FIRE MONITORING: EFFECTS OF SCORCH IN LOUISIANA'S PINE FORESTS

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Abstract—Frequent growing-season burning is essential for restoring longleaf pine (*Pinus palustris* Mill.) plant communities to open parklike landscapes. However, fire can be a destructive force, reducing productivity and causing mortality among overstory longleaf pine trees. On two central Louisiana sites, severe crown scorch reduced longleaf pine diameter growth by 22 percent during five growing seasons after prescribed burning. Crown scorch also reduced root sucrose and starch concentrations, total and live fine-root-mass density, and the initiation of secondary root development. Despite these results, restoring and maintaining historic plant communities as habitat for endangered species is worth a moderate reduction in growth and some root injury among overstory longleaf pine trees.

INTRODUCTION

Restoring longleaf pine (*Pinus palustris* Mill.) plant communities in the Southern United States can provide desirable habitat for nearly 200 threatened or endangered taxa of vascular plants and several vertebrate species (Brockway and others 1998). Frequent growing-season burning is essential for restoring these plant communities, and mature longleaf pine ecosystems require recurrent burning at 2- to 4-year intervals to maintain species-rich understories of native herbaceous plants (Haywood and Harris 1999).

However, fire may reduce productivity and kill overstory longleaf pine trees (Boyer 1987, Boyer and Miller 1994). The decreases in longleaf pine growth on routinely burned sites may be linked to the intensity and timing of burning relative to the seasonal pattern of carbon allocation in trees. Fire-exposed foliage is an important carbon source, and its vulnerability to heat injury may affect stand productivity. We studied how crown scorch influenced the availability of carbohydrates for longleaf pine root metabolism and growth over a 1-year period after burning; we also studied the amount of stem growth over five growing seasons after burning.

METHODS

The study trees are located in two stands on the Kisatchie National Forest, Calcasieu Ranger District, Rapides Parish, LA. In September 1996, at site 1, a stand of 65-year-old longleaf pine was prescribed burned using a series of strip head fires. At strip interfaces, the crowns of longleaf pine were nearly defoliated by late fall. Along 2 of these interfaces, 10 defoliated trees were selected, as were 10 adjacent nonscorched longleaf pine trees. Thus, 40 (20 scorched and 20 nonscorched) trees were studied.

At site 2 in March 1997, a stand of predominately 45-year-old slash pine (*P. elliottii* Engelm.) was prescribed burned using a helicopter-mounted ignition system. Most of the slash pine was scorched. However, there were also natural longleaf pines in the overstory (these trees were > 45 years old), and 10 of the nonscorched longleaf pines were paired with adjacent scorched longleaf trees in May 1997. In total, 20 longleaf pines were studied (10 nonscorched and 10 scorched) within this predominately slash pine stand.

Soils at site 1 were Ruston fine sandy loam on the ridges and Smithdale fine sandy loam on the side slopes. At site 2, the soil was predominately Beauregard silt loam. At both sites in May 1997 and September 2001, tree diameter at breast height (d.b.h.) was measured with a diameter tape and total height with a Criterion 400 Survey Laser (Laser Technology, Inc., Englewood, CO). At site 1 in May 1997 through April 1998, one soil core was randomly collected monthly to a 20-cm depth within 2 m of each tree (Sword and Haywood 1999). Roots were washed from the soil cores and cleaned. Fine-root carbohydrate concentrations and biomass were determined.

For the longleaf pine trees, the dominant effect in this study was crown scorch; thus, we compared d.b.h. and total height using a completely randomized analysis of covariance design with the May 1997 measurements as covariates (Steel and Torrie 1980). At site 1, root data were transformed to natural logarithms and evaluated by a randomized complete block analysis of variance design. Blocking was based on topography.

RESULTS

Longleaf pine d.b.h. growth was significantly less for the scorched trees than for the nonscorched trees during five growing seasons after prescribed burning (1997 to 2001) (table 1). Total tree height, however, was not similarly affected.

Longleaf pine root sucrose and starch concentrations varied seasonally, but overall they were significantly reduced in response to crown scorch through February 1998 (Sword and Haywood 1999) (fig. 1). One year after burning, total and live pine fine-root-mass densities were significantly lower in response to crown scorch (fig. 2). However, this effect was not evident at earlier sampling dates. Also, 1 year after burning, the percentage of live roots exhibiting primary growth was significantly greater for the

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Table 1—Comparisons of longleaf pine d.b.h. and total height over a 5-year period between nonscorched and scorched trees[a]

Groupings	May 1997	Sept. 2001	*P*-value
	- - *d.b.h. (cm)* - -		
Nonscorched	40.9	43.2	0.0089
Scorched	39.1	40.8	
	Total height (m)		
Nonscorched	25.1	25.8	0.2386
Scorched	24.4	25.0	

D.b.h. = diameter at breast height.
[a] The May 1997 data were used as covariates in the analysis of covariance.

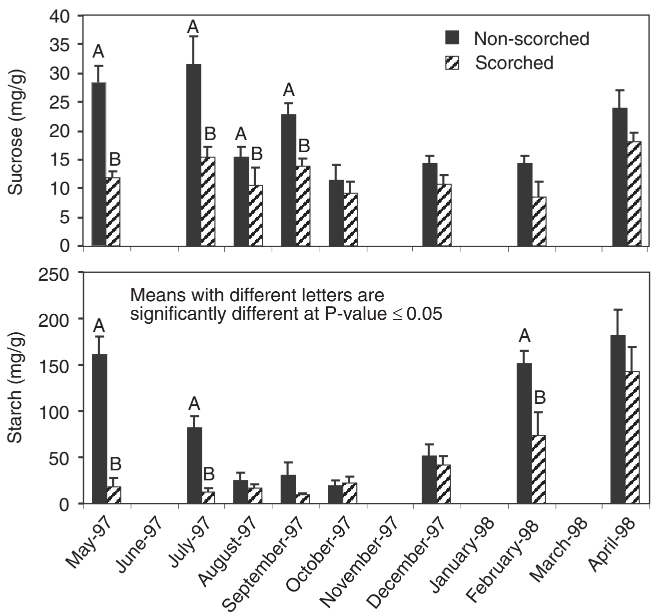

Figure 1—Longleaf pine fine-root sucrose and starch concentrations 8 to 15 months after crown scorch occurred in September 1996.

scorched pine trees, but more importantly, secondary root mass was reduced in response to crown scorch.

DISCUSSION AND CONCLUSIONS

Severe crown scorch reduced diameter growth by 22 percent during five growing seasons after prescribed burning (table 1). Total height, however, was not significantly affected. During the prolonged drought of 1998 through 2000 in Central Louisiana, water deficits likely inhibited the growth of the nonscorched trees. However, the growth of the scorched trees was most inhibited by the loss of nearly 100 percent of foliage in fall 1996 and the need to replace this foliage. Therefore, without drought influencing the growth of the nonscorched trees, we expect that diameter growth reductions after crown scorch would have been more pronounced and total height growth differences may have been apparent.

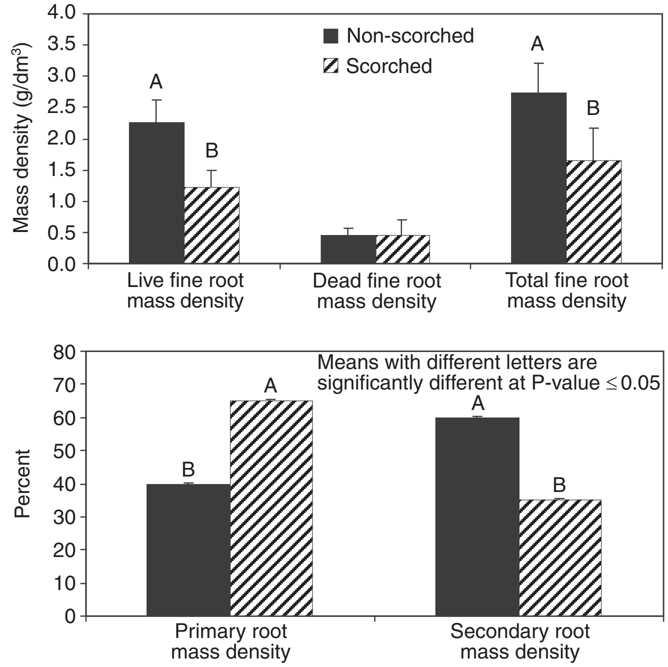

Figure 2—Longleaf pine fine-root-mass density (top) and percentage of root mass exhibiting primary and secondary development (bottom) in September 1997 and 1 year after crown scorch occurred.

Crown scorch also reduced root sucrose and starch concentrations, total and live fine-root-mass density, and the initiation of secondary root development. Fire-induced loss of leaf area potentially reduces carbon fixation and allocation to the stem and root system. However, the magnitude and duration of these effects depend on the amount and season of leaf-area loss, as well as interacting site quality and climate factors.

Nevertheless, the need to restore and maintain historic forest types as habitat for endangered species is worth a moderate reduction in growth among large overstory longleaf pine trees. Regular prescribed burns will reduce fuel loading and favor development of grass-dominated understory vegetation. These fine fuels should support fast-moving fires and eventually reduce the potential for crown scorch following future burns.

FUTURE RESEARCH

In a long-term study, we continue to investigate the effects of prescribed fire on longleaf pine root and stem development. Our work is now concentrated in new longleaf pine plantations on upland sites being converted from hardwood and loblolly pine (*P. taeda* L.) to the historic longleaf pine landscape. We hope to determine how fascicle physiology, leaf-area dynamics, growth, and carbon allocation of sapling longleaf pine are affected by fuel treatments that yield varied fire intensities. At the same time, we evaluate long-term effects of prescribed burning on soil chemical and physical properties.

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