurements from 487 of the trees felled in the 1978 thinning were used in this study.

Diameter outside bark and bark thickness were measured to the nearest tenth of an inch at 25-in. intervals starting from the stump to the tip of each of the 487 trees. Stump height varied between 0.2 and 0.9 ft. Diameter at breast height (dbh) and total height were also recorded.

Trees in the control plots were not used in this analysis because none were cut in the 1978 thinning. The remaining 27 plots were grouped by treatment at age 6. Nine plots were thinned, 9 were pruned, and 9 were thinned and pruned. All 27 plots were pruned at age 11, therefore 9 plots (thinned plots) were pruned once and 18 plots (pruned plots, and thinned and pruned plots) were pruned in two steps (at ages 6 and 11). The means and ranges at age 29 for dbh, total height, and Girard form class by pruning treatment are shown in Table 1.

[1] This study was performed as part of McIntire-Stennis Project No. 2273.

Table 1. Description of data by pruning treatment.

Variable	Minimum	Mean	Maximum
		One-step pruning	
Dbh (in.)	6.4	11.3	18.9
Total height (ft)	46.5	71.6	88.5
Girard form class	65.5	81.3	91.6
		Two-step pruning	
Dbh (in.)	6.1	10.9	17.7
Total height (ft)	45.7	71.1	90.3
Girard form class	70.6	83.9	94.2

RESULTS AND DISCUSSION

Tree Form as Measured by Girard Form Class

Girard form class values for trees in the pruned plots and the thinned and pruned plots (both received a two-step pruning treatment) were compared. There was no significant difference between the form class values of these two groups at the 5% probability level (t = 0.81). These data were therefore pooled to constitute a two-step pruned data set. There was a significant difference in Girard form class, however, between the one-step and two-step pruning treatments at the 5% probability level. Based on Girard form class, loblolly pine trees had less taper if pruned in two steps than if pruned only once.

Tree Form as Described by Taper Equation

Girard form class may not adequately represent tree form since this measure utilizes only the relationship between dbh and one upper-stem diameter (at the top of the first log). The entire tree bole can be accurately described with a taper equation. The taper model chosen for use in this study was the segmented taper equation developed by Max and Burkhart (1976). This three-segment model can be rewritten in the following modified form:

$$d^2 = D^2 [b_1 z + b_2 z^2 + b_3 (z - a_1)^2 I_1 + b_4 (z - a_2)^2 I_2]$$

where

d = dib in inches at any given height h,
D = dbh in inches,
$z = 1 - (h/H)$,
h = height in feet above the ground,
H = total tree height in feet from the ground to the tip,
b_i = regression coefficients estimated from the data, $i = 1,2,3,4$,
a_i = submodel join points estimated from the data, $i = 1,2$,

$$I_i = \begin{cases} 1, \text{ if } z > a_i;\ i = 1,2, \\ 0, \text{ otherwise.} \end{cases}$$

Stem forms of the trees in the pruned plots and the thinned and pruned plots were similar (Figure 1). The F-test also indicated that there was no significant difference between these two groups. As in the case of Girard form class, trees

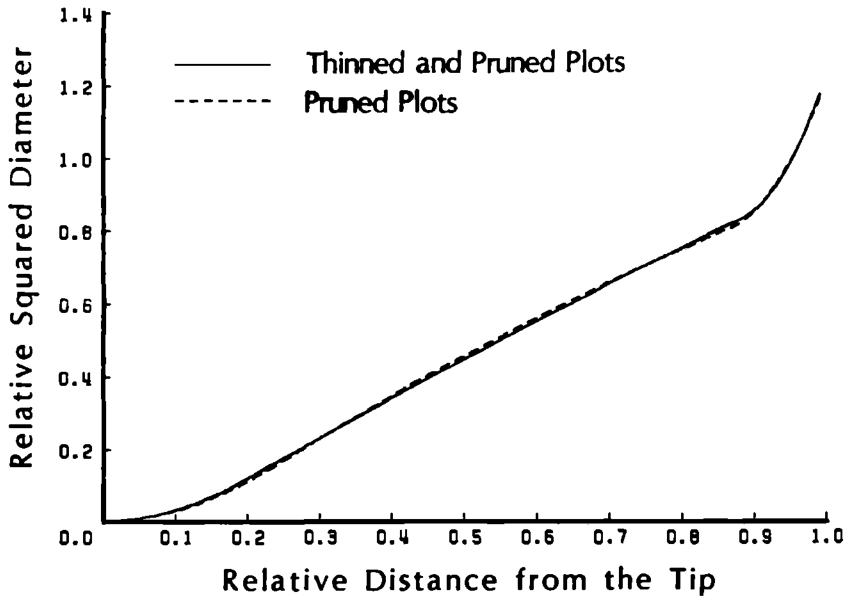

Figure 1. Stem form of trees in the pruned plots and the thinned and pruned plots. All trees in these plots received pruning treatments twice, at ages 6 and 11.

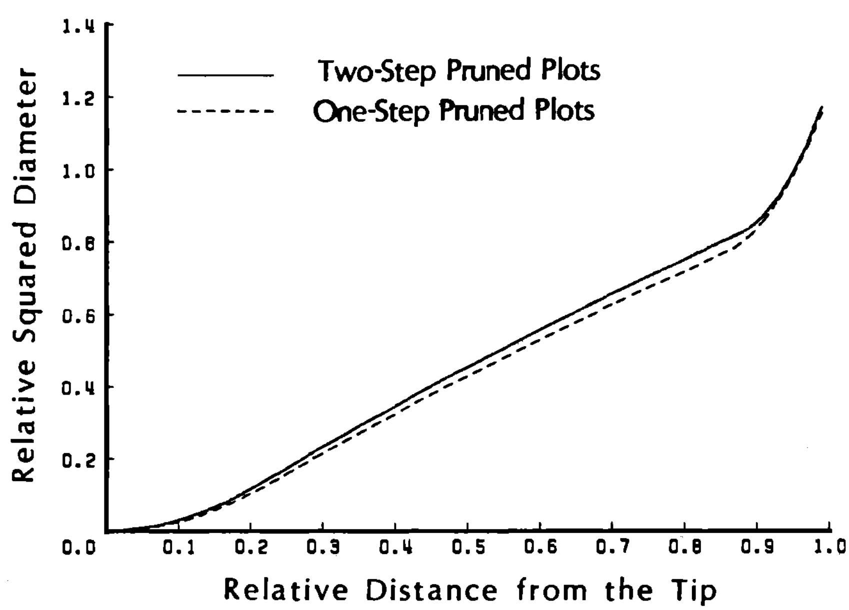

Figure 2. Stem form of trees in the one-step and two-step pruned plots.

Table 2. Regression coefficients for estimating diameter at any height for trees subjected to a one-step or a two-step pruning treatment.

Pruning treatment	Coefficients[a] b_1	b_2	b_3	b_4	a_1	a_2
One-step	−0.0146	2.6207	−2.8186	15.6584	0.2200	0.8579
Two-step	0.0224	2.7370	−2.9585	19.6310	0.2130	0.8769

[a] Taper equation from Max and Burkhart (1976):

$$d^2 = D^2\,[b_1 z + b_2 z^2 + b_3 (z - a_1)^2 I_1 + b_3 (z - a_2)^2 I_2]$$

from the pruned plots and the thinned and pruned plots were pooled to form the two-step pruning data set. Two-step pruned trees had significantly less taper than one-step pruned trees (Figure 2). The regression coefficients for the two pruning treatments are presented in Table 2.

Mathematical integration of the taper equations for the two pruning treatments revealed that for any dbh and height combination two-step pruned trees on the average yielded about 4% more merchantable cubic-foot volume than one-step pruned trees. The increase in average form class from 81 for one-step pruned trees to 84 for two-step pruned trees (Table 1) translates to an increase of approximately 9% in board-foot volume. Although two-step pruned trees in this study had slightly less dbh and total height, the differences were not statistically significant at the 5% probability level (t values are 1.57 and 0.47 for dbh and total height, respectively).

On an individual tree basis, two-step pruning resulted in not only less tapered trees and more volume, for a given dbh and height, but also more knot-free butt sawlogs and thus increased value. However, only thinned trees were available for analyses and the effect of pruning on per-acre volume yields could not be assessed. Whether or not two-step pruning is economically justifiable depends on factors such as the selling price of pine sawtimber, labor costs, impact on stand structure and per-acre yields, and the length of the rotation. Such a treatment might be desirable for southern pine plantations that are managed to produce sawtimber. □

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Effects of Ripping and Herbicide Site Preparation Treatments on Loblolly Pine Seedling Growth and Survival[1]

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*ABSTRACT. Herbicide (1 lb ai/acre hexazinone as Velpar® L) and mechanical (ripping) site preparation treatments increased height and diameter of loblolly pine (*Pinus taeda *L.) seedlings planted on a Ouachita Mountain site in southeastern Oklahoma. Total height after two growing seasons was increased approximately 10% by ripping, 23% by the herbicide treatment, and 49% by the combined herbicide and ripping treatment, as compared with the check treatment. Ground-line diameter was increased 20%, 55%, and 83% respectively by these treatments. Reduction of competing vegetation and increased soil moisture were related to site preparation treatments. The combined ripping and herbicide treatment was the most effective treatment in conserving soil water and in reduction of competing biomass. Competing vegetation biomass was reduced 75% in the first year by the combined ripping-herbicide treatment, and a substantial reduction in competing biomass was still evident at the end of the second growing season.*

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Depending on site conditions and the site-preparation method used, improved seedling performance can be obtained by treatments that reduce competing vegetation and/or improve soil conditions. In the Ouachita Mountains of Oklahoma and Arkansas many acres of mixed oak (*Quercus* spp.) and natural shortleaf pine (*Pinus echinata* Mill.) forests are being