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Effects of Predator Satiation on Seed Predation in New Roadside Prairie Plantings

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Effects of Predator Satiation on Seed Predation in New Roadside Prairie Plantings

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ABSTRACT: Restoration efforts in the tallgrass prairie ecosystem are inhibited by high seed cost and as little as 10% emergence of planted, pure live seed. This study examined the portion of loss due to seed predation and sought to reduce this predation in new roadside prairie plantings. On three sites where native prairie seed was recently drilled, we attempted to satiate seed predators by broadcasting a supplemental food source—birdseed at ten times the rate of the prairie seed. The goal of this method was to capitalize on the evolutionary principals of optimal diet theory and masting in order to protect seed from predation. We quantified seed predation through the use of a buffet experiment during the same fall as the planting, and by monitoring early seedling establishment the following summer. We predicted a reduced loss of prairie seed in the supplemental seed treatment of the buffet experiment. During the growing season, we expected to find increased seedling establishment in the supplemental seed treatment. Results of the buffet experiment show limited seed predation, with no significant effect of the supplemental seed treatment and temporal variation at each of the sites. Results from the growing season showed that the supplemental seed treatment increased early seedling establishment, yielding 37% more seedlings than in control plots. Reducing predation on prairie seed through the use of supplemental seed could provide a practical, inexpensive strategy to improve prairie restorations across the Midwest.

INTRODUCTION

- Tallgrass prairie restoration efforts are primarily inhibited by high seed cost and less than 10% emergence of planted, pure live seed.[5]
- Low rates of establishment can be partially due to predation on seeds by herbivores.[1,3]
- Seed predation is widespread, highly variable, and can affect plant composition[2].
- How to reduce predation in restoration projects is virtually unknown.

This study attempts to use the existing plant defenses of masting and optimal diet theory to examine the portion of loss due to seed predation. We seek an applicable real world strategy to manipulate seed predators using these strategies.

HYPOTHESIS

1. Will the addition of an alternative food source reduce predation of native prairie seed in roadside prairie plantings?
2. Will early seedling establishment be higher in the supplemental seed treatment?

METHODS

Newly planted prairies were supplemented by a plentiful amount of birdseed as an alternative food source immediately following fall 2014 prairie plantings.

- **Two treatments:** plots that receive supplemental seed and control plots that did not.
- **Supplemental seed: 10:1 ratio** of roasted (killed) birdseed: prairie seed
  [Cracked corn, Black oil sunflower, Thistle, Millet + mineral salt (for palatability)

STUDY SITES

- Integrated Roadside Vegetation Management (IRVM) county road rights-of-way
- Benton County Sites (2) seeding rate: 5.61g/m^2 (drilled/hydroseeded + nurse crop)
- Linn County Site seeding rate: 1.17g/m^2 (drilled + cover crop)
- PLOTS: 29 plots, 5-10m wide x 37m long

SEED REMOVAL EXPERIMENT (FALL 2014)

- 30 *Echinacea pallida* seeds were glued to heavy weight sand paper with a spray adhesive[6]. Study plots received 7 cards/plot, spread evenly across ditch width.
- Seeds remaining per card were counted every few days in two trials.
- A linear mixed model was used in R to evaluate the difference between:
  - Control and supplemental seed plots on day 14
  - A pre-planting trial and a planting time trial on day 7

SEEDLING ESTABLISHMENT EXPERIMENT (SUMMER 2015)

- Number of established seedlings/m^2 were counted & identified at all sites in July
- Five, 0.1-m^2 quadrats were sampled in each of the three sections of the ditch profile (fifteen per plot), in the center 5m of the plot, at random positions down the length
- Results analyzed via linear model in R to test for site, treatment, and section effects

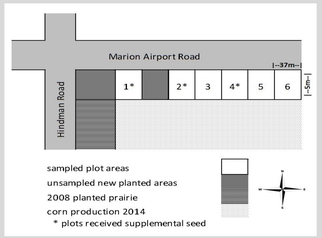


Figure 1: Example site layout

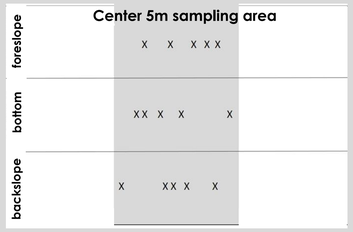


Figure 2: Seedling emergence sampling layout

RESULTS

SEED REMOVAL EXPERIMENT

- Low overall predation at all sites (6.2-8.4%)
- **No treatment effect**: no difference between plots that received supplemental seed and plots that did not (p = 0.2596).
- **Significant trial effect: Significantly more seeds were consumed by predators before the frost in the pre-planting trial (24.8%) than at the planting count, which occurred after the frost (4.8%) (p <0.001).**

SEEDLING ESTABLISHMENT EXPERIMENT

- **142.02 native seedlings/m^2 established across all three sites, a 9.21% establishment rate**

Table 1: Mean seeds removed (out of 30) in the control and supplemental seed treatments on day 14 and the pre-planting and planting trials on day 7.

	mean seeds removed	Standard error	Predation rate
control	1.86	0.41	6.20%
seed	2.53	0.48	8.44%
pre-planting	7.44	0.94	24.80%
planting	1.29	0.31	4.30%

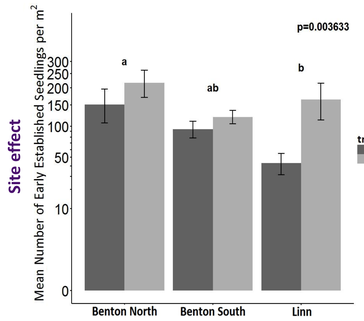


Figure 3: Mean early established seedlings per m^2 at each of the three sites. P value represents the main effect of site.

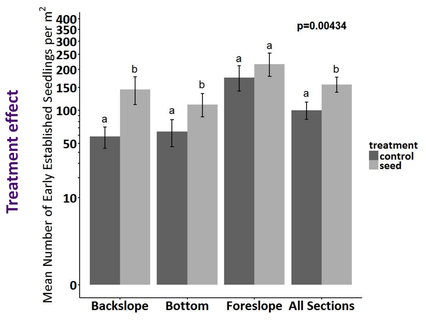


Figure 4: Mean number of early established seedlings per m^2 in the control and supplemental seed treatments for the whole plot (all sections) and each of the sections individually. P-value represents the main effect of treatment (all sections).

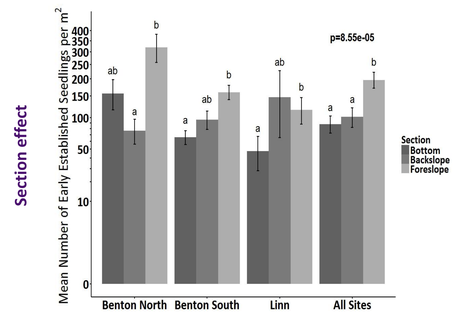


Figure 5: Mean number of early established seedlings per m^2 in each section for all sites combined and each site individually. P-value represents main effect of section.

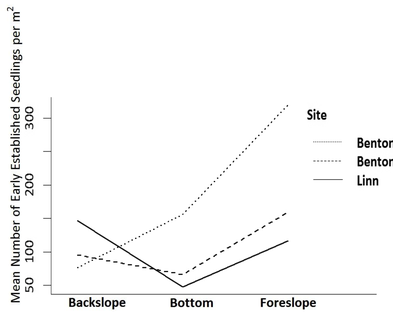
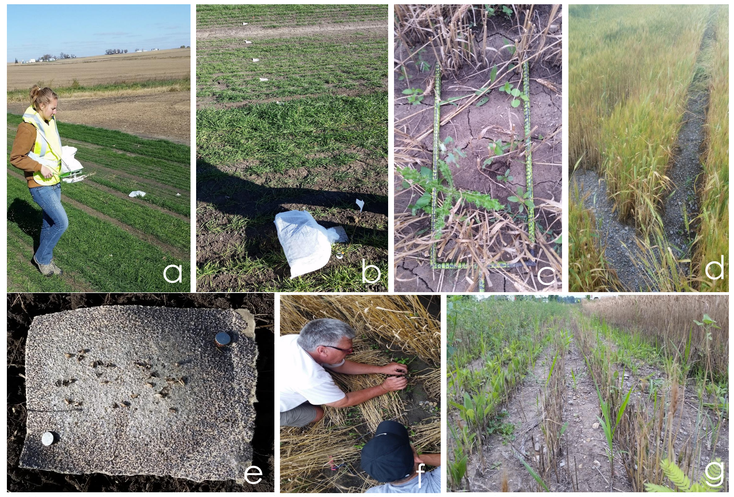


Figure 6: Interaction of site and section of mean early established seedlings per m^2.



a. Hand broadcasting supplemental birdseed over newly planted prairie. b. Example plot with cards laid out along center line. An additional card was placed inside an insect barrier bag and metal cage to control for losses not due to predation. c. 0.1m^2 quadrat used to sample early seedling emergence. d. example of roadside disturbances: gravel deposition and erosion. e. example seed card f. identifying seedlings according to The Tallgrass Prairie Seedling ID Guide[7] with the help of Dave Williams. g. drill rows of seedlings emerged in the roadside rights-of-way.

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CONCLUSIONS

- **SITE EFFECT:** Benton North site had significantly more than the Linn site but neither the Linn site, nor the Benton North site were significantly different than the Benton South site.
  - Site differences could be due to roadside disturbances and differences in management
- **TREATMENT EFFECT: Significantly more seedlings established in the supplemental seed treatment (157.29 ± 19.33) compared to the control treatment (99.57 ± 15.99), a 36.7% increase in seedlings established.**
- **SECTION EFFECT:** Across all sites, the bottoms and backslopes differed significantly from the foreslopes, but not from each other. Different sites show different section effects. Differences could be due to roadside disturbances and management.
  - Backslopes and foreslopes aren't generally much different from each other, but they are very different at Benton N
  - Generally a low number of seedlings in the bottoms, but higher at Benton N
- Higher seedling establishment with the supplemental seed treatment shows that:
  - High seed densities may have the ability to overwhelm consumer's ability to change plant populations
  - Masting &/or optimal diet theory could have influenced predation in this system
  - The benefits of this treatment are comparable to physically excluding predators with cages[4]
- No treatment effect in seed removal shows that planting time is not the peak predation time. A significant trial effect with a frost between trials shows that either insects are the main predator in this system, or that rodents are not.

FUTURE DIRECTIONS: seed cards at more times of the year + analysis of how this treatment affects species composition

ECONOMIC IMPLICATIONS

seed mix: $810.73/ha
supplemental seed: $129.39/ha → $940.11/ha +13.7%

Spending 13.7% more yielded 37% more seedlings

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