Effects of seed source and burn severity on jack pine seedling establishment

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Prescribed burning is used throughout the state of Wisconsin to manage fire-dependent jack pine (*Pinus banksiana*) forests and barrens. Jack pines vary in the proportion of serotinous cones that they produce, and the extent of serotiny has been previously linked to gradients in climate and fire regimes. Furthermore, prescribed fire is hypothesized to increase conifer recruitment, but it is unclear how fire-induced changes to soils influence jack pine germination and establishment. Kranz and Whitman (2019) collected soils from a prescribed burn study and used them in greenhouse experiments to investigate relationships among burn severity, soils, seed source, and jack pine seedling establishment.

Researchers collected soils from a prescribed burn in Coon Fork Barrens, Wisconsin, where burns are conducted to mimic a low severity and high frequency (3 – 10 year fire return interval) fire regime. Soil sampling was completed one hour prefire and two hours postfire at 1-m intervals along a 25 m transect. Next, researchers pooled soil samples by burn status (pre-burn vs. post-burn) and horizon. The two soil horizons studied were (1) the organic (O) horizon, from the uppermost 0-3 cm, and (2) the 3-30 cm layer of the mineral soil. Subsamples of the pre-burn soils were heated to 400 °C in a laboratory to mimic the effects of high burn severity, resulting in three soil treatments for use in subsequent pot experiments: pre-burn, post-burn, and lab-burn. Soil chemistry for each pooled soil treatment was determined in a laboratory. Intact soil cores were also collected from visibly burned and unburned patches at the field site, 15 days after fire.

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MANAGEMENT IMPLICATIONS

1. A low severity prescribed burn had minimal effects on measured soil properties and did not improve jack pine seedling establishment in pot experiments.

2. Despite minimal changes to the soil chemical environment, low severity burns may still affect field seedling establishment by altering soil moisture dynamics, altered plant competition, or cumulative effects of repeated burns, which were not measured in this study.

3. High burn severity conditions affect soils in ways which may improve jack pine nutrient uptake, as suggested by increased root and shoot biomass for seeds grown in lab-burned soils.

4. Seed source matters: jack pine seeds from northern Wisconsin outperformed seeds from central Wisconsin, likely due to genetic differences between these two populations.

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Next, three distinct pot studies were conducted using the field-collected soils and jack pine seeds from two locations: northwest Wisconsin (85 % serotinous) and central Wisconsin (65 % serotinous). First, researchers planted jack pine seeds from northwest and central Wisconsin in each of the three soil treatments and maintained them in a greenhouse for 24 weeks. The purpose of this experiment was to determine whether soil burn severity and seed source influence jack pine seedling growth. The researchers assessed whether seed responses were consistent across seed lots within a region by growing seeds from four unique lots (i.e. collection years) from each of the two regions in unburned soil and a standard potting mix. 30 germinated jack pine seeds per lot were transplanted and maintained in a greenhouse for 2 weeks, after which seedling survival and growth were determined. Finally, the intact soil cores were used to determine whether visibly burned vs. unburned impact seed germination and growth. For this experiment, seeds were extracted from local field-collected jack pine cones which were heated to 100 °C for 30 minutes, and fifty seeds were planted in each of the two intact soil core treatment groups.

Prescribed burning did not affect soil pH, total organic matter, or available phosphorus (P) in either the soil O or A horizon. Laboratory-burned soils, however, had significantly depleted O horizon organic matter and increased pH, ammonium (NH_4^+), and available P compared to pre and post-burn field-collected soils. The northern WI jack pine seed stock exhibited greater seedling establishment and seedling survival over the 24-week experiment than the central Wisconsin seed stock. Seedlings grown in the lab-burned soils had greater root and shoot biomass than seedlings grown in pre and post-burn soils, but there were no differences in root or shoot biomass between seedlings grown in pre-burn versus post-burn soils. Seedlings grown in visibly burned and visibly unburned intact soil cores did not differ in germination frequency, height, or aboveground biomass.

Reference

Kranz, C., Whitman, T., 2019. High-Severity Burning Increases Jack Pine Seedling Biomass Relative to Low-Severity Prescribed Fires. Soil Science Society of America Journal 83, S141. https://doi.org/10.2136/sssaj2018.09.0342