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The complex role of tall fescue in grassland ecology

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Abstract
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Keywords
Ecology Evolution and Organismal Biology, Animal management and forage, Economic and environmental impacts

Disciplines
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Abstract: Tall fescue invasion of grazing land is an increasing concern due to its association with a fungal endophyte that can produce compounds toxic to livestock and wildlife. The project compared patch-burn grazing as a management tool relative to complete pasture burning in tall fescue-invaded pastures.

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Q Can patch-burn grazing could serve as a better management tool in reducing tall fescue relative to complete pasture burning? Is the fungal endophyte associated with tall fescue detectable in the pastures and are its alkaloids detectable in the feces of the cattle that had grazed the pastures? How does the presence of tall fescue affect the litter and nutrient dynamics of the grassland, which could have implications for using fire as a management tool?

ECOLOGY

A Over a three-year period, the team compared fescue cover in patch-burn grazed pastures to that in pastures managed with a complete pasture burn every third year. They measured presence of endophyte in the tall fescue plants and ergovaline in cattle feces. They also measured plant litter and its carbon and nitrogen content during the fall of each year.

Background

Tall fescue is an exotic-invasive, cool-season grass that originated in Eurasia. Although used widely as a seeded perennial forage for beef cattle, tall fescue also has invaded about 35 million acres of land in the eastern United States where it is considered undesirable. Several beneficial traits (primarily forage yield and hardiness) are offset by negative impacts to agriculture and natural resources. Tall fescue can host a fungal endophyte (*Epichloë coenophiala*) that produces toxic ergot alkaloids which cause symptoms in beef cattle commonly known as fescue toxicosis.

Objectives of the project were to:

1) Assess the extent to which fungal endophyte infection of tall fescue communities changes over time in response to fire and grazing management and determine the frequency the occurrence of ergovaline in cattle feces in the associated pastures.

2) Quantify the extent to which patch-burn grazing management interacts with tall fescue invasion to influence native warm-season grass communities, including litter dynamics and litter nutrient retention.

Approach and methods

Among the methods employed:

- Two grazing and burning treatments that included: 1) patch-burn grazing (PBG) and 2) graze-and-burn (GAB); each treatment was replicated four times on unique pastures.
- Fescue tiller sampling for specific alkaloids that involved sampling tall fescue for endophyte infection within permanent Whittaker plots across all patch-burn graze and graze-and-burn pastures
- Cattle toxicosis sampling required assessment of fescue toxicosis of cattle by

Green River Grasslands fire

measuring ergovaline in fecal samples collected as composite fecal samples from each grazed pasture (eight total) of the two treatments that were grazed at two different time periods in the summers of 2012, 2013 and 2014.

- Assessment of litter dynamics and litter nutrient content as a function of tall fescue cover using all three treatments (patch-burn graze, graze-and-burn and burn-only pastures). There were four replications of each treatment. Burn-only pastures served as a comparison treatment because tall fescue presence is minimal in most of these pastures.

Results and discussion

The researchers compared patch-burn grazing as a management tool relative to complete pasture burning in tall fescue-invaded pastures. They found that patchy fires produced by patch-burn grazing can increase cattle utilization of endophyte-infected tall fescue patches, with no apparent negative effect on cattle, as ergovaline was never detected in feces of cattle in patch-burn pastures. Alkaloids measured in cattle feces in summer (one year since burning) in the complete burn pastures were sufficient to cause fescue toxicosis, whereas alkaloids greater than toxic levels were not observed in any year in patch-burn pastures. This result should encourage additional research because fescue toxicosis, which does not occur every year, can adversely affect the livestock enterprise in those years it occurs.

Further, the presence of tall fescue did not alter grassland litter and nutrient dynamics. Burning and grazing management were not influenced directly by variation in litter dynamics associated with tall fescue because, contrary to team expectations, the investigators found no link between tall fescue abundance and litter dynamics. The project demonstrated that patch-burn grazing can be an effective management tool for working landscapes, synergizing cattle production and conservation goals.

Conclusions

Patchy fires can be used to increase cattle utilization of endophyte-infected tall fescue in discrete patches and to overcome other utilization constraints such as topography or distance to water. This result indicates that the forage consumption in the recently burned patch is driven by fire, which overrides potential negative feedback from alkaloids or endophyte infection. However, the grassland management program that the researchers employed did not alter specific alkaloid composition or endophyte infection frequency in the tall fescue community. Based on the analyses of ergovaline in cattle feces any time fire was used, regardless of whether the fire was a patch burn or complete pasture burn, during the year of the fire cattle had no detectable levels of ergovaline. One year after fire in the GAB treatment, two herds had detectable ergovaline levels, which is sufficient evidence to encourage additional research into using prescribed burning to serve as prophylactic to fescue toxicosis. If so, prescribed burning would provide an important economic benefit to producers who graze cattle on mixed-species pastures invaded by tall fescue in the summer. This is tempered by the fact that two years after fire, cattle in the GAB treatment had no detectable ergovaline levels. These changing results after one versus two years post-burning dem-onstrate the variability in response levels, which could be a factor of both endophyte expression in the plants and differences in cattle grazing patterns.

Green River Grasslands cattle on post-fire regrowth.

Additional research at a finer scale (i.e., individual animals rather than herd composites) would be needed to further elucidate this relationship. Furthermore, the high level of cattle herbivory of infected tillers in a burn patch may force utilization in patches that have high rates of infection without any measureable cattle toxicosis as indicated by fecal ergovaline. It is possible that potential negative effects of endophyte-infected tall fescue in the study area were offset by the fact that these pastures were not tall fescue monocultures. High levels of grazing in burned patches may have resulted in a diverse diet because cattle selectively forage in the burn patch rather than selectively foraging on individual plant species.

The results also demonstrated that the years-since-fire altered litter dynamics more than differences in plant community composition. In terms of the fire return intervals used in the project, patterns of litter depth and litter cover were similar across all treatments. In patch-burn grazed pastures, cattle preferred to graze in the burned patch. The major difference between treatments was that in patch-burn grazing, one patch per pasture is burned every year, while the other patches accumulate litter. Thus, the patch-burn grazing system provides a greater diversity of litter depths during any one year than in graze-and-burn and burn-only treatments. Such a mosaic of litter depths creates habitat heterogeneity and the opportunity for refuge that likely are important for many insect and bird species.

It had been suggested that tall fescue could potentially modify fire behavior because of changes to litter moisture at the time of fire. The investigators did not assess this relationship directly, but they found only a marginally significant relationship between litter depth and fescue cover. Given that many fires occur in the spring, additional **r**esearch could provide valuable information regarding spring litter and moisture content.

Based on the results from the project, patch-burn grazing by itself may not eliminate or reduce tall fescue in these landscapes. Application of herbicide also may be necessary. However, this work illustrates that patch-burn grazing can increase cattle consumption of endophyte-infected fescue, with few apparent negative consequences. It suggests that this management strategy may provide a way to successfully synergize cattle production and conservation goals in these systems.

Future research on the effects of tall fescue on litter dynamics ideally would include sites with high fescue cover in the burn-only category; however, such grasslands are uncommon in the Grand River Grasslands because most sites with high tall fescue cover are grazed. Nevertheless, including sites with high fescue dominance in a burn-only treatment would lend important additional insight into understanding ways to manage fescue with natural disturbances like fire and/or grazing. Future research also could assess both plant and cattle responses at more frequent temporal scales. These data would enable scientists to assess the differences between within vs. among year variability in alkaloid content.

Impact of results

The project objectives were achieved. The results are relevant to Iowa agriculture because they illustrate that patch-burn grazing can increase cattle consumption of endophyte-infected fescue, with few apparent negative consequences. This management strategy may provide a way to successfully synergize cattle production

and conserva tion goals in these grassland systems. In Iowa, grassland managers, landowners, and cattle ranchers can use this information to inform their use of grazing in the context of pastures that contain tall fescue.

Education and outreach

Professional presentations:

2015

- Debinski, D.M. Working with landowners to manage and conserve tallgrass prairie biodiversity: Ecological and sociological challenges and successes. University of Michigan School of Natural Resources and Environment.
- Debinski, D.M., J.R. Miller, W. Schacht and L. Wright-Morton. Adaptive Management in Working Landscapes to Provide Habitat for Species of Greatest Conservation Need. Dunn Ranch, Eagleville, MO.
- Debinski, D.M. J.R. Miller, W. Schacht and L. Wright-Morton. Adaptive Management in Working Landscapes to Provide Habitat for Species of Greatest Conservation Need. Iowa Dept. of Natural Resources, Boone, IA.
- Debinski, D.M. Grassland management for pollinators in a working landscape: Ecological and sociological perspectives. Lakeside Laboratory, IA.
- Delaney, J. T., D. M. Debinski, R. A. Moranz, D. M. Engle, and J. R. Miller. A synthesis on insect responses to fire: Questions, concerns, implication, and future research needs. Tallgrass Prairie and Oak Savanna Regional Fire Conference, Dubuque, IA.

2014

- Debinski, D.M., J. Delaney, R. Moranz, J. Miller, D. Engle, and L. Wright Morton. Grassland management for pollinators in a working landscape: Ecological and sociological challenges and successes. In symposium on Global Grand Challenges and Opportunities in Grassland Entomology. Entomological Society of America. Portland, OR.
- Debinski, D.M. Working with landowners to manage and conserve tallgrass prairie biodiversity: Ecological and sociological challenges and successes. Grinnell College, IA.

2013

- Debinski, D.M. Working with landowners to manage and conserve tallgrass prairie biodiversity: Ecological and sociological challenges and successes. University of Colorado, Boulder, CO.
- Miller, J.R., L.W. Morton, D.M. Engle, D.M. Debinski, R.N. Harr, S.R. Rusk. Both sides now: Forging links between grassland conservation on protected areas and private lands. 98th Annual Meeting of the Ecological Society of America, Minneapolis, MN.

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