Prairie species from a temperate environment exhibit positive germination responses to smoke treatments

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Introduction

Fire has been a natural disturbance in grassland ecosystems since the Holocene period. In the Midwestern USA, for example, fire determines, in part, the structure of the landscape as prairie, savanna or woodland. Prairies require a high fire frequency to reduce the encroachment of woodland species. In other fire-prone environments (Australian, South African and American Mediterranean ecosystems), seeds of many species will only germinate in response to fire-related cues. Without these cues, the seed may remain dormant within the soil seed bank. Smoke is one such cue that can break seed dormancy. The effect of smoke on the seed of prairie species had not previously been investigated.

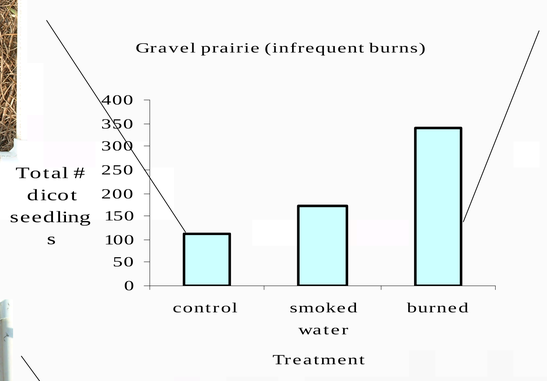
Methods

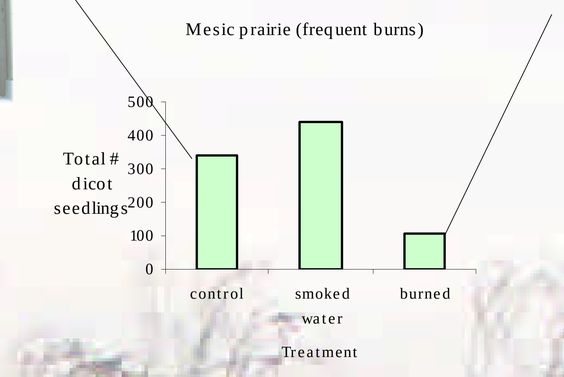
Field Trial

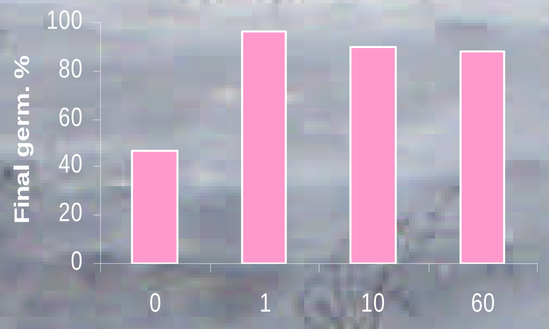
The number of dicot seedlings were counted in plots that had one of the following treatments: burned, not burned and not burned but treated with smoked water (1:32 dilution). Two prairie sites were chosen: a restored mesic prairie and a restored gravel prairie at the Chicago Botanic Garden. The burn occurred in the spring of 2005.

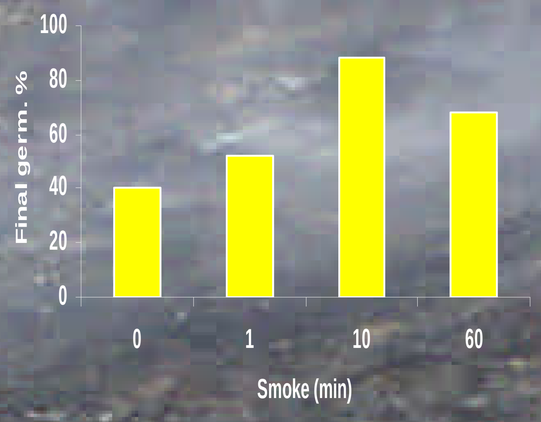
Germination Trial

Seeds of native prairie species from the Asteraceae, Asclepidaceae, Caryophyllaceae, Commelinaceae, Fabaceae, Laminaceae, Onograceae and Poaceae families were exposed to aerosol smoke for periods of 0, 1, 10, and 60 minutes or smoke water at concentrations ranging from 1X to 1 part smoke water :32 parts de-ionized water. Dried straw was burned to generate smoke. Smoke was pumped through a cooling hose into a 20 gallon glass container or bubbled through 20L of de-ionized water for 60 minutes. Four replicates of 25 seeds were then sown in a pre-moistened soil-less germination mix, covered with vermiculite, and grown under ambient light. Water was provided by a mist sprinkler system.









The concentration of smoke that provides the best germination results is species-specific.

Results

Field Trial

The smoke water treatment increased germination in comparison to the control (no burn) on both prairie sites The effect of the burn treatment differed between sites. The number of dicots to germinate on the gravel prairie site was greatest in plots that had been burned. However, there were significantly less seedlings in burned plots in the mesic prairie.

Germination Trial

The results were mixed; some species experienced increased final germination percentage, others had decreased final germination percentages and others were unaffected. Species that do not have secondary dormancy often showed an increase in the rate of germination in response to smoke treatments.

Smoke had a positive effect on a variety of species from different plant families.

Discussion

The role of smoke as a cue for seed germination has been well documented in the American chaparral, South African fynbos and Australian heathland plant communities. These communities exist in Mediterranean environments where cold stratification does not play a role in breaking seed dormancy. We have found that smoke increases germination of some species from tall-grass prairies, a fire-prone ecosystem in a temperate environment, in Midwestern North America. Smoke does not replace cold stratification, instead compliments its effect and thus improves germination of some species.

Preliminary results from field studies also revealed that smoke increases germination. Further investigation is required to determine the effect of fire frequency on germination outcomes.

This study has shown that the role of smoke in breaking seed dormancy may extend to other fire-prone ecosystems in the USA, such as the ponderosa pine communities, lodgepole pine communities, jack pine communities and Alaska's boreal forest and tundra.

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