EXPLORING THE EFFECTS OF FIRE RETURN INTERVALS ON RESOURCE-USE STRATEGIES OF PYROPHYTIC AND MESOPHYTIC SPECIES

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PURPOSE AND SCOPE

Fire exclusion in Southeastern U.S. forests has led to significant changes in species composition. This change is typically associated with mesophication, a phenomenon characterized by fire-sensitive, shade-tolerant species (mesophytes) replacing fire-tolerant, shade-intolerant species (pyrophytes). To reverse mesophication, managers reintroduce low-intensity fires in these systems, but they usually fail to change species demographics. We hypothesized that trait plasticity, specifically a transition to a more conservative strategy, may account for the persistence of mesophyte species in fire-disturbed areas (Ruswick et al. 2021). Thus, the goal of this study was to test the occurrence of functional plasticity of mesophytes under frequent fire disturbance and compare them with a pyrophytic competitor.

METHODS AND APPROACH

The study was conducted at Tall Timbers Research Station in Tallahassee, FL, and the Bankhead National Forest in northern Alabama. To test this, we investigated the effects of fire return intervals on above and belowground functional traits of three species: one pyrophyte, southern red oak (*Quercus falcata*), and two mesophytes, sweetgum (*Liquidambar styraciflua*) and red maple (*Acer rubrum*). At Tall Timbers, resprouts were sampled across unburned plots, 3-year, 2-year, and 1-year fire return interval plots, and at the Bankhead National Forest, they were sampled across unburned plots and 3-year fire return interval plots. We measured above and belowground traits, including specific leaf area (SLA), leaf dry matter content, root nonstructural carbohydrates (NSC), and height before and after prescribed burns. We analyzed our data using two-way analysis of variance to test the differences due to species, fire-return interval, and their interaction.

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FINDINGS AND IMPLICATIONS

Our preliminary findings on SLA support the trait plasticity hypothesis, showing a shift towards a more conservative resource-use strategy in both sweetgum and southern red oak in response to fire frequency (P <0.001). Despite this trait plasticity, sweetgum maintained a more acquisitive strategy than oaks across all fire return intervals (P <0.001). This suggests that sweetgum has the potential for a higher relative growth rate and resource acquisition while conserving resources under frequent fire disturbances (fig. 1a).

Our findings on NSC revealed an interaction between species and fire-return interval (P <0.001). We observed a significant increase in total root NSC percentages in sweetgum in fire-disturbed plots at Tall Timbers, with values significantly exceeding those of oaks (fig. 1b). Analysis of postburn resprout heights, which reflects the mobilization of NSC reserves, revealed consistent taller growth in sweetgum compared to southern red oak across all fire-return intervals except for the 2-year cycle (fig. 1c), indicating higher resprout vigor and a competitive advantage over oaks.

We propose that trait plasticity and sweetgum's generalist strategy might explain its persistence across the landscape, irrespective of fire frequency. Our findings highlight species' functional responses to fire, posing challenges for forest and fire management aimed at restoring fire-tolerant vegetation. Future analyses will explore red maple's response to varying fire frequencies.

LITERATURE CITED

Ruswick, S.K.; O'Brien, J.J.; Aubrey, D.P. 2021. Carbon starvation is absent regardless of season of burn in Liquidambar styraciflua L. Forest Ecology and Management. 479: 118588. https://doi.org/10.1016/j.foreco.2020.118588.

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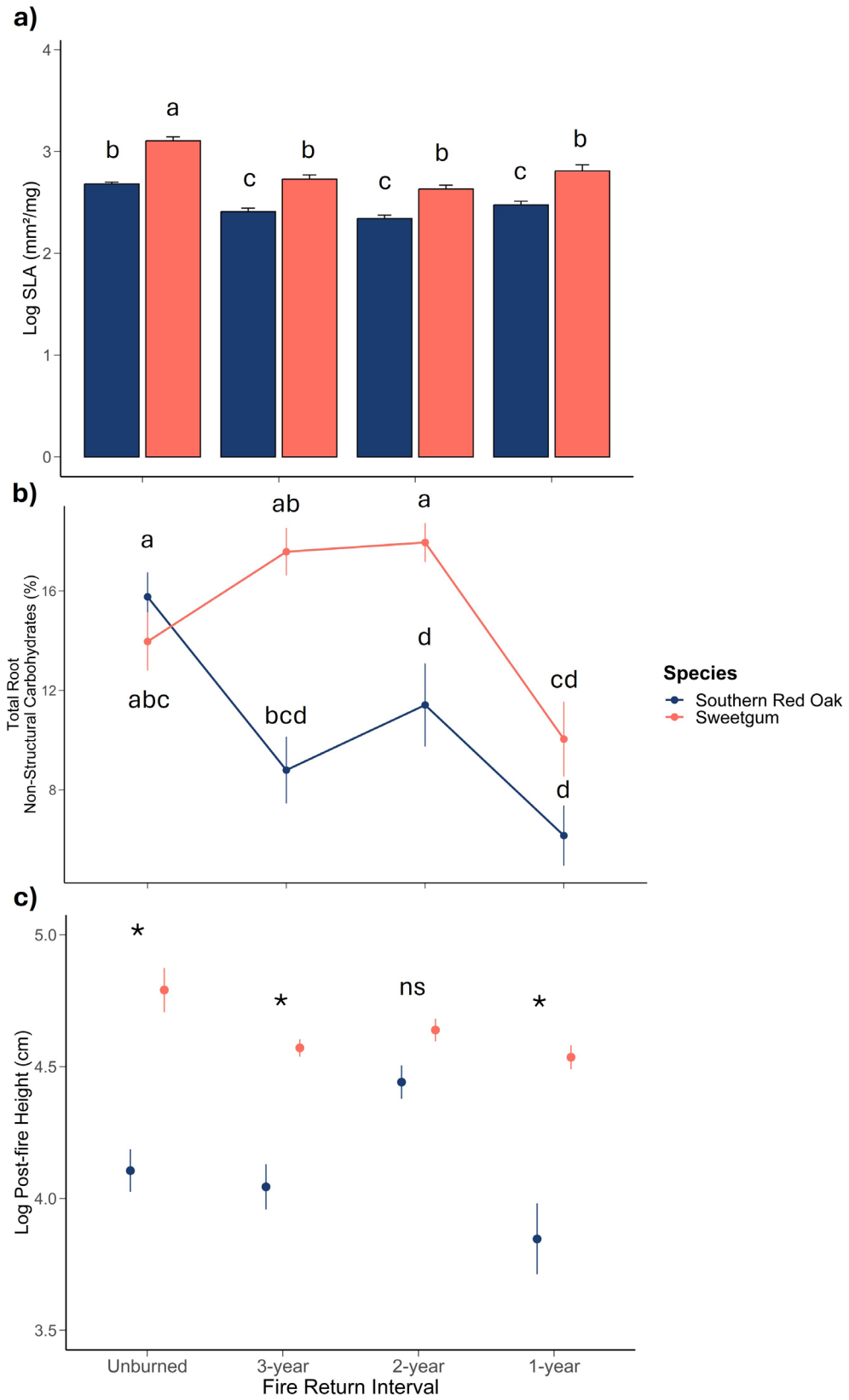

Figure 1—Above and belowground traits measured across fire return intervals in southern red oak (blue) and sweetgum (orange) resprouts. (a) Specific leaf area (SLA) (log-transformed); (b) total root nonstructural carbohydrates; (c) postfire height (log-transformed). Letters in (a) and (b) indicate statistical similarity or differences after Tukey's HSD corrections, where groups sharing the same letter are statistically similar, and groups with different letters are statistically different. In (c), * = significant differences in postfire height between species; ns = nonsignificant differences. Error bars represent one standard error from the mean.