Response of Old World and Little Bluestem to a Spring Prescribed Fire

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Story in Brief

Ten plots each of Old World and little bluestem were spring burned or not burned to determine if an introduced and a native grass differed in response to fire. Although taxonomically related bunchgrasses, they have continentally separated origins (Old vs New World) and different selection histories. Following burning in April, clipped samples were harvested 12 times from May to September to estimate production of total herbage, either grass, other grasses, or forbs, along with phenological stage (to estimate maturity) and percentage leaf or stem. Burning reduced production of total herbage, other grass species, and forbs for 40 d post-fire; whereas, burning did not alter production of total herbage, or other grass species by the end of the growing season. Burning increased production of both grasses at the completion of the growing season. Burning Old World bluestem eliminated forbs during the trial, whereas unburned plots contained forbs at 40 d post-fire. Burning did not alter maturity, or percentage leaf or stem. Old World and little bluestem responded similarly to fire, as burning increased productivity of both grasses, and maturity and percentage leaf or stem were similar in both grasses. This indicates that selection history of these two grasses has not influenced their response to spring burning, suggesting that prescribed fire can be an efficacious management tool for Old World bluestem.

Key Words: Burning, Grasses, Production, Phenology

Introduction

Old World bluestem is a highly productive, introduced grass species with the common perception that it can become unpalatable, as a result of the high proportion of stem produced during the growing season (McCoy et al., 1992). Old World bluestem declines in nutritive value as it matures (Dabo et al., 1987). This can result in a large quantity of unpalatable residual forage following the growing season that must be managed. One option to manage this residual standing crop is prescribed fire (McCoy et al., 1992). Land managers have used prescribed fire on range sites and pastures as a management tool to increase forage production, palatability, and nutritive value (Mitchell et al., 1997), all of which have been linked to livestock performance. If the use of prescribed fire negatively affected any of these factors, reductions in livestock performance could occur. We designed this study to investigate the differences in response of herbage production, maturity, and percentage stem and leaf, to prescribed fire by two taxonomically related, phenotypically unique, bunchgrasses in two diverse systems.

Materials and Methods

Design, Treatments, and Plots. We designed this experiment as a replicated (n=5) completely randomized design with a 2 × 2 factorial arrangement of treatments. Two Poaceae Andropogoneae grasses in their respective grassland communities were subjected to a spring burn, or were left unburned. Grasses investigated were Plains Old World bluestem ([OWB], *Bothriochloa ischaemum* [L.] Keng) in an existing pasture and little bluestem ([LB], *Schizachyrium scoparium* [Michx.] Nash) in a native tallgrass prairie pasture. The burning treatments were: 1) NBRN, a control consisting of no treatment; and 2) BURN, an application of prescribed fire on April 4, 2000. Prescribed fire removed all residual forage mass, whereas unburned plots did not have any residual material removed. Native tallgrass prairie plots containing LB were not grazed, sprayed with pesticide, or fertilized during the current growing season, or for several years prior to the trial. These plots had not been burned for the 2 yr prior to the trial, but they had been burned every 3 to 5 yr previously. The OWB plots had not been burned, but had been grazed, sprayed (Grazon P+D), and fertilized (60 kg of N/ha) for several years prior to the trial, but were not grazed, sprayed, or fertilized during the trial. We conducted this experiment using 10 native tallgrass prairie plots that contained LB at a native tallgrass prairie site on the OSU Research Range and 10 plots that were predominately OWB in a pasture of Plains OWB at the OSU Bluestem Research Range. Native tallgrass prairie at this site has predominate grass species of LB, big bluestem (*Andropogon gerardii* Vitman), indiangrass (*Sorghastrum nutans* [L.] Nash), and switchgrass (*Panicum virgatum* L.). Dominant forbs are western ragweed (*Ambrosia psilostachya* DC) and sericea lespedeza (*Lespedeza cuneata*). Major grass species found in the OWB plots are Plains OWB and downy brome (*Bromus tectorum*). The two plot sites are located 22 km southwest of Stillwater, OK, and are separated by approximately 100 m. Five plots of each specie were randomly assigned to either NBRN or BURN and were separated by 3-m alleyways. The OSU Research Range Fire Crew burned all plots within 1 h using headfires on April 4, 2000, in an attempt to minimize differences in fire intensity and behavior throughout each plot, as well as among plots. Climatic conditions at the time of the burn consisted of an 11 km/h southwest wind, ambient air temperature of 18ºC, and 39% relative humidity.

Sampling Procedures. We collected samples approximately every 7 d during May and the first 2 wk of June, approximately every 17 d for the remainder of June and July, and every 29 d during August and September. Therefore, sampling occurred from each plot five times in May, three times in June, twice in July and once each in August and September, for a total of 12 sampling periods. We determined above-ground net primary production (ANPP) of the entire community, each bluestem specie, grasses other than OWB or LB, and forbs from 20 clipped (ground-level) .1 m^2 quadrats at each sampling date. Clipped samples were separated into live and dead fractions, and the live fraction was separated into OWB or LB, other grasses, and forb fractions. All fractions were dried in a forced-air oven for 48 h at 55°C and weighed. At each sampling date an OWB or LB plant located approximately 10 cm from the clipped site was selected for harvesting of five randomly chosen tillers at ground level. We staged and separated these tillers phenologically using the mean stage count (MSC) method described by Moore et al. (1991). Staged and separated tillers were further divided into leaf and stem fractions by removing the leaf blade and sheath portions from the stem material. Seed head portions were included in the stem fraction following their appearance from the boot and all fractions were dried in a forced-air oven for 48 h at 55°C and weighed.

Statistical Analysis. We analyzed all variables as a replicated (n=5) completely randomized design with a 2 × 2 factorial arrangement of treatments using PROC GLM (SAS Inst. Inc., Cary, NC). Linear and quadratic regression analyses were performed by regressing the variable of interest on days after the burn event. Effects included in the regression models were determined by using model selection techniques and included burning treatment, grass specie, days following burning, days following burning squared, all two-way combinations, and the three-way combinations between either days after burning or days after burning squared with grass type and fire treatment. Means were calculated using LSMEANS and predicted values were generated at four dates (40, 80, 120, and 160 d post-fire), separating the summer growing season into four quarters representing: early season growth (d 40), the rapid growth phase (d 80), peak production (120), and total season accumulation (d 160). The values generated for each variable at each date were separated by least significant difference when a significant (P<.05) F-test was observed.

Results and Discussion

Weather patterns provided favorable growing conditions for the majority of the trial. However, the last observed rainfall during the growing season occurred on July 29 (d 116). The next rain event of greater than 2.5 mm occurred on October 15. Between July 29 and October 15, five rainfalls occurred totaling 5.3 mm of precipitation.

Above-ground Net Primary Production. At 40 d post-burning, prescribed fire decreased (P<.01) ANPP of total herbage, primarily as a result of the reduction in other grass species and forbs that occurred as a result of burning (Table 1). Prescribed fire did not alter (P>.61) ANPP of total herbage on d 80 or 160, while it increased (P<.01) on d 120. This indicates that both communities responded similarly to prescribed fire, and that while prescribed fire appeared to reduce the production early in the growing season, burning either did not affect production, or was favorable, over the remainder of the growing season. This agrees with Bidwell et al. (1990) who reported no effect or a reduction in total standing crop of tallgrass prairie sites over 2 yr in mid-summer, and also reported no change in late-summer forage production. Both communities increased production quadratically (P<.01) as the summer growing season progressed. At d 40, both communities had similar (P>.93) ANPP of total herbage, with greater (P<.01) amounts recorded in the OWB plots for the remainder of the growing season (80, 120, and 160 d). We observed similar quantities of herbage production in OWB plots as Dabo et al. (1987). However, production of forage in OWB plots was greater in the current study than that observed by Berg (1993) and may be a result of differences in soil type, precipitation patterns, environmental factors, fertilization, or previous management. The production of total herbage in LB plots in our study was similar to amounts observed by other researchers studying native tallgrass prairie (Towne and Owensby, 1984).

Prescribed fire did not affect (P>.29) ANPP of either OWB or LB at 40 and 80 d post-burning (Table 1). However, the ANPP of both species was increased (P<.07) at 120 and 160 d as a result of burning. This is similar to the observations of Bidwell et al. (1990), who found that fire did not alter standing crop of LB in the early- to mid-summer. However, it does not agree with their finding that burning also had no effect on late-summer productivity of LB. Possible explanations for this difference include grazing management (we did not have previous grazing pressure), and climatological factors (we observed considerably above average rainfall in June and July). The results of the current study are also similar to those reported by other workers for total production of LB (Towne and Owensby, 1984). However, we did not detect any reduction in ANPP of OWB as a result of burning, which differs from the results of Berg (1993). We believe that the differences between these studies are a result of different responses of soil moisture to soil type and climatological factors following the prescribed fire event. As the growing season progressed, both OWB and LB increased quadratically (*P*<.01).

Table 1. Above-ground Net Primary Production (kg/ha) of mixed species plots containing little bluestem (LB) or Old World bluestem (OWB) at four time points over the summer growing season following no treatment (NBRN) or application of prescribed fire (BURN) on April 4, 2000

		ANPP of total plot herbage, kg/ha					ANPP of LB or OWB, kg/ha				
		Days after burning[1]					Days after burning[1]				
Grass	Fire	40	80	120	160	SE[2]	40	80	120	160	SE[2]
LB	NBRN	2401	4144	5026	4282	1.1	333	717	1025	975	1.2
LB	BURN	1475	4298	6004	4020	1.1	300	776	1334	1527	1.2
OWB	NBRN	2386	5875	10,163	12,353	1.1	1096	4929	10,163	9609	1.2
OWB	BURN	1475	6130	12,213	11,666	1.1	961	5197	12,878	14,634	1.2
	Effect[4]	B	G	B, G	G		G	G	B, G	B, G	

		ANPP of other grasses, kg/ha						ANPP of forbs, kg/ha					
Grass	Fire	40	80	120	160	SE[2]	Q,L[3]	40	80	120	160	SE[2]	Q,L[3]
LB	NBRN	500	955	1329	1347	1.7	L	1255	2107	2311	1657	1.4	Q
LB	BURN	408	729	947	897	1.7	L	641	2492	1754	223	1.4	Q
OWB	NBRN	845	90	6	0	1.7	L	47	0	0	0	1.4	Q
OWB	BURN	101	31	6	0	1.7	L	0	0	0	0	1.4	Q
	Effect[4]	B*G	B*G	G	G			B, G	G	G	B, G		

[1]Increasing days after burning resulted in a quadratic effect (*P*<.05) for Total and OWB or LB ANPP

[2]SE = Standard error of the means

[3]Q = quadratic, or L = linear, (*P*<.05) effect with increasing days after burning

[4] Effect within column of burning treatment = B, or grass species = G, (*P*<.05), B*G = burning decreased (*P*<.01) other grasses in OWB plots, but did not alter (*P*>.43) production of other grasses in LB plots

Fire reduced (*P*<.04) ANPP of other grasses in both grasses at 40 d after the fire, yet had no effect (*P*>.29) in the second half of the summer (d 120 and 160; Table 1). From d 80 through 160 after the burn, the ANPP of other grasses in LB plots was unaffected (*P*>.29) by fire. We detected a linear increase (*P*<.01) in the production of other grass species in LB plots as the summer progressed from d 40 to 160 for both burned and unburned LB plots. The contribution of other grasses to total ANPP of OWB plots was <2% after d 40, as other grasses were virtually absent from both burned and unburned OWB plots on d 120 and 160 with >75% of the OWB plots having no other grasses after mid-June. These differences are related to the species of the other grasses. In OWB plots, other grass species were predominately downy brome, a cool season annual that rapidly matures, dies out, and is separated and removed in the dead fraction. In comparison, other grasses in LB plots include big bluestem (*Andropogon gerardii* Vitman), indiangrass (*Sorghastrum nutans* [L.] Nash), and switchgrass (*Panicum virgatum* L.), warm-season grasses that contribute a great deal of productive capacity to these sites and whose growth would be expected to continue to increase as the summer progressed.

At 40 d following the burn, plots of LB that had been burned had reduced (*P*<.01) ANPP of forbs when compared with unburned plots (Table 1). Burning tended to increase (*P*<.07) forb

ANPP in LB plots at d 80 and 120, with no effect (*P*>.14) on d 160. Our observations support Bidwell et al. (1990), who reported no effect of fire on forb standing crop in either mid- or late-summer. However, Towne and Owensby (1984) observed a reduction in forb production as a result of burning native tallgrass prairie plots, which agrees with our early season findings, but does not support our late-summer results, which may be related to different fire histories at the two locations. Forbs were not observed in OWB plots in any month other than May, resulting in a low occurrence (> 83% of OWB plots had 0 kg/ha) of forbs in OWB plots. Burning eliminated forbs from almost all OWB plots (only 1 burned OWB plot had forbs present). As the summer growing season progressed, ANPP of forbs in LB plots increased quadratically (*P*<.01).

Phenological Stage. There was no effect (*P*>.60) of prescribed fire on MSC, as MSC did not differ (*P*>.49) between burned and unburned plants at any of the days after burning (Table 2). This agrees with the data reported by Schacht et al. (1998) who found similar response curves for MSC of burned and unburned LB from May through August over 2 yr. As the growing season progressed, MSC was greater (*P*<.01) for OWB than for LB, agreeing with producer perceptions that OWB is a rapidly maturing forage that has a large proportion of stem (McCoy et al., 1992). However, the rate of increase in MSC was similar between OWB and LB. This suggests that many of the common perceptions about how fast OWB matures may be related to a rapid rate of maturity in the first 40 d of growth, especially when compared to the later maturing native grasses, such as LB. The maturity of LB is similar to the MSC values reported by Mitchell et al. (1997) for big bluestem and switchgrass at similar times of the growing season.

Percentage Leaf and Stem. Prescribed fire did not change (*P*>.51) the percentage of leaf or stem as both percentage leaf and stem were similar (*P*>.44) for all sampling days (Table 2). The two grasses exhibited different (*P*<.02) responses to increasing days after burning, as the percentage leaf was lesser (*P*<.01) and stem was greater (*P*<.01) for OWB vs LB at all days. This supports the notion that OWB is a more rapidly maturing grass, with a greater proportion of stem than LB. However, both LB and OWB exhibited quadratic declines (*P*<.01) in percentage leaf and quadratic increases (*P*<.01) in stem with the progression of the growing season. Our findings agree with those of Dabo et al. (1987), who reported similar changes in percentage leaf and stem for OWB.

Table 2. Percentage leaf or stem and maturity, as determined by mean stage count, of mixed species plots containing little bluestem (LB) or Old World bluestem (OWB) at four time points over the summer growing season following no treatment (NBRN) or application of prescribed fire (BURN) on April 4, 2000

		Percentage leaf						Percentage stem					
		Days after burning						Days after burning					
Grass	Fire	40	80	120	160	SEM[1]	Q,L[2]	40	80	120	160	SEM[1]	Q,L[2]
LB	NBRN	100	91	71	43	3.0	Q	0	9	29	57	3.0	Q
LB	BURN	100	89	69	43	3.0	Q	0	11	31	57	3.0	Q
OWB	NBRN	92	55	37	38	3.0	Q	8	45	63	62	3.0	Q
OWB	BURN	92	55	37	40	3.0	Q	8	45	63	60	3.0	Q
	Effect[3]	G	G	G	NS			G	G	G	NS		
		Mean stage count, (MSC)											
Grass	Fire	40	80	120	160	SEM[1]	Q,L[2]						
LB	NBRN	1.4	1.8	2.9	4.6	0.1	Q						
LB	BURN	1.4	1.8	2.9	4.6	0.1	Q						

OWB	NBRN	1.8	3.2	4.1	4.7	0.1	Q
OWB	BURN	1.8	3.3	4.2	4.7	0.1	Q
	Effect[3]	G	G	G	NS		

[1]SEM = Standard error of the means

[2]Q = quadratic, or L = linear, (P<.05) effect with increasing days after burning

[3]G = effect of grass species, (P<.05), NS = not significant (P>.24) within a column

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