Burning and grazing cool-season grasslands to promote native grass recruitment for agronomic, ecological, and social benefits

Final Report for GNC07-076

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Grant Recipient: University of Wisconsin-Madison
Region: North Central
State: Wisconsin

Graduate Student:

Emma Bouressa

Faculty Advisor:

Randall Jackson
University of Wisconsin-Madison

Project Information

Summary:

We combined burning and rotational grazing to blend restoration and livestock production by promoting and maintaining native and non-native grass coexistence. Native grass tiller density increased under the burn and graze treatments, but not the burn-graze treatment. However, native grass tillers in 2007 were higher in the burn only than the graze only treatment. We found no loss to native grass tiller density when rotational grazing was applied after 2 years of grazing exclusion with burning. Our results suggest that the use of burning and grazing as a management tool for native grass persistence may be possible with deferred grazing during establishment phase.

Introduction:

The effects of burning on the tallgrass prairie has been widely studied but very little is known about burning and grazing cool-season pasture to promote reintroduced tallgrass prairie species. Prior to European settlement, prairie ecosystems dominated much of the upper Midwest, providing a foundation for efforts to restore patches of the tallgrass prairie in the Midwest (Brye et al. 2002a, Brye et al. 2002b).

In Wisconsin about 850,000 ha of prairie existed at the time of European settlement (Curtis 1959) with about 8000 ha (

Project Objectives:

Results from this experiment will help determine whether burning and grazing can be combined for improved forage and root production (agronomic and ecological benefits). In addition, these practices will highlight farmers as land stewards, which promotes rural prosperity (social benefit).

The expected short-term outcomes of this project are:
1. Management techniques to promote the re-introduction and recruitment of warm season, native grasses into cool season, non-native grass pastures under grazing and burning practices.

2. Quantification of root production and forage production under grazing, burning, and a combination of grazing and burning.

The intermediate-term outcomes are:
1. Increase farm participation in the conservation effort by promoting the re-establishment of native plant species.

2. Burning for agricultural benefit should promote sustainable farming.

The long-term outcomes of this project will help many stakeholders (researchers, farmers, policy makers, general public, conservationists) envision the integration of conservation efforts with farm management. This model should encourage adoption of new techniques and practices that improve production while enhancing the environment. These outcomes strongly fit the mission of NCR-SARE, which strengthens farmer profitability while improving the environment by supporting sustainable research.

Cooperators

- Randall Jackson

  rdjackson@wisc.edu

  Assistant Professor

  University of Wisconsin-Madison

  Moore Hall
  1575 Linden Drive
  Madison, WI 53706-1590

  (608) 261-1480 (office)

Research

Materials and methods:

This study occurred at the Cates Family Farm in Spring Green, Wisconsin during the 2007 growing season. Soils from the study site are classified as Fayette silt loam (fine-silty, mixed, superactive, mesic Typic Hapludalfs) and have a 12 to 20% slope (USDA-NRCS Web Soil Survey). The study site is of a temperate climate. According to UW Automated Weather Observation Network (AWON) average temperatures in Spring Green, WI during 2007 were -5 °C in January to 22 °C in July.

The farm produces ~50 head of cattle of the Jersey and Angus breeds. The cattle are grazed using a management-intensive rotational grazing system on pastures dominated by introduced, cool-season grasses such as meadow fescue (Festuca pratensis Huds.), smooth brome (Bromus inermis Leyss.), orchardgrass (Dactylis glomerata L.), and quackgrass (Elytrigia repens (L.) Gould). Dominate forbs are white clover (Trifolium repens L.), red clover (Trifolium pratense L.), and common dandelion (Taraxacum officinale F.H. Wigg.). Native, warm-season grasses were drill seeded in fall 2003 and spring 2004 at a rate of ~1 g pure live seed m-2 and with a mix by weight of 70% big bluestem (Andropogon gerardii Vitman), 15% switchgrass (Panicum virgatum L.), and 15% indiangrass (Sorghastrum nutans (L.) Nash) (Woodis 2008).

Three disturbance treatments – burn, burn-graze, and graze – were applied during 2007 in a complete randomized block design using three 0.5 ha pastures as experimental blocks (Figure 1). Graze only and burn only treatments were randomly chosen within each block while burn-graze treatment was not. The burn treatment was the control in our experiment because we were interested in testing burning and grazing together to promote native grasses of the tallgrass prairie. During the establishment phase of native grasses, burning and grazing disturbances were applied (separately) from 2004 through 2006. In order to combine burning and grazing disturbances, we included grazing on one-half of the previously burned treatments. Burning occurred in April of 2005, 2006, and 2007 and removed 100% of the above-ground biomass. Management-intensive rotational grazing system uses short duration (

Research results and discussion:

Results:
Native grass tiller density increased from 2006 to 2007 under the burn only ($P = 0.006$) and graze only ($P = 0.005$) treatments, but not the burn-graze treatment ($P = 0.18$). While 2 of 3 results were statistically significant, it is important to note the disparity in absolute native grass tiller density. Native grasses in burn plots increased from 19.8 ± 6.5 to 59.6 ± 7.3 while graze was only 1.0 ± 0.24 to 2.8 ± 0.11.

When comparing differences in native grass tiller density between 2006 and 2007, we found that the burn only treatment was significantly greater than the burn-graze and graze only treatments, while there was no significant difference between burn-graze and graze treatments.

Native grass cover in the burn treatment was significantly higher than in the burn-graze and graze treatments. There was no significant difference in native grass cover between burn-graze and graze treatments.

Visual assessment of ancillary data indicated little variability among treatments in soil temperature or gravimetric water content for 2007. However, net nitrogen mineralization appeared to be lower in the burn only plots than the graze only plots for June and October of 2007.

Discussion:
Many studies have examined the effects of burning (Collins et al. 1998a) and grazing (Seastedt et al. 1994, Knapp et al. 1999, Fuhlendorf and Engle 2001, Fuhlendorf and Engle 2004) on native grass establishment in western tallgrass prairie; however, there has been less research on the use of burning and grazing to encourage native grass persistence in the eastern tallgrass prairie. The work described here focused on the first year of combined burning and grazing after a 3-year establishment phase under burning alone and grazing alone. The lesson from the establishment phase was that burning greatly facilitated native grass recruitment into an existing stand of cool-season grasses (Woodis 2008). Grazing during the establishment phase did not preclude recruitment, but neither did it allow

native grasses to recruit into the stand in an agronomically significant way.

Studies have shown that fire enhances native grass establishment and abundance and reduces non-native species (Howe 2000, Camill et al. 2004, Prober et al. 2005, MacDonald et al. 2007). Camill et al (2004) found a significant shift to warm-season grasses in prairie ecosystems around year 3 of restoration, and Howe (2000) found that spring burning promoted 5 to 6 times greater warm-season grass production than fall burning and no burning treatments. Burning increases soil temperature and reduces soil moisture and nutrient availability, which allows for greater dominance of native, warm-season grasses (Collins et al. 1998b). However, we observed no consistent effects of management on soil temperature or moisture for 2007. We did observe that nitrogen availability was somewhat lower in the burn treatment during June and October, which may have given the native grasses in the burn plots a competitive advantage.

In the western tallgrass prairie, grazing regimes increase species diversity (Collins et al. 1998a, Knapp et al. 1999) and promote patch diversity (Fuhlendorf and Engle 2001). However, one study examined bison grazing on native, warm-season grasses east of the Mississippi and found that grazing caused a decline in native grass persistence (Jackson et al. in press). Similarly, we found that native grass establishment was limited under the graze treatment. While we found a significant increase in native grass density from 2006 to 2007, the establishment was limited under grazing alone (i.e. an increase of roughly 1 to 3 native grass tillers/m2 under graze only). Studies have examined that less intense and/or less frequent grazing promotes persistence of big bluestem (Mousel et al. 2003, Mousel et al. 2005). The apical meristem of cool-season grasses is closer to the ground than most native, warm-season grasses, so grazing native grasses too closely to the soil surface could suppress regrowth after defoliation.

Studies have found that combining grazing and burning increases species diversity and heterogeneity (Collins and Gibson 1990), and enhances wildlife habitat (Fuhlendorf and Engle 2001). We found that a combination of burning and grazing in the first year of application resulted in little to no change in native grass density, suggesting that once native grasses are established, rotational grazing regimes may be applied without immediate detriment to native grass persistence. However, these results must be viewed with caution as longer-term rotational grazing may reduce native grass persistence. Jackson et al. (in press) found a precipitous decline of warm-season grasses (though rates of decline were species-specific) under summer rotational bison grazing. While stocking rates were quite high, and the timing of grazing may not have been ideal, native grass cover on their plots decline from ~90% to ~30% over a 6-year period. Hence, more work with other types, intensities, and timings of grazing livestock is needed.

When burning grazed pastures, farmers will need to take into consideration the amount of accumulated biomass remaining from the previous season. We found it difficult to maintain a consistent fire on the graze only plots. Farmers may need to reduce or eliminate grazing in the fall to allow biomass to accumulate for the following spring burn. One alternative is to incorporate “rest paddocks” (Jackson 1999, Hickman et al. 2004, Firn 2007) for 1 to 2 years to facilitate burning and then reintroduce rotational grazing, but with follow-up monitoring that can inform adaptive management.

While combining burning and grazing did not result in native grass loss, there was significantly less native grass cover in these treatments compared to burning alone. This shows how different vegetation metrics might lead to alternate conclusions. Density is calculated as the mean number of individuals per unit area, while species cover reflects how much ground area is covered by the vertical projection of the plant (Packard and Mutel 1997). Native grasses were present in significant numbers (density), but occupying much less space (cover) under the burn-graze treatments. Under both the burn and burn-graze treatments native grasses were present, but when grazing was included, native grasses were not apparent to the observer. The tallgrass prairie species were not allowed to fully express themselves when grazing was applied. This shows the importance of sampling method selection and interpretation of results. Farmers and land managers will need to carefully quantify native grass presence when grazing is applied.

Participation Summary

Educational & Outreach Activities

PARTICIPATION SUMMARY:

Education/outreach description:

Bouressa EL, Woodis JE, Cates RL, Jackson RD. Accepted pending revision. Burning and grazing cool-season grasslands to promote persistence of native, warm-season grasses. Ecological Restoration.

Bouressa EL, Woodis JE, Kummel H, Jackson RD. In press. Tradeoffs in ecosystem services using warm-season grasses in managed pastures. Center for Integrated Agricultural Systems Research Brief #78.

Project Outcomes

Project outcomes:

Project outcomes:
1. Burning and rotational grazing can be successfully combined during the first year after 2 years of grazing exclusion with burning.
2. Coexistence between warm-season and cool-season grasses was obtained using burning and grazing management.
3. Root production increased under burning and forage production increased under grazing.
4. Contributed to on-going and future research in agroecosystems, especially in the use of native, warm-season grasses in livestock production.
5. Provides a sense of farmer pride and community awareness through the restoration of native flora while maintaining a working landscape.

Economic Analysis

N/A

Farmer Adoption

This project worked closely with one farmer. Rotational grazing was already an established practice by the farmer. However, the farmer did adopt the use of prescribed burns to help promote the establishment of native grasses to their grassland pastures. Although the use of fire is well known east of the Mississippi River, it is a management tool that is seldom used in Wisconsin. The use of fire will continue on this particular farm in order to promote continued establishment throughout the landscape.

Recommendations:

Areas needing additional study

Our land management approach was to blend biodiversity, conservation efforts with agricultural, pasture production by reintroducing native, warm-season grasses into a cool-season grass pasture. The coexistence of warm-season and cool-season grasses offers many potential ecological, agronomic, and social benefits, including improved forage production, restored native species, carbon sequestration, wildlife habitat, and weed exclusion (Firn 2007). Introducing native grasses as part of the pasture community also offers flexibility to the management system (Moore et al. 2004), especially when production of cool-season grasses are low during hot summer months. One goal in the field of restoration ecology is to enhance conservation values in productive landscapes through integrating production and conservation values (Hobbs and Norton 1996). Combining burning and grazing as a management tool for native grass persistence in the eastern tallgrass prairie region may be difficult to implement initially, but is feasible with deferred grazing during the establishment phase. Further research into “rest paddocks” or rotating paddocks in and out of rotational grazing cycles to allow for spring burning and native grass recruitment is needed.