Long-Term Effects of April, August, or October Prescribed Fire on Yearling Stocker Cattle Performance and Native Rangeland Plant Composition in the Kansas Flint Hills

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Abstract

A six-year experiment was conducted between June 2018 and August 2023 to evaluate the effects of prescribed-fire season on stocker cattle growth performance and plant species composition in the Kansas Flint Hills. Eighteen pastures were grouped by watershed and each watershed was assigned randomly to one of three prescribed-fire treatments (n = 6 pastures per treatment): spring (April 11 ± 5.7 days), summer (August 25 ± 6.2 days), or fall (October 2 ± 9.0 days). Over five consecutive years, 1,939 yearling cattle [initial body weight (BW) = 619 ± 129.8 lb] were grazed for 90 days at a targeted density of 250 lb of live-weight per acre. Soil cover and plant species composition was measured annually beginning in June 2018 using a modified step-point technique. In addition, standing forage biomass was estimated in 2018, 2020, and 2022. Total BW gains and average daily gains were greater ($P \leq 0.03$) for calves grazing spring-burned pastures compared with calves grazing summer- or fall-burned pastures. Proportion of bare soil was greater ($P \leq 0.02$) while proportion of litter on the soil surface was lesser ($P \leq 0.01$) in the spring prescribed-fire treatment compared with the summer and fall prescribed-fire treatments. Standing forage biomass did not differ ($P = 0.58$) among fire regimes. In addition, basal cover of total grasses, native grasses, total forbs, and native forbs did not differ ($P \geq 0.24$) among prescribed-fire treatments. Conversely, basal cover of C3 grasses tended to be greater ($P = 0.06$), while basal cover of C4 grasses tended to be lesser ($P = 0.08$) in fall-burned pastures compared with spring-burned pastures. These data were interpreted to suggest that prescribed-fire timing had small influences on yearling stocker cattle growth performance and was associated with minor changes in rangeland plant composition.

Introduction

Flint Hills ranchers use spring-season prescribed fire on pastures to improve yearling stocker cattle weight gains, increase native warm-season grass production, and reduce encroachment of woody and invasive plant species. Although spring fire has been established as a standard practice in the Flint Hills community, there are challenges associated with burning during that time of the year. Strong winds and low relative humidity are common during this period and when combined with elevated fuel loads, can make fires difficult to control. When the number of days to safely conduct a burn are reduced, large amounts of rangeland are often burned when conditions allow. As a result, large volumes of smoke are produced in a relatively short period of time. Smoke produced from burning can travel to areas downwind of the Flint Hills and reduce air quality. In addition, spring-season prescribed fires do not control sericea lespedeza (*Lespedeza cuneata*). Sericea lespedeza is an invasive perennial legume that has degraded over 600,000 acres of native rangeland across the Kansas Flint Hills. Shifting prescribed-fire application from April to August or September reduced sericea lespedeza vigor and seed production in previous experiments. However, widespread adoption of growing season prescribed fires in the Flint Hills have been limited because burning pastures later in the year could have unknown major effects on the growth performance of stocker cattle during the next grazing season. The objective of our experiment was to determine if prescribed fire applied in April, August, or October influenced stocker cattle growth performance, plant community characteristics, or standing forage biomass accumulation in the Kansas Flint Hills over a 6-year period.

Experimental Procedures

A 6-year experiment was conducted at the Kansas State University Beef Stocker Unit from June 2018 to August 2023. Eighteen pastures were grouped by watershed and each watershed was assigned randomly to one of three prescribed-fire treatments (n = 6 pastures per treatment): spring (April 11 ± 5.7 days), summer (August 25 ± 6.2 days), or fall (October 2 ± 9.0 days). All burn treatments were applied prior to grazing in years 1, 2, 3, and 5 of the experiment; however, burn treatments were not applied in year 4 due to unfavorable burn conditions. At the start of the experiment, a permanent 328-ft transect was established within each pasture. Soil cover and plant species composition were measured alongside each transect using a modified step-point method. Pre-treatment measurements were recorded in June 2018 and annually in June thereafter. Standing forage biomass was determined in 2018, 2020, and 2022 by clipping vegetation within ten 0.82-ft^2 frames randomly placed at 33-ft intervals along each transect. After frames were placed, litter from the previous growing season was removed and all remaining plant material was clipped at a height of 0.39-in above the soil and dried in a forced-air oven (122°F; 96 hours).

A total of 1,939 yearling cattle [initial body weight (BW) = 619 ± 129.8 lb] were grazed over five consecutive growing seasons beginning in 2019. Calves were grazed for 90 days at a targeted density of 250 lb of live-weight per acre. Upon arrival, calves were held in earth-floor pens and limit-fed a growing diet until the start of the grazing season. Prior to grazing, calves were individually weighed and randomly assigned to one of 18 pastures. On the day grazing began, calves were individually weighed, treated for internal and external parasites, and allocated to their assigned pastures. Based on cattle availability, heifers were grazed in year 1 and steers were grazed in years 2 to 5. Steers received a growth-promoting implant. At the completion of the 90-day grazing period, calves were gathered and individual BW were immediately measured.

Results and Discussion

After five consecutive grazing seasons, total body weight gains (TBW) and average daily gains (ADG) were greater ($P \leq 0.03$; Table 1) for calves grazing spring-burned pastures compared with those grazing summer- or fall-burned pastures; however, TBW and ADG did not differ ($P = 0.55$) between calves grazing summer- or fall-burned pastures.

As a result, TBW at the end of the 90-day grazing season were 10 and 14 lb lower for calves grazing summer- and fall-burned pastures compared with calves grazing spring-burned pastures, respectively. Differences in growth performance among prescribed-fire treatments may have been associated with differences in diet quality. Proportions of litter on the soil surface were greatest ($P \leq 0.04$; Table 2) in summer-burned pastures, intermediate ($P \leq 0.04$) in fall-burned pastures, and least ($P \leq 0.01$) in spring-burned pastures. Calves grazing summer- or fall-burned pastures may have consumed lesser quality regrowth from the previous growing season which could have contributed to reduced growth performance.

Proportions of bare soil were greater ($P \leq 0.02$) in spring-burned pastures compared with summer- and fall-burned pastures. Soil cover was measured annually in June; therefore, as the length of time between fire application and sampling increased, proportions of bare soil decreased while proportions of litter on the soil surface increased. Basal vegetation cover did not differ ($P = 0.19$) among prescribed-fire treatments and accounted for 12 to 13.3% of total area. Similarly, standing forage biomass accumulation did not differ ($P = 0.58$) among treatments.

Basal cover of total grasses and native grasses did not differ ($P \geq 0.24$) among prescribed-fire treatments; however, prescribed-fire timing tended to influence the relative basal cover of cool- and warm-season grasses. Basal cover of C3 grasses tended to be greater ($P = 0.06$) in fall-burned pastures, intermediate in summer-burned pastures, and least in spring-burned pastures. The trend in increased basal cover of C3 grasses may have been associated with differences in basal cover of sedges and Kentucky bluegrass. Basal cover of sedges was numerically greater in fall- and summer-burned pastures compared with spring-burned pastures. In addition, basal cover of Kentucky bluegrass was greater ($P < 0.01$) in the fall prescribed-fire treatment compared with the spring prescribed-fire treatment, whereas basal cover of Kentucky bluegrass in the summer prescribed-fire treatment was intermediate to and not different ($P \geq 0.11$) from the spring- or fall-prescribed-fire treatments. Conversely, basal cover of C4 grasses tended ($P = 0.08$) to be greatest in the spring-fire treatment, intermediate in the summer-fire treatment, and least in the fall-fire treatment. Basal cover of C4 tallgrasses did not differ ($P = 0.35$) among prescribed-fire treatments; however, basal cover of C4 mid- and short-grasses was greater ($P \leq 0.02$) in spring-burned pastures compared with summer- or fall-burned pastures. Increased basal cover of C4 mid- and short-grasses in spring-burned pastures likely contributed to the overall trend in increased basal cover of total C4 grasses.

Basal cover of total forbs and native forbs did not differ ($P \geq 0.43$) among spring, summer, or fall prescribed-fire treatments; however, basal cover of nectar producing forbs was greater ($P \geq 0.03$) in fall-burned pastures compared with spring- and summer-burned pastures. Increased basal cover of nectar producing forbs could have potential benefits to grassland-obligate invertebrates and the native birds that feed upon them. Conversely, basal cover of total shrubs tended ($P = 0.06$) to be greater in pastures burned in the summer and fall compared with pastures burned in the spring. The trend in increased basal cover of shrubs for the fall and summer prescribed-fire treatments was largely driven by numerical increases in basal cover of leadplant and New Jersey tea compared with the spring prescribed-fire treatment. In addition, basal cover of increaser shrubs (i.e., shrubs that tend to proliferate in response to grazing) tended ($P \leq 0.08$)

to be greater in summer and fall prescribed-fire treatments compared with the spring prescribed-fire treatment. Although increaser shrubs tended to increase with summer and fall fire, basal cover of increaser shrubs in our experiment was low and represented less than 0.25% of total basal cover.

Implications

Shifting prescribed fire from April to August or October reduced yearling stocker cattle weight gains by 10 to 14 lb during a 90-day grazing season and was associated with small but benign changes in rangeland plant composition in the Kansas Flint Hills. When developing a plan to manage sericea lespedeza infestations, ranchers are encouraged to consider the cost associated with herbicides versus the costs associated with any reduction in growth performance.

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Table 1. Effects of prescribed-fire timing on stocker cattle growth performance in the Kansas Flint Hills

	Prescribed fire season			Standard error of	
Item	Spring	Summer	Fall	the mean[1]	*P*-value
Initial BW, lb[2]	633	639	629	5.6	0.23
Final BW, lb	847[a]	842[a]	828[b]	5.5	0.01
Total BW gain, lb	213[a]	202[b]	199[b]	4.6	0.02
Average daily gain, lb/day	2.37[a]	2.24[b]	2.21[b]	0.052	0.02

[1]Mixed-model standard error of the mean (SEM) associated with comparison of treatment main-effect means.
[2]Body weight.
[a,b]Within rows, means with unlike superscripts differ ($P \leq 0.05$).

Table 2. Effects of prescribed-fire timing on forage biomass accumulation, soil cover, and plant species composition in the Kansas Flint Hills

Item	Prescribed-fire season			Standard error of the mean[1]	*P*-value
	Spring	Summer	Fall		
Forage biomass, lb/a	1756	1919	1972	220.7	0.58
Soil cover, % of total area					
Bare soil	66.0[a]	55.7[b]	59.8[b]	2.40	< 0.01
Litter cover	20.7[c]	32.3[a]	27.2[b]	2.33	< 0.01
Total basal vegetation cover	13.3	12.0	13.0	0.70	0.19
Basal cover, % of total basal vegetation cover					
Total grass cover	89.4	89.3	85.8	2.53	0.30
Native grass species	85.0	85.2	80.0	3.41	0.24
C3 grasses	19.2[z]	26.1[yz]	27.2[y]	3.44	0.06
Sedges	13.9	19.6	16.3	2.80	0.15
Kentucky bluegrass	2.0[a]	4.1[ab]	5.8[a]	1.25	0.02
C4 grasses	70.1[y]	63.2[yz]	58.7[z]	4.79	0.08
Tallgrasses	33.8	37.3	35.1	2.37	0.35
Mid-grasses	33.1[a]	25.0[b]	22.3[b]	3.73	0.02
Short-grasses	3.1[a]	0.8[b]	1.2[b]	0.83	0.03
Total forb cover	9.97	9.79	12.53	2.517	0.49
Native forb species	9.81	9.72	12.52	2.401	0.43
Nectar-producing forbs	1.54[b]	1.82[b]	2.71[a]	0.381	0.02
Total shrub cover	0.50[z]	1.20[y]	1.58[y]	0.438	0.06
Increaser shrubs[2]	0.02[z]	0.12[y]	0.24[y]	0.092	0.08

[1] Mixed-model standard error of the mean (SEM) associated with comparison of treatment main-effect means.
[2] Shrubs that tend to proliferate in response to grazing.
[a,b] Within rows, means with unlike superscripts differ ($P \leq 0.05$).
[y,z] Within rows, means with unlike superscripts tend to differ ($P \leq 0.10$).