



United States
Department of
Agriculture



Forest Service

Southern Forest
Experiment Station

Research Note

SO-31 2
May 1985

Prescribed Winter Burns Can Reduce the Growth of Nine-Year-Old Loblolly Pines

Michael D. Cain

SUMMARY

Prescribed winter burning was done in a pre-commercially thinned, 9-year-old, natural stand of loblolly and shortleaf pines (*Pinus taeda* L. and *P. echinata* Mill.). Growth and survival of 174 loblolly pines were monitored one growing season after this burning. Mortality was highest for pines with less than 2 inches groundline diameter or pines that were less than 8 feet tall. Diameter and height growth during the year after burning showed statistically significant, negative correlations with increasing crown scorch.

Additional keywords: Crown scorch, fire intensity, *Pinus taeda* L.

INTRODUCTION

Prescribed burning is a useful silvicultural treatment to reduce fuel hazard and to control unwanted competition in even-aged pine management in the South. Thus, knowledge about fire's effects on survival and growth of southern pines is important in the decision-making process of forest managers.

Published information is available on the effects of prescribed fire in 17- to 20-year-old stands of loblolly pine (Mann and Gunter 1980, McNab 1977, Villarrubia and Chambers 1978, Chambers and Villarrubia 1980, Waldrop and Van Lear 1984), but documentation of fire effects in younger stands has been lacking (Muckenfuss 1974). This study addresses that information gap.

METHODS

In mid-January 1983 prescribed burns were conducted on six 0.4-acre plots of a precommercial thinning study in a 9-year-old natural stand of loblolly-shortleaf pine. The precommercial thinning study is located on the Crossett Experimental Forest in south Arkansas. The six plots had been mechanically thinned in October 1979 by rotary mowing 12-foot-wide swaths that alternated with 1-foot-wide uncut strips. Prior to the prescribed burns, pine density averaged 2,000 stems per acre, mean total height was about 10 feet, and mean diameter at breast height (dbh) was about 1 inch.

Burning was done between 10:00 am and 3:30 pm; air temperature ranged from 49° to 60° F; and relative humidity ranged between 31% and 52%. Wind speed was 5 mph from the northwest. There had been no precipitation for 7 days prior to burning. Surface fuels consisted of pine litter and grasses on the 1-foot-wide uncut strips, but on the 12-foot swaths there were mostly grasses, briars, and undecomposed wood fiber from the mechanical thinning that occurred 3 years earlier. Surface fuels were sampled down to mineral soil and at the time of burning had a moisture content of 28% and a dry weight of 6 tons per acre. Because of the patchiness of combustible surface fuel, headfires were required to insure complete area coverage. The rate of fire spread was 5.5 chains per hour. Nearly 200 ocular estimates of flame length were made during the burns. Mean flame length over all 6 plots was 2.8 feet with a

Southern Forest Experiment Station/T-10210 U.S. Postal Services Bldg., 701 Loyola Avenue, New Orleans, La. 70113
Forest Service, U.S. Department of Agriculture.

Serving Alabama, Arkansas, Louisiana, Mississippi, E. Oklahoma, Tennessee, E. Texas, Puerto Rico, U.S. Virgin Islands

standard deviation of 1.1 feet. Fireline intensity was calculated from flame length estimates (Byram 1959) and averaged 60 Btu/ft-sec.

Two weeks after the prescribed fires, 174 loblolly pines were tagged to provide a full range of sizes and scorch damage within the following categories:

Number of pines	Height class (feet)	Crown Scorch (percent)
24	<5	≤50
25	5 to 10	≤50
25	>10	≤50
35	<5	>50
33	5 to 10	>50
32	>10	>50

Total=174

For each pine, groundline diameter (gld) and dbh were measured to the nearest 0.1 inch. Although gld and dbh were measured after the burns and some bark-char occurred, the fires were not hot enough to consume the bark. Total height, height to live crown, height of crown scorch, and height of stem-bark char were measured to the nearest 0.1 foot on individual pines. Percent crown scorch, the proportion of live crown delineated by yellowing or browning needles, was determined 2 weeks after burning by ocular estimation to the nearest 5 percent. Mortality was assessed in October 1983, one growing season after burning, when height and diameter measurements were re-taken for calculation of growth.

Statistical analyses included linear regression and correlation coefficients. The arc sine transformation was used for percent values in statistical analyses. All analyses were carried out at the 0.05 level of significance.

RESULTS AND DISCUSSION

Either total height or groundline diameter of 9-year-old loblolly pines appear to be suitable predictors of pine survival following a winter prescribed fire. In general, pines survived the prescribed fire if, at the time of burning, they were taller than 8 feet (fig. 1) and larger than 2 inches in groundline diameter (fig. 2), regardless of the degree of crown scorch. Regression analysis indicated that total height and groundline diameters were highly correlated in this study (fig. 3).

During the year following the prescribed fire, growth in total height (fig. 4) and growth in dbh

(fig. 5) were significantly reduced as crown scorch increased. Regression analysis provided the following equations:

Height growth (Y)

Pines >10 feet tall; $Y = 3.6366 - 0.0253(X)$, $r^2 = 0.58$

Pines 5 to 10 feet tall; $Y = 2.7572 - 0.0216(X)$, $r^2 = 0.44$

Pines <5 feet tall; $Y = 1.5632 - 0.0102(X)$, $r^2 = 0.33$

Dbh growth (Y)

Pines >10 feet tall; $Y = 0.5632 - 0.0058(X)$, $r^2 = 0.57$

Pines 5 to 10 feet tall; $Y = 0.2910 - 0.0025(X)$, $r^2 = 0.40$

where (X) was percent crown, scorch by arc sine transformation.

All of the above growth correlations with crown scorch were statistically significant, but the strongest were for pines 10 feet and taller for which the variation in height growth and diameter growth associated with crown scorch, explained by the regression equation, was more than 50 percent. Somewhat more pronounced decline appeared in mean annual growth relative to increasing crown scorch for surviving pines taller than 10 feet (figs. 4, 5). For pines up to 10 feet tall, there was higher mortality with more crown scorch (fig. 1); so, survivors in those smaller height classes may have been less stressed from crown scorch for subsequent growth response compared to survivors 10 feet tall and taller. Without mortality for pines less than 10 feet tall, declining height growth trends similar to that of taller pines may

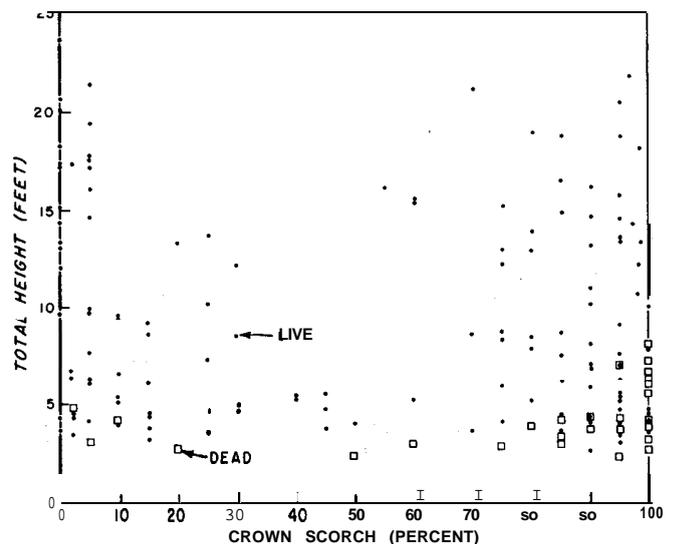


Figure 1-Survival of loblolly pines, one growing season after a prescribed winter burn, relative to total height at the time of burning and crown scorch after burning.

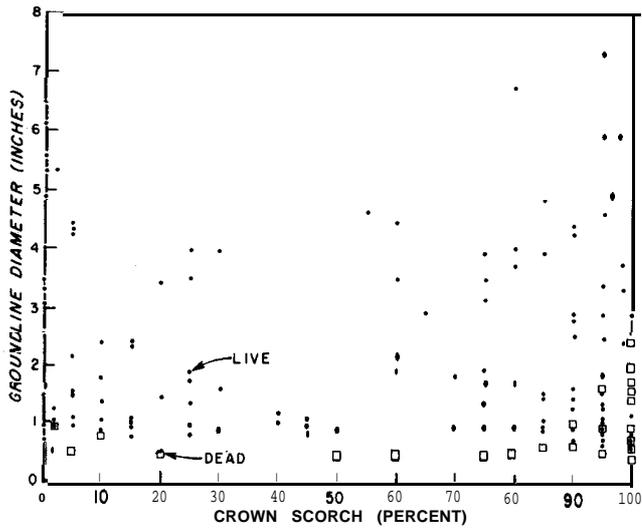


Figure 2—Survival of loblolly pines, one growing season after a prescribed winter burn, relative to groundline diameter at the time of burning and crown scorch after burning.

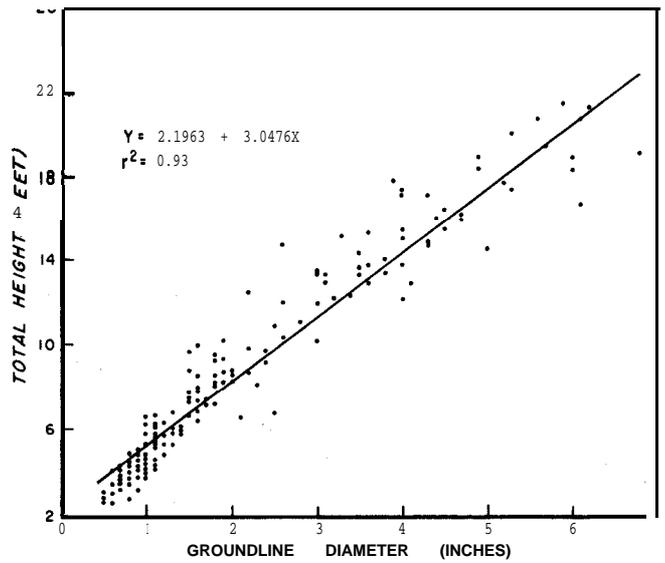


Figure 3—Relationship of total height to groundline diameter for Q-year-old loblolly pines.

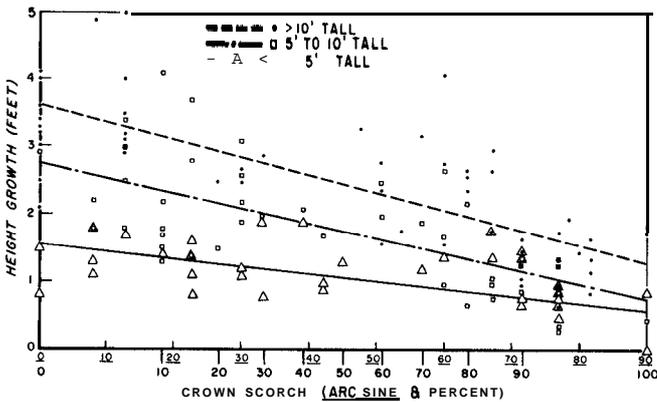


Figure 4—Impact of crown scorch on height growth of 9-year-old loblolly pines one growing season after a prescribed winter burn.

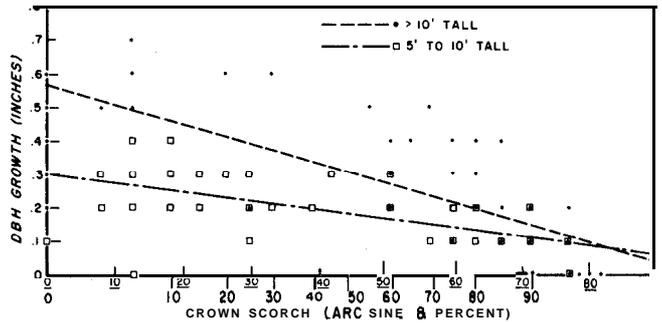


Figure 5—Impact of crown scorch on dbh growth of 9-year-old loblolly pines one growing season after a prescribed winter burn.

have been expected relative to increasing crown scorch.

Results of this investigation are not necessarily applicable to all loblolly pine stands. Working in the South Carolina Piedmont, Waldrop and Van Lear (1984) found that diameter growth of 17-year-old, pole-size loblolly pines was not significantly affected in the year following prescribed burning, even when fire intensity was reported to be over 235 Btu/ft-sec.

The use of measured variables often provides more definitive results than subjective judgments. Yet ocular estimates of crown scorch were more useful in this investigation. For example, when re-

lated to length of crown, height of crown scorch overestimated the degree of scorch because such measurements assume uniform discoloration of needles throughout the crown when, in fact, only one side of the crown may have been affected. Ocular estimation compensated for nonuniformity of crown scorch. Also, ocular estimates of crown scorch were more easily made in the field than measurements of scorch height or char height. In post-burn situations, however, measurements of scorch height or char height on loblolly pines may provide forest managers the dependent variables needed for estimation of relative fireline intensity (Cain 1984).

MANAGEMENT IMPLICATIONS

Groundline diameters and total heights may be useful in predicting mortality of young loblolly pines prior to burning—that is, whether or not prescribed burning can or should be done. High mortality of loblolly pines can result from prescribed winter burns if total heights average less than 8 feet, groundline diameters average less than 2 inches, and predicted **fireline** intensity approaches or exceeds 60 Btu/ft-sec.

Backfires are the recommended burning technique in young loblolly pine stands in order to minimize crown scorch. When crown scorch does occur, ocular estimates of scorch percentage may be useful in assessing potential mortality of young loblolly pines following a winter fire. As crown scorch increases, both dbh growth and height growth of young loblolly pines can be significantly reduced during the growing season that immediately follows a prescribed winter burn.

LITERATURE CITED

- Byram, G.M. Combustion of forest fuels. In: Davis, K.P., ed. Forest fire: control and use. New York: McGraw-Hill Book Co., Inc.; 1959: 61-89.
- Cain, M.D. Height of stem-bark char underestimates flame length in prescribed burns. Fire Manage. Notes **45**(1): 17-21; 1984.
- Chambers, J.L.; Villarrubia, C.R. An assessment of the effects of crown scorch on loblolly pine growth and survival. La. State Univ. Forestry Notes 131; 1980. 2 p.
- Mann, W.F., Jr.; Gunter, E.R. Predicting the fate of fire-damaged pines. Forests and People **10**(1): **26-27, 43**; 1960.
- McNab, W.H. An overcrowded loblolly pine stand thinned with fire. South. J. Appl. For. **1**(1): 24-26; 1977.
- Muckenfuss, G.E. Use of prescribed fire in young loblolly pine stands. In: Proc. Symp. on Manage. of Young Pines; 1974 October 22-24; Alexandria, La. 1974 December 3-5; Charleston, S.C.: U.S. Department of Agriculture, Forest Service, Southeastern Area State and Private Forestry, Southern and Southeastern Forest Experiment Stations; 1974: 337-339.
- Villarrubia, C.R.; Chambers, J.L. Fire: its effects on growth and survival of loblolly pine, *Pinus taeda* L. La. Acad. Sci. 51: 85-93; 1978.
- Waldrop, T.A.; Van Lear, D.H. Effect of crown scorch on survival and growth of young loblolly pine. South. J. Appl. For. **8**(1): 35-40; 1984.