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Effects of Late-Summer Prescribed Fire on Botanical Composition, Soil Cover, and Forage Production in Caucasian Bluestem-Infested Rangeland in the Kansas Smoky Hills: Final Report

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Abstract

The old world bluestem species yellow bluestem (*Bothriochloa ischaemum*) and Caucasian bluestem (*Bothriochloa bladhii*) have been spreading rapidly through the Great Plains since their introduction in Texas for soil conservation purposes. While nonselective herbicides have been successfully employed to control the grass, the high cost of the treatment, as well as the negative effect on native species, make the advantages of herbicide use questionable. Traditional spring prescribed fire has not been a successful management tool; however, following promising results of late-summer fire application to yellow bluestem, a similar experiment was undertaken with Caucasian bluestem in the native mixed-grass prairie of Ellsworth County, Kansas. A grazed Caucasian bluestem-infested pasture was broken into 18 one-acre plots and assigned to one of three treatments: no burn (control), one burn (August 14, 2019), or two burns (August 14, 2019, and August 11, 2021). Soil cover, botanical composition, and forage biomass were recorded annually in each plot. Prescribed fire was associated with decreased old world bluestem cover ($P < 0.01$) and bare soil ($P < 0.01$), both of which may have contributed to increases in native forb cover ($P < 0.04$) and grass species richness ($P = 0.01$). Warm-season midgrasses, which include old world bluestems, had less basal cover in burned plots following fire treatment ($P = 0.04$) while fire treatment did not affect C4 tall or shortgrass cover ($P \geq 0.13$). Frequency of old world bluestem was less in plots burned twice compared with nonburned plots in year four ($P = 0.03$); however, this difference was lost in year five ($P = 0.15$), suggesting repeated fire application may be necessary to maintain low presence of the invasive species. These results suggest late-summer prescribed fire may be an effective, low-cost means of controlling old world bluestem while having positive to neutral effects on native species.

Introduction

Introduced for forage and soil-conservation properties, old world bluestems began establishing and spreading through the Great Plains to the great detriment of native flora populations. While they are grazable grasses early in the growing season, rapid rates of maturation lead to unpalatability and decreased nutrient profiles much earlier than

native warm-season grasses. Grazing, mowing, and spring burning seem to promote old world bluestem populations. When decreased cover of yellow bluestem was reported following late-summer prescribed fire treatment, our objective was to determine if similar effects could be found in Caucasian bluestem.

Experimental Procedures

The experiment took place in Ellsworth County, Kansas, on a privately owned grazed pasture with overwhelming Caucasian bluestem presence. Eighteen one-acre plots were arranged in a 9×2 block with each set of two plots randomly assigned to one of three treatments: no burn, one burn (August 14, 2019), or two burns (August 14, 2019, and August 11, 2021). Initial evaluation of soil cover, botanical composition, and forage biomass was made in July 2019, while post-fire assessments were conducted annually in July of each following year.

The ground cover and botanical composition along permanent 162-ft transects were evaluated using a modified step-point approach, while forage biomass was estimated using three randomly placed 19.7×19.7 -in. clipping frames per plot. Litter was removed from the frame and discarded. Live vegetation was clipped at a height of 0.4 in. and dried in a forced-air oven for 96 hours at 131°F. Overall forage biomass was estimated from the dry weights of the clipped material. Finally, Caucasian bluestem aerial frequency was evaluated with a 12×12 -in. frame placed at 50 points along each transect.

Results and Discussion

As expected, litter cover decreased ($P < 0.01$) following each application of fire leaving more bare soil exposed ($P < 0.01$). Litter removal allowed for increased grazing activity, lesser forage biomass, and shorter forage height in burned plots compared with nonburned plots following fire treatment ($P < 0.01$). In each year after preliminary data collection, basal plant cover did not differ between treatments ($P < 0.01$).

Total grass cover tended to differ between treatments ($P = 0.07$). Although C4 grass cover was less for burned plots each year following fire application ($P \leq 0.04$), this difference was no longer evident two or more years post-fire for either burn treatment ($P \geq 0.15$). Treatment had no effect on C4 tallgrass ($P = 0.13$) or shortgrass ($P = 0.48$) cover, but C4 midgrass cover tended to be less in plots burned twice compared to nonburned plots in both years following the second burn ($P \leq 0.06$; Figure 1). This was associated with less old world bluestem cover and frequency in year four ($P \leq 0.03$; Figures 2 and 3, respectively). Conversely, frequency and cover of Caucasian bluestem was no longer different in year five ($P \geq 0.15$; i.e., two years post-treatment), suggesting repeated application of late-summer prescribed fire may be required for management of Caucasian bluestem. Cool-season grass cover increased in fire-treated plots only in the first year following fire but was no longer different two or more years post-fire ($P < 0.01$). Treatment had no effect on native or introduced grass cover ($P \geq 0.27$). Overall, these results suggest late-summer prescribed fire has the potential to temporarily control Caucasian bluestem while not negatively affecting native vegetation.

In burned plots, total forb cover increased to exceed that of nonburned plots in years two and three; interestingly, this difference was no longer present in year four, but in year five there was greater forb cover in plots burned twice compared to nonburned plots ($P = 0.03$). There was no treatment effect among leguminous forbs ($P = 0.80$), but

the trend among all other forb sub-groups (annual, perennial, nectar-producing, introduced, and native) in burned plots was to increase drastically in year two then decrease to nonsignificant levels from control plots by year three or four ($P \leq 0.06$). Contributing to the difference in total forb cover in year five, cover of annual and native forbs was greater ($P \leq 0.04$) in plots burned twice compared to nonburned plots, and perennial forb cover tended to be greater ($P = 0.07$) in these plots, as well.

Due to fire's tendency to eliminate presence of woody species, total shrub cover decreased with fire treatment ($P < 0.01$). Basal cover was less in both burn treatments until year five when cover in plots burned once no longer differed from nonburned plots ($P = 0.35$). The same relationship was noted in increaser shrub (shrubs that increase in abundance) cover (Figure 4). There was no difference in leguminous shrub cover between treatments ($P = 0.39$).

Total species richness was positively affected by fire treatment and, after a drastic increase in burned plots following the first fire treatment, continued to remain greater for these plots throughout the experiment ($P < 0.01$). The initial spike in species richness can likely be attributed to a sizable increase in forb species richness among burned plots in year two ($P < 0.01$), while continued high values can be attributed to improved grass species richness ($P = 0.01$; Figure 5). Loss of Caucasian bluestem cover and canopy removal may have allowed more species to establish in the newly exposed soil. Fast-growing forbs likely filled in the open soil spaces until grasses were able to establish. Unsurprisingly, due to the general loss of shrub cover with fire treatment, shrub species richness decreased in burned plots following fire ($P < 0.01$).

Implications

These data are interpreted to suggest that late-summer prescribed fire application may reduce Caucasian bluestem frequency in an effective, low-cost manner while improving native grass species richness and having no overall detrimental effects on forage cover.

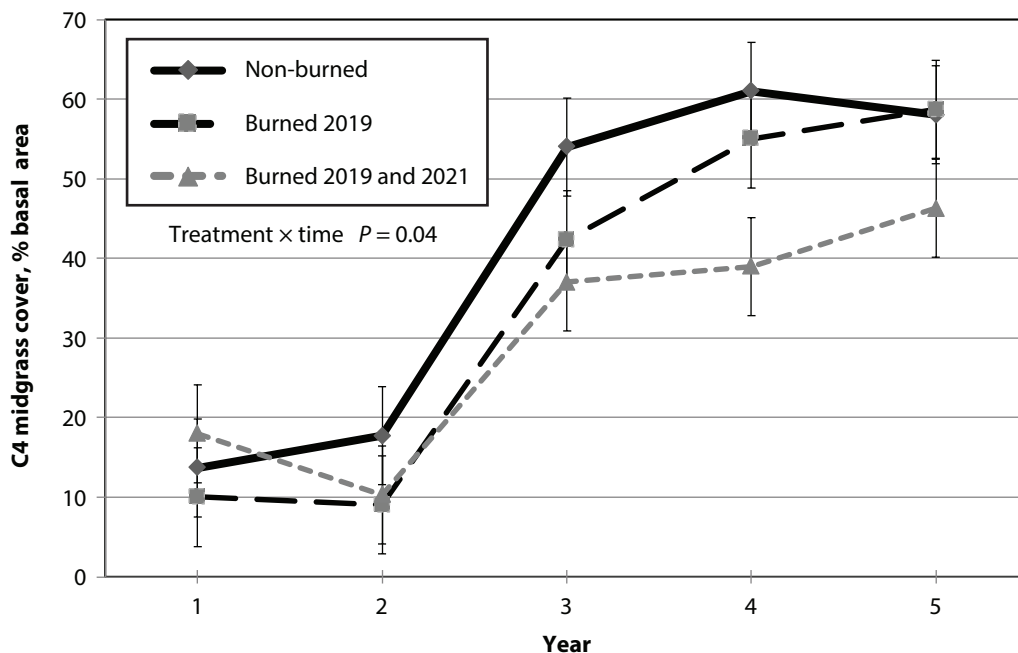


Figure 1. Effects of late summer prescribed fire on percent C4 midgrass cover

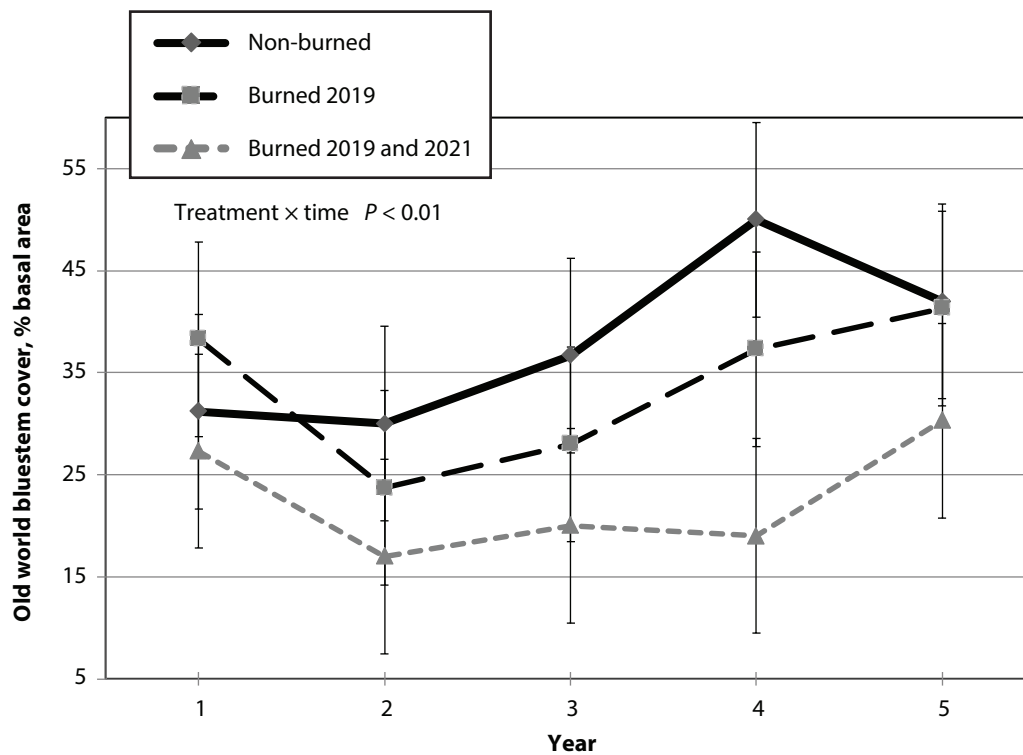


Figure 2. Effects of late summer prescribed fire on percent Caucasian bluestem cover

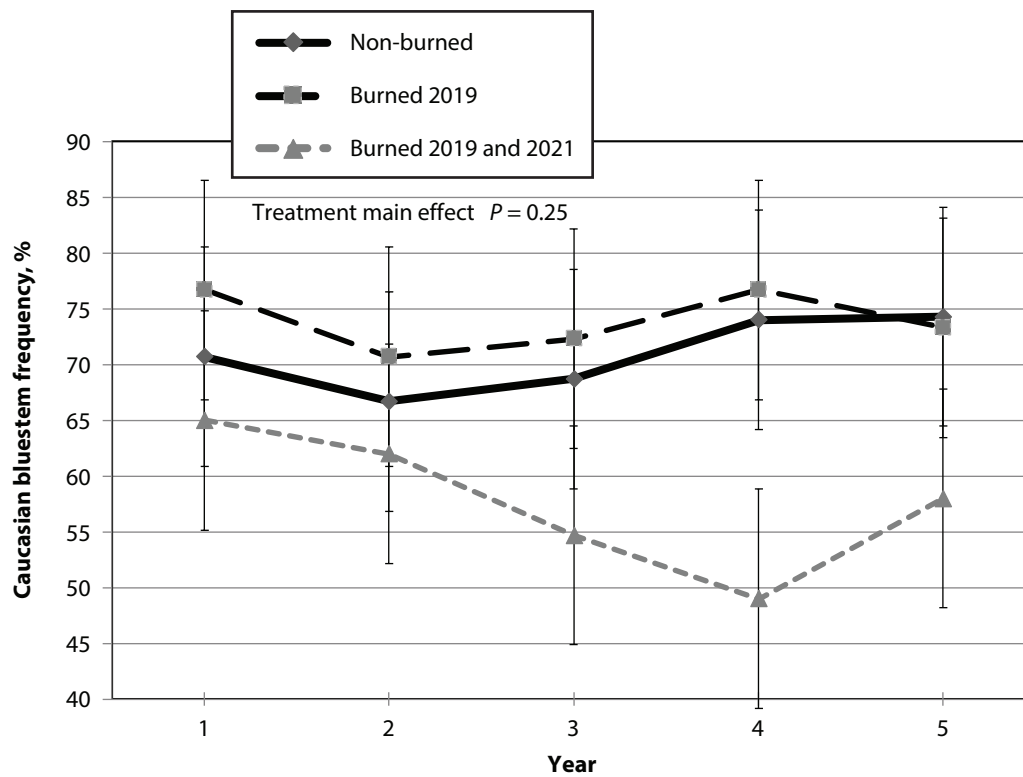


Figure 3. Effects of late summer prescribed fire on percent Caucasian bluestem frequency

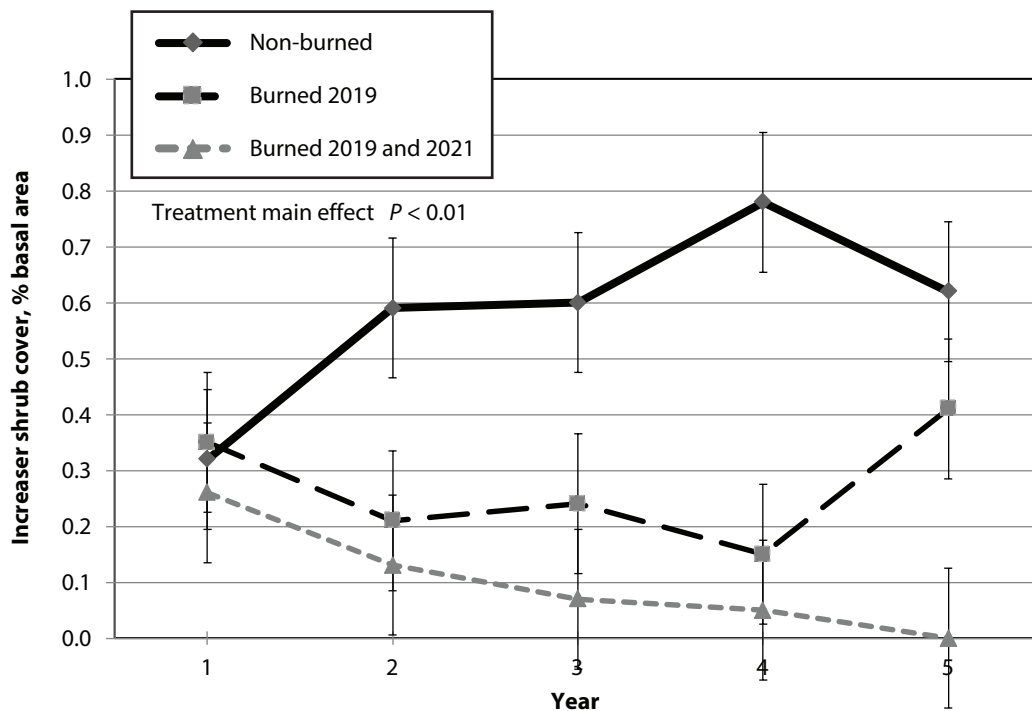


Figure 4. Effects of late summer prescribed fire on percent increaser shrub cover

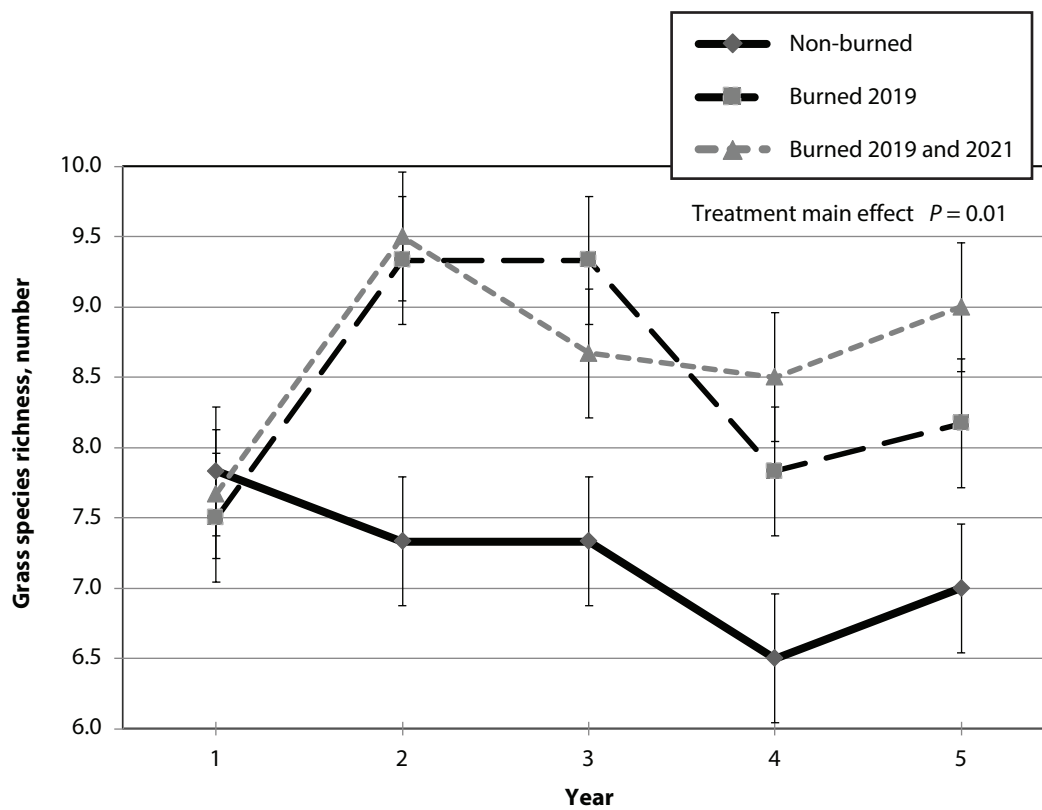


Figure 5. Effects of late summer prescribed fire on grass species richness