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Burning has little effect on seed production in a restored prairie

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Abstract

Seed rain can be an important indicator of the composition and density of prairie plant populations. Due to the importance of seeds in prairie reconstruction, we studied the effects of burning on the seed rain on twenty plots (ten burned and ten unburned) at Grinnell College's Conard Environmental Research Area (CERA). We found that there was no significant effect of burning on either the seed rain or weight of the seeds for a given species. P. virgatum was the only species which showed a significant effect of burning in the seed rain.

Introduction

The last two decades have seen a resurgence of interest in prairie reconstruction and restoration due to increased awareness to this endangered ecosystem (Smith 1998). This interest has in part been spurred on by a recognition of the importance of grasslands in the history of our country, as well as a greater appreciation for the immense intricacy of the prairie as a natural system. While it is known that burning has a significant effect on the diversity of forbs and grasses in the prairie (Howe 1995; Howe 1998; Hulbert 1969), we were interested in the effects of burning on the seed rain because it is directly connected to plant reproduction. One way to study the seed rain of a community is to quantify seed numbers. This provides information about the resource dynamic in a community; availability of resource that can be used by plants, animals, etc. (Price *et al.* 1997). The seed rain also provides information on the successional direction of a community (Schott *et al*. 1997; Lippert *et al*. 1950). This is valuable information for the restoration ecologist because it reveals not only the current history of the community but also the future direction of the area.

We studied the effects of burning on the seed production of a restored prairie. In addition to the relative number of seeds for each species in the seed rain, we looked at the possibility of variation due to burning in the number of species between the plots and the weight of the seeds between the plots. Our experiment was inspired by a previous study (Schott *et al.*, 1997) of the effects of disturbance on the seed rain and seed bank of a native tallgrass prairie, mowed and biannually burned, and an adjacent unmanaged, reconstructed grassland. Schott *et al.* found that the native tallgrass prairie had a seed rain seven times greater than that of the grassland. Based upon their findings, we hypothesized that the seed rain on the disturbed (burned) plots should have a significantly higher seed rain than the undisturbed (unburned) plots.

Methods

We looked at the seed rain from twenty 10x 10 m alternating burned and unburned prairie plots at Grinnell College's Conard Environmental Research Area (CERA), a restored prairie in central Iowa (Appendix A). Due to the possibility of wind drifting seeds from plot to plot, we decided not to place seed traps randomly, which might have placed the traps near the edges of the adjacent plots.

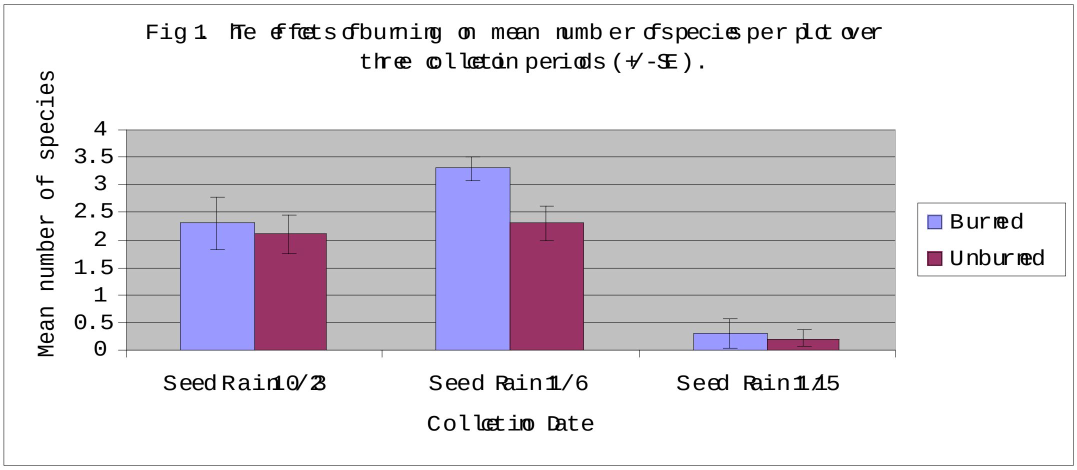


Fig 1 The effects of burning on mean number of species per plot over three collection periods (+/-SE).

Therefore, we used a systematic system of sampling with traps set at two set locations within each plot, 4 m and 6 m in from the edge of the plot that is adjacent to the road (Appendix B). The seed traps consisted of 4 in. diameter PVC piping sunk into the ground and funnels of the same diameter placed over the opening of the PVC pipes in order to prevent predation (Schott *et al.* 1995). We then placed nylon mesh netting around the inside of the funnel to collect the seeds. We initially placed the traps into the plots on 11 October 2000 and collected and replaced them on 23 October 2000, 6 November 2000, and 15 November 2000. After collecting, we combined the seeds from both traps in each plot and dried them at 60°C for 48 hours. We then identified our samples using a reference collection of seeds. We recorded the total seed rain as the total number of seeds collected. We also recorded the distribution of different species within the seed rain and calculated the average weight of the seeds to a tenth of a milligram.

We applied an ANOVA statistical test to check for a spatial gradient that would affect any difference caused by burning. We achieved this through grouping the twenty plots into ten blocks, each containing two adjacent burned and unburned plots before running the tests. Specifically, we looked for significance of burning on the seed rain of, *Panicum virgatum, Sorghastrum nutans,* and *Andropogon gerardii.*

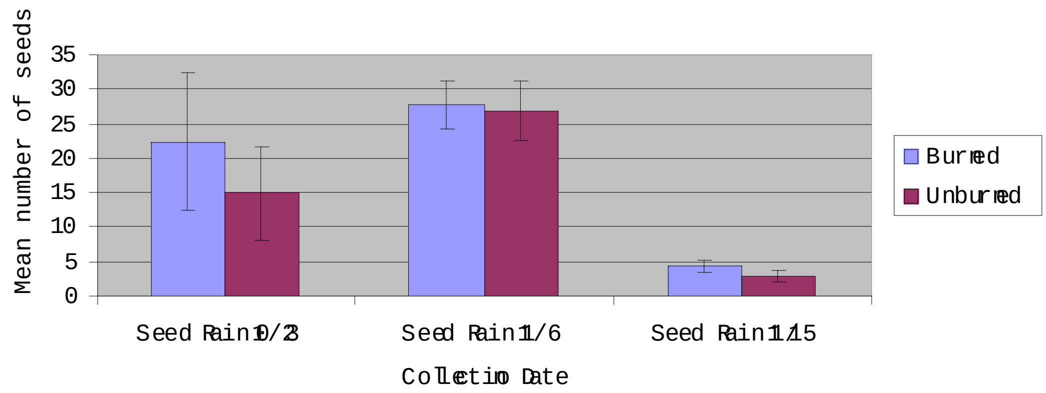
Results

The seed rain between the burned and unburned plots consisted of ten species, two of which could not be identified. The burned plots tended to have a higher average number of species than the unburned plots over the three collection periods (Fig. 1). In fact, *Panicum virgatum* seeds, switch grass, only appeared within the burned plots (Table 1). *Sorghastrum nutans*, indian grass, was the dominant species in the seed rain for both the burned and unburned plots over two of the collection dates. *Lespedeza cuneata* dominated the seed rain for the burned plots on the 23 October collection date while the dominant species in the unburned plots remained *S. nutans.*

The seeds in the burned plots were more numerous than in the unburned plots (Fig. 2), but the difference was not statistically significant (t= 0.87, p=0.39). The seed rain for *S. nutans* and *A. gerardii* was not significantly different (*S. nutans* (f= 0.36, p= 0.565), *A. gerardii* (f=0.10, p=0.759)) between the burned and unburned plots. However, burning significantly increased seed rain of *P. virgatum* (f=8.65, p=0.016).

Burning had no statistically significant effect on the seed weights of *S. nutans* (t= 0.38, p= 0.709) and *A. gerardii* (t=0.09, p=0.926) whereas burning caused a significant

Fig 2 The effects of burning on mean number of seeds per plot over three collection dates (+/- SE)



increase in seed weight for *P. virgatum* (t=3.73, p=0.034).

Over time, the seed rain increased and then decreased over our plots with the highest seed collection on 6 November 2000 (Table 1).

Discussion

Although the seed rain on the burned plots was larger than the unburned plots by about 100 seeds, this difference was not statistically significant. Likewise, burning had no significant effect on the weight of seeds in the same species. We observed that there were higher numbers of seeds in blocks 1-3 and 7-10 respectively. *P. virgatum,* however, was the only species that showed a significant difference in seed rain between the burned and unburned plots according to the ANOVA, and a significant difference in its seed weight according to a t-test. We expected these results because *P. virgatum* seeds were only collected in traps from the burned plots.

Lespedeza cuneata had an unexpectedly high percent not only of the seed rain on the 23 October collection date but also of the entire seed rain (table 1). All of the *L. cuneata* seeds came from plots 5-10 (in blocks 3-5) and in fact, 132 seeds out 145 total seeds came from plot 5. A *L. cuneata* plant was located about 2 ft from our trap on this plot and this is a probable explanation for the high percentage in the total seed rain. Diller (1999) studied the presence of *L. Cuneata* on these experimental plots in 1999. He found that virtually all *L. cuneata* plants were located within blocks 3-5 with the highest number of plants, (65), located in plot 5. Our data of the *L. cuneata* seed rain parallels his findings.

Our original hypothesis, based upon Schott *et al.'s* 1997 study, that there would be a significant difference between the disturbed and undisturbed seed rain in the plots was not supported. We attribute this to a variety of factors. Schott *et al.* investigated the effects of disturbance on seed production between a native prairie, which was burned and mowed biannually, and an old field that had been converted to grass and was unmanaged. This study had the additional factor of two different communities separated not only by burning disturbance, as ours was, but by the fact that one was a remnant prairie and the other was a restored grassland. In addition to this factor, the plots in the native prairie were burned on a biannual basis. It has been shown that burning more frequently than every other year decreases the biomass production on the prairie (Reichman 1987). It is possible that these two factors, the burning regimes and the type of prairie

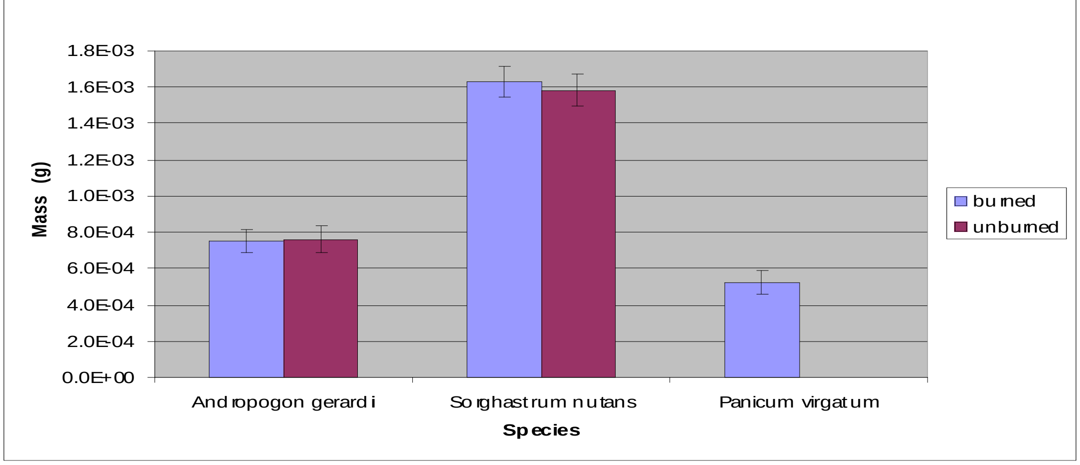


Fig. 3 Effects of burning on the mean weight of seeds for three sp

studied are reasons why our hypothesis was not supported. It is important to note that even though our data had the same trends as Schott *et al.*'s study, i.e. that burning increased the seed production, our lack of significance might be due to these factors.

Even though our study does not show the same significant results in the seed rain as Schott *et al.*'s 1997 study, our data does correlate well to other reproductive biological factors of burn vs. no burn in the CERA plots. For instance, a study by Blodgett *et al.* (2000) found no significant difference in the density of grasses due to annual burning among these plots but a trend towards increased reproductive potential. Even though the general trend of our data and that of the Blodgett *et al.* study indicate some effect of burning on the seed rain and the height of the grass, neither is statistically significant. Our study of the seed rain correlates well with other data that shows a trend in burning (but not significant effect) on the reproductive potential of plants in these plots.

A long-term study of the seed rain on plots with different burning regimes may yield more conclusive evidence to the effect of fire on reproductive potential. More specifically, a look at the effects of a bi- or tri-annual burn rotation instead of the annual burning, which does not show the predicted effects, would be useful. Since many of the plants studied here also reproduce through rhizomes, a study of the effects of burning on rhizome production would complete the understanding of the effects of fire on reproduction in prairie species. Though seed production is only part of the measure of reproductive potential of many prairie species, understanding the effects of fire on seed production it is an important aspect in the ongoing process of restoration.

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	23 October 2000		6 November 2000		11 November 2000			
Species	Burned	Unburned	Burned	Unburned	Burned	Unburned	Seed rain	% Seed Rain
Andropogon gerardii big bluestem	32 (14.7)	60 (40.3)	83 (29.9)	84 (31.2)	16 (37.2)	1 (3.4)	276	27.9
Aster pilosus hairy aster	1 (0.4)	0	0	1 (.4)	0	0	2	0.2
Lespedeza capitata bush-clover	1 (0.4)	0	9 (3.2)	1 (0.4)	0	0	11	1.1
Lespedeza cuneata japanese lespedeza	105 (49.6)	4 (2.7)	36 (12.9)	0	0	0	145	14.7
Panicum virgatum switch grass	6 (2.7)	0	7 (2.5)	0	1 (2.3)	0	14	1.4
Sorghastrum nutans Indian grass	77 (34.4)	72 (48.3)	138 (49.6)	176 (65.4)	26 (60.5)	28 (96.6)	517	52.3
Solidago speciosa Showy goldenrod	0	12 (8.1)	4 (1.4)	2 (0.7)	0	0	18	1.8
Unknown	2 (.9)	1 (0.4)	1 (0.3)	2 (0.7)	0	0	6	0.6
Burned Plots	224		278		43		544	
Unburned Plots	149		266		29		445	
Totals	373		544		72		989	100

Table 1. Complete listing of species and seed numbers for seed rain over three collection dates. Percentage of the seed rain for day are shown in parenthesis.

Appendix A

Diagram showing experimental plots for the burn/no burn experiment. Only first half of the plots were studied as none of our work involved the effects of mowing.