Impacts of Strategic Grazing and Fire on Soil Seed Bank Heterogeneity in Mixed-Grass Prairie

Kassidy Weathers[UG], Lan Xu, and Patricia S. Johnson
Department of Natural Resource Management, South Dakota State University, Brookings, SD 57007

Introduction

- Northern Great Plains evolved under periodic fire and substantial grazing pressures.
- Fire and grazing maintain structural and compositional heterogeneity of grassland ecosystems.
- Contemporary management practices focus on maximizing livestock production through fire suppression and uniform use of plant communities.
- These practices result in decreased vegetation heterogeneity and reductions in species richness, wildlife habitat, and biodiversity.

Objectives

- Evaluate and compare patch-burn grazing (PBG) and winter-patch grazing (WPG) in mixed prairie on soil seed bank heterogeneity in:
  1) Composition 2) Abundance 3) Diversity

Hypothesis

- Winter-patch grazing and patch-burn grazing managements create different environmental conditions during and after disturbances.
  - Hypothesis: patch-burn grazing and winter-patch grazing will have different impacts on species richness, composition, abundance, and diversity of seed banks in the years post-disturbance.

Study Area

- Cottonwood Range and Livestock Research Station, western South Dakota (Lat. 43° 55'08" N, Long. 101° 52'58" W)
- Climate: Continental and semiarid; hot summers & cold winters
  - Annual mean precipitation: 419mm
  - Annual mean temperature: 8°C (Jan.= -14°C, Jul. = 32°C)
- Predominant soil: clay
- Vegetation: typical mixed-grass prairie with dominant species *Pascopyrum smithii* (western wheatgrass), *Bouteloua gracilis* (blue grama), and *Bouteloua dactyloides*) (buffalograss)
- Land use: Livestock grazing
- Wildfire burned part of each pasture in October 2016

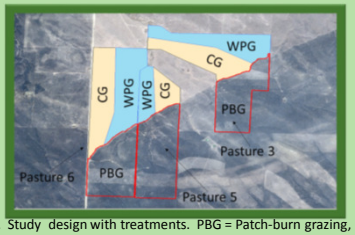


Fig. 1. Study design with treatments. PBG = Patch-burn grazing, WPG = Winter-patch grazing, CG = Control, no burn, no winter grazing Three pastures (3, 5, and 6) as replicates

Kassidy.Weathers@Jacks.sdstate.edu
Lan.xu@sdstate.edu (605-688-4564)
Paticia.Johnson@sdstate.edu

Methods

- 3 treatments (PBG, WPG, and CG) with 3 replicates (pasture 3, pasture 5, pasture 6)
- 2 soil cores (10-cm dia. x 10-cm depth) randomly selected and composited in each of 5 exclosures in each pasture. Total 90 cores and 45 samples.
- Soil samples went through a 2-mm sieve into a 25-cm X 25-cm seed flat. Maintained in environmentally controlled greenhouse: 16-hr light/8-hr dark photoperiod and 23±2°C temperature.
- Seedlings identified and counted as they emerged; removed weekly for 3 months.
- Unidentifiable seedlings were transplanted and allowed to grow until identification could be made.
- One-way ANOVA with significance $P < 0.05$

Fig. 2. (A) Exclosure where samples were drawn, and emerged seedlings: (B) *Androsace occidentalis* (western rockjasmine), (C) *Triodanis lepocarpa* (slimpod venus' lookingglass), (D) *Draba reptans* (Carolina draba), (E) *Silene antirrhina* (catchfly), (F) *Ratibida columnifera* (prairie coneflower), (G) *Achillea millefolium* (common yarrow)

Results

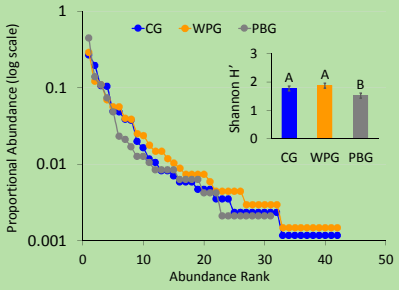


Fig. 3. Rank-abundance curves of seed banks for CG, WPG, and PBG treatments, and Shannon Diversity Index (insert bar chart).

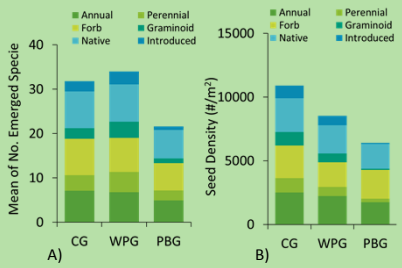


Fig. 4. Comparison of plant life span, growth form, and origin among treatments A) emerged species, B) seed density

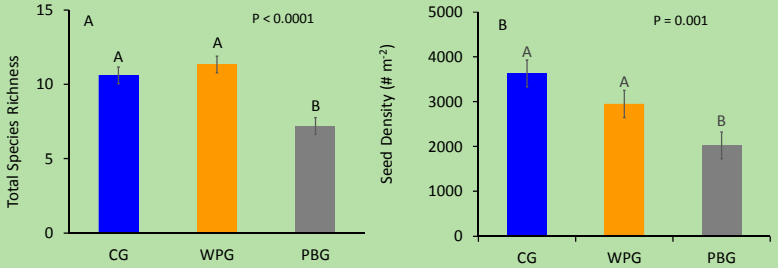
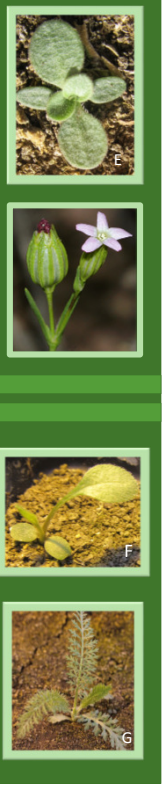


Fig. 5. Total species richness (A) and seed density (B) for CG, WPG, and PBG treatments.

Note: Different letters within comparison indicate significant differences at $P < 0.05$. One year post patch-burn grazing significantly reduced the seed bank species richness, abundance, and diversity.



Results

- Overall, 2006 seedlings of 54 species identified from the seed banks, including CG (855 seedlings, 42 species), WPG (674 seedlings, 42 species), and PBG (477 seedlings, 31 species).
- Jaccard's Index Similarity for treatments were between 55 to 58%.
- Majority of seedlings that emerged in each treatment were annual native forbs. Most abundant species were *Androsace occidentalis, Triodanis lepocarpa,* and *Draba reptans*.
- *Poa pratensis* was more abundant in CG (20%), lower in WPG (10%), and 2% in PBG.
- Species evenness and richness were more similar between CG and WPG, compared to PBG. PBG dominated by 3 species (70%) (Fig. 2) and had lower diversity.
- Average total species richness for PBG pastures significantly lower (approx. 7 species) compared to CG and WPG treatments at 11 and 12 species respectively (Fig. 5A).
- PBG pastures had a significantly lower seed density (2,000 seeds/m^2) than CG pastures (3,400 seeds/m^2) and WPG pastures (3,000 seeds/m^2) (Fig. 5B).

Conclusions

- Results demonstrated that patch-burn grazing has negative impact on seed bank species richness, diversity, and seed density compared to winter-patch grazing and conventional summer grazing.
- Patch-burn grazing appears to reduce perennial, graminoid, and introduced species, and their seed reserve.
- Winter-patch grazing may serve as a better management tool than patch-burn grazing when it comes to species composition diversity.

References

1. Sanderson, M., Goslee, S., Klement, K., & Soder, K. (2007). Soil Seed Bank Composition in Pastures of Diverse Mixtures of Temperate Forages. *Agronomy Journal*, *99*(6), 1514-1520.
2. Fuhlendorf, S., & Engle, D. (2001). Restoring Heterogeneity on Rangelands: Ecosystem Management Based on Evolutionary Grazing Patterns. *Bioscience*, *51*(8), 625-632.
3. Helzer, C., & Steuter, A. (2005). Preliminary Effects of Patch-Burn Grazing on a High-Diversity Prairie Restoration. *Ecological Restoration*, *23*(3), 167-171

Acknowledgements

This project was funded by the Griffith Undergraduate Research Award. This research was supported by the SD Agricultural Experiment Station and by grants awarded to South Dakota State University from the USDA NIFA-AFRI (Grant # 2017-67020-26511) and NCR-SARE (Grant # 2015-38640-23781) programs. Thanks to Dr. Lan Xu for mentoring the project. Special thanks go out to Jameson Brennan and Surendra Bam and the SDSU Natural Resource Management Department for their help and support.