Patch-burning on tall-grass native prairie does not negatively impact stocker performance or negatively impact pasture composition

J. K. Farney, C. B. Rensink, W. H. Fick, D. Shoup, and G. A. Miliken

Abstract

The purpose of this study was to determine stocker weight gain on patch-burned native tall-grass prairie while also determining plant species influenced by fire. The study was conducted in a split-block experimental design where treatments consisted of a yearly spring burn on the pastures (CON) or patch-burning of 1/3 pasture per year (PB). Stocker steers grazed the pastures using a three-quarter season (~114 d) grazing period from about mid-April to mid-August from the years 2006-2012. Steer ADG, final weight, and total weight gain was not different by treatment ($P > 0.35$). However, when comparing treatment effects with precipitation classification (HIGH, AVE, LOW) cattle on PB had a greater ADG ($P = 0.02$; 0.22 lb/d), final weight ($P = 0.07$, 26.5 lb), and total weight gain ($P = 0.02$; 26.1 lb) in LOW precipitation years (2011 and 2012). Overall patch -burning provides similar weight gains as yearly burning on native tall-grass prairie, while providing a weight gain advantage in low precipitation years. Switchgrass (*Panicum virgatum*) declined ($P < 0.05$) on CON treatment, while other perennial grasses increased. Annual grasses, including hairy crabgrass (*Digitaria sanquinalis*) and yellow foxtail (*Setaria pumila*) increased ($P < 0.05$) under PB. Botanical composition shifts were similar on patch-burn pastures and full-burn pastures with the exception of increasing annual grasses with patch-burning.

Introduction

Burning tallgrass prairie is an effective and widely used management tool to improve weight gains and manipulate grazing distribution of cattle on native range. Traditional singe fire and intensive grazing systems are commonly accepted management practices for cattle producers across the nation, and especially in the Flint Hills (Fuhlendorf and Engle, 2001; Hamilton, 2007). Patch-burning has been discussed as a management practice for pasture control, cattle gains, and natural resource conservation. Numerous benefits have been associated with patch-burn grazing; however the system has been promoted primarily as a way to increase biodiversity, heterogeneity, and wildlife habitat (Fuhlendorf et al., 2006; Bidwell et al., 2009; NPS 2009). Patch-burning has been theorized to mimic the historical patterns of lightening and the American bison results in a management unit with a shifting mosaic of grazing distribution (Weir et al., 2007). Since cattle production is a large component of the tall-grass prairie environment, quantifying cattle performance with patch-burning was an objective of this study.

Experimental Procedures

The Bressner unit was divided into 8 individual pastures (approximately 78 ac each) in which 4 pastures were assigned to be burned yearly (CON) and 4 pastures were assigned to the patch-burn treatment (PB) for the years of 2006-2012. For the PB pastures, each 1/3 patch of the pasture was burned once in every 3-year cycle. Therefore, in each PB pasture cattle had access to 1/3 pasture that was burned within the year, 1/3 burned the prior year, and 1/3 that had not been burned for 2 years.

Cattle were weighed individually using electronic scales (Tru-Test Incorporated, Mineral Wells, Texas) at the start and end of the grazing period. Steers were randomly assigned to treatment using a pre-determined sort order through the chute, which resulted in similar beginning weights for all steers within pasture. Cattle had free access to the entire pasture and were allowed to graze from mid-April to mid-August. Cattle on the patch burn pastures (n=773 over the 7 years, average initial weight = 523.92 lb ± 3.05 lb) were stocked at 2.8 ac/hd and cattle on the control pastures (n=724 over the 7 years average initial weight = 523.00 lb ± 3.57 lb) were stocked at 3.0 ac/hd for a ¾ grazing season.

Results and Discussion

There was a treatment by precipitation classification interaction for ADG, final weight, and total weight gain ($P < 0.05$) where differences in weight gains were observed in LOW precipitation years. In LOW precipitation years (2011 and 2012), steers on PB pastures had a 0.24 lb/d greater ADG ($P = 0.02$, Table 1) than steers on CON pastures. This ADG advantage tended to result in heavier final weight ($P = 0.07$; 26 lb) and increased total weight gain ($P = 0.02$; 26 lb) for PB cattle in LOW precipitation years (Table 1). A speculated reason why the PB steers had a greater ADG was biomass availability. A common observation from the droughts in the 1980s and early 2010s is lowered biomass in pasture land (summarized by Kellner and Niyogi, 2014). Even though biomass was not measured in the current study, a logical conclusion was biomass production was a limiting factor for CON cattle weight gains. In

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Table 1: Comparison of treatment means for each level of precipitation for initial BW, final BW, total BW gain, and ADG

Prec Class[1]	CON[2]	PB[3]	SEM[4]	P-value[5]
	Initial weight (lb)			
LOW	591	591	7.3	0.98
MED	547	546	5.5	0.85
HIGH	549	550	6.2	0.89
	Final weight (lb)			
LOW	844	870	13.2	0.07
MED	855	852	11.2	0.77
HIGH	804	803	12.3	0.92
	Total weight gain (lb)			
LOW	251	277	10.4	0.02
MED	308	306	8.4	0.78
HIGH	255	253	9.5	0.82
	ADG (lb/d)			
LOW	2.16	2.38	0.1	0.02
MED	2.69	2.67	0.1	0.78
HIGH	2.23	2.23	0.1	0.82

[1] Prec Class: Precipitation classifications for LOW (years 2011 and 2012), MED (years 2006, 2009, and 2010), and HIGH (years 2007 and 2008).
[2] CON: control pastures burned yearly
[3] PB: patch-burned pastures where 1/3 of pasture was burned yearly on a rotation
[4] SEM: standard error or means
[5] P-value: Comparison of means within precipitation classification and treatment

the CON pastures the DM availability consisted of the forage that grew post fire, which was speculated to be limited due to rainfall.

Fire has been found to improve livestock weight gains in a wide variety of environments (Launchbaugh and Owensby, 1978; Hilman and Hughes, 1965, McGinty et al., 1983; Angell et al., 1986; Svejcar, 1989). Quality and quantity of forage impact cattle performance and fire and environment (temperature and moisture) can alter quality and quantity of forage. Even though PB pastures as a whole have a lower crude protein than pastures that were entirely burned, due to a portion of the pasture not being touched by fire in that given year (Allred et al., 2011), there are still areas of the pasture that have high crude protein that help with cattle performance. Cattle prefer to graze in areas that have been recently burned (Vermeire et al., 2004), where the highest quality forage is located. In the instance of severe drought in 2011 and 2012, it is hypothesized that cattle in the PB pastures would consume all the vegetation within the burned section which should have similar nutritional composition as CON pastures and thus similar ADG until that forage is completely consumed. After this high-quality forage is depleted the cattle begin consuming the non-burned portions of the pasture which provide DM for the cattle, which might be limiting in the pastures that were entirely burned. This effect was recorded in Tennessee where once the burned patch failed to provide sufficient forage, cattle consumed the unburned portion of the pasture and maintained condition (McGranahan et al., 2014). These authors refer to this as developing a "grass-bank" in patch-burning management.

Plant composition

Major grass species were relatively stable with some year-to-year fluctuation on CON pastures (Table 2). Big bluestem tended to decline in 2009 and 2010 compared to 2006 ($P < 0.10$), but recovered by the end of the study. Other perennial grasses tended to increase ($P < 0.10$) in 2010 and 2012 (Table 2) when switchgrass was declining ($P < 0.05$). Brazle et al. (1999) in a study done at the same location from 1990 to 1998 found that big bluestem, Indiangrass, and switchgrass all increased under a full-burn treatment. Annual grasses, including hairy crabgrass, yellow foxtail, and switchgrass (*Panicum capillare*) were generally less than 10% of the botanical composition except in 2009, a year following a wet summer.

After two PB cycles, botanical composition shifts were similar on PB pastures and CON pastures (Table 3). The only difference was the increase ($P < 0.05$) in annual grasses on the PB units. In other studies forbs have increased dramatically within recently burned and grazed patches (Hamilton, 2007).

Big bluestem decreased ($P < 0.05$) 1-year post-burn (Table 4), but stabilized thereafter. Little bluestem and Indiangrass tended to decrease ($P < 0.10$) the year of burn compared to the previous year. Similar to CON

Table 2. Average percent plant composition ± SE during 2006 to 2012 on Bressner Pastures (full burn treatment).

Species/ Category	2006	2007	2008	2009	2010	2011	2012
Big bluestem	38.0 ± 2.1^{a}	34.6 ± 2.4^{ab}	32.0 ± 2.1^{ab}	29.5 ± 2.1^{ab}	21.2 ± 3.4^{b}	32.2 ± 4.0^{ab}	32.8 ± 3.7^{ab}
Little bluestem	11.5 ± 0.9	11.5 ± 1.4	9.6 ± 1.0	11.6 ± 1.5	16.2 ± 3.2	8.8 ± 2.0	7.8 ± 1.9
Indiangrass	9.7 ± 2.1^{xy}	13.4 ± 1.9^{x}	12.1 ± 1.9^{xy}	8.8 ± 1.7^{xy}	11.1 ± 1.8^{xy}	7.1 ± 1.1^{y}	11.8 ± 1.6^{xy}
Switchgrass	13.3 ± 1.5^{a}	14.8 ± 1.3^{a}	12.2 ± 1.5^{a}	4.5 ± 0.8^{b}	4.5 ± 0.6^{b}	7.6 ± 1.2^{ab}	4.4 ± 1.1^{b}
Other perennial grasses	15.0 ± 1.7^{a}	14.8 ± 1.9^{a}	20.1 ± 1.9^{ab}	22.8 ± 2.5^{ab}	25.1 ± 3.3^{ab}	34.4 ± 4.0^{b}	29.5 ± 4.1^{b}
Annual grasses	2.6 ± 0.6^{a}	2.0 ± 0.5^{ab}	5.1 ± 1.5^{a}	11.6 ± 3.4^{a}	9.1 ± 2.3^{a}	1.8 ± 0.5^{ab}	0.4 ± 0.2^{b}
Annual forbs	0.3 ± 0.1^{b}	0.8 ± 0.3^{b}	0.9 ± 0.2^{b}	1.1 ± 0.2^{a}	0.7 ± 0.2^{ab}	0.1 ± 0.1^{b}	1.7 ± 0.3^{a}
Perennial forbs	8.6 ± 2.2	7.4 ± 1.7	7.2 ± 1.3	8.5 ± 1.5	10.2 ± 1.0	7.4 ± 0.7	10.4 ± 1.6
Woody	0.6 ± 0.4	0.3 ± 0.2	0.4 ± 0.2	0.2 ± 0.1	0.2 ± 0.1	0.2 ± 0.2	0.7 ± 0.3
Sericea lespedeza	0.4 ± 0.1	0.4 ± 0.2	0.3 ± 0.1	1.4 ± 0.5	1.5 ± 0.4	0.4 ± 0.2	0.6 ± 0.3

[ab] Different superscripts within row indicate differences $P < 0.05$
[xy] Different superscripts within row indicate differences $0.05 < P < 0.10$

pastures, switchgrass declined over time ($P < 0.05$) with PB and other perennial grasses increased ($P < 0.05$) 2-years post-burn. Sericea lespedeza (*Lespedeza cuneata*) decreased ($P < 0.05$) with the first burn but increased thereafter under PB. Cummings et al. (2007) found that sericea lespedeza increased in both patch-burn and full-burn pastures, but the rate of increase was less with patch -burning.

Implications

Patch-burning offers a viable option for pasture management in regards to stocker cattle performance. Patch-burning might have added benefits for cattle producers in years where summer drought might occur due to additional residue available for consumption, along with high quality burned patches. Botanical composition shifts were similar on patch-burn and full-burn pastures with the exception of increasing annual grasses with patch-burning.

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Literature Cited

Allred, B. W., S. D. Fuhlendorf, D. M. Engle, and R. D. Elmore. 2011. Ungulate preference for burned patches reveals strength of fire-grazing interaction. Ecol. Evol. 1:132-144. doi:10.1002/ece3.12.

Angell, R. F., J. W. Stuth, and D. L. Drawe. 1986. Diets and liveweight changes of cattle grazing fall burned Gulf cordgrass. J. Range Manage. 39:233-236. doi: 10.2307/3899056.

Bidwell, T. G., R. E. Masters, J. R. Weir, and D. M. Engle. 2009. Fire effects in native plant communities. NREM-2877. Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. 12 p.

Brazle, F. K., G. L. Kilgore, and M. R. Fausett. 1999. Effects of half- vs three-quarter-season grazing of native grass pastures. Cattlemen's Day Report of Progress. SRP-831. Kansas State University Ag. Exp. Sta. and Cooperative Extension Service, Manhattan, Kansas. 160-161 p.

Cummings, D. C., S. D. Fuhlendorf, and D. M. Engle. 2007. Is altering grazing selectivity of invasive forage species with patch burning more effective than herbicide applications? Rangeland Ecol. Manage. 60:253-260. doi: 10.2111/1551-5028(2007)60[253:IAGSOI]2.0.CO;2.

Federation of Animal Science Societies (FASS). 1999. Guide for the care and use of agricultural animals in agricultural research and teaching. 2nd ed. Federation of Animal Science Societies, Champaign, IL

Fuhlendorf, S. D. and D. M. Engle. 2001. Restoring heterogeneity on rangelands: ecosystem management based on evolutionary grazing patterns. BioScience. 51:625-632. doi: 10. 1641/0006-3568(2001)051[0625:RHOREM]2. 0.CO;2.

Fuhlendorf, S. D., W. C. Harrell, D. M. Engle, R. G. Hamilton, C. A. Davis, and D. M. Leslie Jr. 2006. Should heterogeneity be the basis for conservation? Grassland bird response to fire and grazing. Ecol. Appl. 16:1706-1716. doi: 10.1890/1051-0761(2006)016[1706:SHBTBF]2.0.CO;2.

Hamilton, R. G. 2007. Restoring heterogeneity on the Tall-grass Prairie Preserve: applying the fire-grazing interaction model. P 163-169 in R.E. Masters and K.E.M. Galley (eds). Proceedings of the 23rd Tall Timbers Fire Ecology Conference: Fire in Grassland and Shrubland Ecosystems. Tall Timbers Research Station, Tallahassee, Florida.

Hillman, J. B. and R. H. Hughes. 1965. Fire and forage in the wiregrass type. J. Range Manage. 18:251-254. doi: 10.2307/3895491.

Kellner, O. and D. Niyogi. 2014. Forages and Pastures Symposium: Assessing drought vulnerability of agricultural production systems in context of the 2012 drought. J. Anim. Sci. 92:2811-2822. doi: 10.2527//jas2013-7496.

KSU Mesonet. 2016. Historical weather. http://mesonet.k-state.edu/weather/historical/. Accessed 6/1/2016.

Launchbaugh, J. L. and C. E. Owensby. 1978. Kansas rangelands: their management based on a half century of research. Kansas Agr. Exp. Sta. Bull. 622:56.

McGinty, A., F. E. Smeins, and L. B. Merrill. 1983. Influence of spring burning on cattle diets and performance on the Edwards Plateau. J. Range Manage. 36:175-178. doi: 10.2307/3898157

McGranahan, D. A., C. B. Henderson, J. S. Hill, G. M. Raicoich, W. N. Wilson, and C. K. Smith. 2014. Patch burning improves forage quality and creates grass-bank in Old-field pasture: Results of a demonstration trial. Southeastern Nat. 13:200-207. doi:10.1656/058.013.0203.

National Park Service. 2009. Tallgrass Prairie National Preserve patch-burn grazing brochure. http://www.nps.gov/tapr/publications.htm. Accessed 1/14/16.

Natural Resources Conservation Service. 2008. Electronic Field Office Technical Guide (eFOTG). http://efotg.nrcs.usda.gov/treemenuFS.aspx. Accessed 1/14/16.

Owensby, C. E. 1973. Modified step-point system for botanical composition and basal cover estimates. J. Range Manage. 26:302-303. doi: 10.2307/3896585.

Smith, E. F. and C. E. Owensby. 1978. Intensive-early stocking and season-long stocking of Kansas Flint Hills Range. J. Range. Manage. 31:14-17.

Svejcar, T. J. 1989. Animal performance and diet quality as influenced by burning on tallgrass prairie. J. Range Manage. 42:11-15. doi: 10.2307/3899649.

Weir, J. R., S. D. Fuhlendorf, D. M. Engle, T. G. Bidwell, D. C. Cummings, and D. Elmore. 2007. Patch burning: Integrating fire and grazing to promote heterogeneity. E-998. Oklahoma Cooperative Extension Service, Oklahoma State University, Stillwater, Oklahoma. 28 p.

Winter, S. L., S. D. Fuhlendorf, and M. Goes. 2014. Patch-burn grazing effects of cattle performance: research conducted in a working landscape. Rangelands. 6:2-7. doi: 10.2111/Rangelands-D-13-00079.1.

Vermeire, L. T., R. B. Mitchell, S. D. Fuhlendorf, and R. L. Gillen. 2004. Patch burning effects on grazing distribution. J. Range. Manage. 57:248-252. doi: 10.2111/1551-5028(2004)057[0248:PBEOGD]2.0.CO;2.

Table 3. Change in percent plant composition ± SE by treatment on Bressner Pastures between 2006 and 2012.

Species/Category	Patch burn	Full burn
Big bluestem	-10.7 ± 3.1	-5.2 ± 2.5
Little bluestem	-6.3 ± 1.9	-3.8 ± 1.9
Indiangrass	-2.1 ± 1.8	2.1 ± 2.0
Switchgrass	-7.2 ± 1.0	-8.9 ± 2.3
Other perennial grasses	16.4 ± 3.6	14.5 ± 3.3
Annual grasses	7.2 ± 3.4 *	-2.2 ± 0.8
Annual forbs	2.8 ± 0.8	1.4 ± 0.4
Perennial forbs	-1.2 ± 2.2	1.9 ± 2.4
Woody	-0.7 ± 0.5	0.1 ± 0.4
Sericea lespedeza	1.5 ± 0.7	0.3 ± 0.4

*Treatments are different at $P \leq 0.05$.

Table 4. Percent plant composition ± SE relative to yr of patch-burn.

Species/ Category	Year before burn	First burn	1 year post burn	2 yeas post burn	Second burn
Big bluestem	22.8 ± 2.5^{ab}	26.1 ± 2.5^{a}	17.5 ± 1.2^{b}	20.9 ± 1.3^{ab}	21.4 ± 2.4^{ab}
Little bluestem	15.1 ± 1.4^{a}	9.9 ± 1.5^{ab}	12.9 ± 1.3^{a}	12.5 ± 1.6^{ab}	7.1 ± 1.3^{b}
Indiangrass	11.4 ± 0.9^{a}	7.6 ± 1.0^{ab}	9.8 ± 0.9^{a}	12.2 ± 1.1^{a}	5.8 ± 0.9^{b}
Switchgrass	6.2 ± 0.8^{a}	10.2 ± 0.8^{c}	4.9 ± 0.7^{ab}	4.4 ± 0.7^{ab}	2.5 ± 0.6^{b}
Other perennial grasses	26.0 ± 1.9^{a}	15.6 ± 2.7^{b}	24.9 ± 2.1^{ab}	30.4 ± 2.0^{a}	22.9 ± 1.8^{ab}
Annual grasses	6.3 ± 1.4^{a}	10.3 ± 3.9^{ab}	16.0 ± 2.9^{b}	9.4 ± 2.5^{ab}	18.1 ± 5.2^{ab}
Annual forbs	1.7 ± 0.5	2.3 ± 0.8	2.8 ± 0.6	2.1 ± 0.6	3.5 ± 0.8
Perennial forbs	8.6 ± 0.8	9.5 ± 2.1	9.6 ± 0.9	7.9 ± 0.8	10.4 ± 1.2
Woody	0.4 ± 0.1	0.4 ± 0.1	0.2 ± 0.1	0.2 ± 0.1	0.3 ± 0.1
Sericea lespedeza	1.7 ± 0.5^{a}	0.3 ± 0.1^{b}	1.3 ± 0.3^{a}	1.9 ± 0.6^{a}	2.8 ± 1.0^{a}

[ab] Different superscripts within row indicate differences $P < 0.05$