



Influence of Smoke Solutions on the Germination of Twenty Prairie Plant Species

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Abstract

One management technique often used for prairies is fire. Studies from fire prone plant communities over the last twenty years report that seeds of some species require smoke exposure to germinate. Our objective was to examine the influence of four smoke/ash solutions on seed germination of twenty prairie species. Smoke/ash solutions were: Illinois Smoke, Illinois Ash, African Smoke, and Hickory Seasoning. For each species, 50 seeds were placed in each of three Petri dishes on filter paper moistened with each smoke solution. Germinated seeds were counted for six weeks. Data were analyzed using ANOVA. At least one of the smoke/ash solutions increased germination for thirteen species: *Astragalus crassicaarpus*, *Ceanothus americanus*, *Ceanothus herbaceus*, *Coreopsis palmata*, *Echinacea atrorubens*, *Echinacea pallida*, *Echinacea simulata*, *Liatris aspera*, *Liatris punctata*, *Oligoneuron riddellii*, *Oligoneuron rigidum*, *Pycnanthemum pilosum*, and *Pycnanthemum virginianum*. The Illinois Ash for *Ceanothus herbaceus* was the only combination that decreased germination relative to the control. Smoke solutions had no effect on germination of seven species including: *Astragalus canadensis*, *Bouteloua curtipendula*, *Bouteloua hirsuta*, *Coreopsis lanceolata*, *Echinacea purpurea*, *Lespedeza capitata* and *Lespedeza virginica*. This information has implications relative to fire management of prairies, and to protocols for growth of native plants for use in restoration or sales by the horticulture industry.



Introduction

Research from fire dependent plant communities such as fynbos of South Africa and chaparral of California show that heat or chemical products of combustion are necessary for seed germination of certain species (Brown and van Staden, 1997; Landis, 2000). Recently, investigations into the possible benefit of smoke exposure on germination of tallgrass prairie species were conducted (Jefferson *et al.*, 2008; Pennacchio *et al.*, 2007). Chemicals found in smoke produced by prairie fires may lead to breaking seed dormancy for some prairie species, but may inhibit germination in other species. Some methods developed for treating seeds with smoke include aerosol smoke fumigation, smoke infused water, concentrated liquid smoke, and ash infused water (Brown and van Staden, 1997; Gonzalez-Rabanal *et al.*, 1994; Keeley *et al.*, 2005; Landis, 2000). Little is known about effects of smoke/ash solutions on seed germination of tallgrass prairie species.

Objective

To examine the influence of four smoke/ash solutions on seed germination of twenty tallgrass prairie plant species native to Illinois.

Materials and Methods

- The following seeds were obtained from Prairie Moon Nursery, Winona, MN: *Astragalus canadensis*, *Bouteloua curtipendula*, *B. hirsuta*, *Ceanothus americanus*, *Coreopsis lanceolata*, *C. palmata*, *Echinacea pallida*, *E. atrorubens*, *E. purpurea*, *E. simulata*, *Lespedeza capitata*, *L. virginica*, *Liatris punctata*, *L. aspera*, *Oligoneuron rigidum*, *O. riddellii*, *Pycnanthemum pilosum* and *P. virginianum*; from Macoupin Co., IL, collected by John Ebinger in 1999: *Astragalus crassicaarpus*; from Pure Air Native Seed, Novinger, MO: *Ceanothus herbaceus*.
- Illinois Smoke (smoke from 250 grams of dried prairie plant material was passed through 4 liters of water to create the full strength solution, full strength was diluted to create the half strength); Illinois Ash (3, 6 and 12 grams of ash from burnt prairie plant material was mixed with 1 liter of water); African Smoke (“Instant Smoke Plus Seed Primer” from Kirstenbosch National Botanical Garden, South Africa at full and half strength); and Wright’s All Natural Hickory Seasoning (concentrations of 1:1000, 1:500 and 1:100). Distilled water was used as a control. The concentrations used for each of the smoke/ash solutions and species were based on previously conducted pre-trials.
- For each species, 3 replications with 50 seeds each were used.
- Seeds were placed in Petri dishes on 3 sheets of filter paper moistened with 7 milliliters of a designated concentration of smoke/ash solution or the control.
- Dishes were sealed with Parafilm, and placed into a plastic tub in a Percival Scientific® seed germinator at 25° C with continuous light (38 ± 5 µmol/m²/sec).
- Germinated seeds were counted for six weeks.
- Means and standard errors were calculated.
- ANOVA was run, followed by mean separation using Duncan’s multiple range test at 5% level.

Asteraceae-Germination(%)

Treatment	<i>Liatris</i>		<i>Oligoneuron</i>		<i>Echinacea</i>				<i>Coreopsis</i>	
	<i>L. punctata</i>	<i>L. aspera</i>	<i>O. rigidum</i>	<i>O. riddellii</i>	<i>E. pallida</i>	<i>E. atrorubens</i>	<i>E. purpurea</i>	<i>E. simulata</i>	<i>C. lanceolata</i>	<i>C. palmata</i>
Control	52.7±12.1 b	74.0±3.1 b	62.7±10.5 bc	47.3±5.5 b	25.3±2.7 b	36.7±15.4 b	92.7±1.8 a	31.3±2.9 c	96.7±1.3 a	27.3±1.3 c
IL Smoke	77.3±6.6 a	75.3±4.7 b	86.0±3.5 a	46.0±2.3 b	78.0±3.1 a	83.3±0.7 a	90.0±4.2 a	67.3±1.3 a	90.0±1.2 a	50.7±0.7 b
IL Ash	82.0±0.0 a	76.7±2.9 b	68.7±8.7 ab	54.0±7.0 ab	34.0±5.3 b	80.7±2.4 a	88.7±5.5 a	50.7±1.8 b	96.0±3.1 a	48.7±3.3 b
African	80.7±8.4 a	90.0±2.0 a	74.7±4.1 ab	66.0±4.0 a	80.0±2.3 a	80.0±4.0 a	94.7±1.3 a	72.7±3.7 a	94.0±1.2 a	75.3±8.4 a
Hickory	88.7±2.7 a	80.0±1.2 b	41.3±1.3 c	43.3±4.4 b	72.0±2.0 a	83.3±4.4 a	92.0±1.2 a	51.3±4.4 b	94.7±1.3 a	34.7±2.7 bc

Means ± standard errors; means within a column followed by different letters are significantly different at 5% level.

Rhamnaceae-Germination(%)

Treatment	<i>Ceanothus</i>	
	<i>C. americanus</i>	<i>C. herbaceus</i>
Control	24.7±14.7 bc	11.3±6.6 b
IL Smoke	34.7±2.9 b	18.0±4.6 b
IL Ash	7.3±0.7 c	1.3±1.3 c
African	86.7±5.3 a	45.3±0.7 a
Hickory	40.0±10.1 b	15.3±4.8 b

Means ± standard errors; means within a column followed by different letters are significantly different at 5% level.

Fabaceae-Germination(%)

Treatment	<i>Astragalus</i>		<i>Lespedeza</i>	
	<i>A. canadensis</i>	<i>A. crassicaarpus</i>	<i>L. capitata</i>	<i>L. virginica</i>
Control	94.0±6.0 a	61.3±17.9 b	93.3±1.8 a	89.3±1.8 a
IL Smoke	98.7±1.3 a	96.7±0.7 a	92.7±1.3 a	84.0±6.1 a
IL Ash	100±0.0 a	78.7±3.5 ab	92.0±1.2 a	80.7±5.9 a
African	97.3±1.3 a	95.3±3.7 a	95.3±0.7 a	84.0±4.0 a
Hickory	94.7±2.9 a	89.3±4.8 ab	96.0±2.3 a	84.7±1.3 a

Means ± standard errors; means within a column followed by different letters are significantly different at 5% level.

Poaceae-Germination(%)

Treatment	<i>Bouteloua</i>	
	<i>B. curtipendula</i>	<i>B. hirsuta</i>
Control	76.0±8.3 a	14.0±5.0 a
IL Smoke	87.3±5.9 a	7.3±2.9 a
IL Ash	88.0±9.0 a	17.3±2.4 a
African	81.3±5.2 a	12.0±1.2 a
Hickory	85.3±5.7 a	12.0±2.0 a

Means ± standard errors; means within a column followed by different letters are significantly different at 5% level.

Lamiaceae-Germination(%)

Treatment	<i>Pycnanthemum</i>	
	<i>P. pilosum</i>	<i>P. virginianum</i>
Control	71.3±8.2 b	49.3±4.4 c
IL Smoke	95.3±0.7 a	71.3±5.7 b
IL Ash	71.3±3.7 b	55.3±2.7 c
African	87.3±5.8 ab	87.3±1.3 a
Hickory	88.7±3.3 ab	70.0±6.1 b

Means ± standard errors; means within a column followed by different letters are significantly different at 5% level.

Summary

- At least one smoke/ash solution promoted germination in thirteen species.
- The only combination that decreased germination relative to the control was the Illinois Ash solution for *Ceanothus herbaceus*.
- Smoke/ash solutions had no effect on the germination of seven species.

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