Range Burning and Fertilizing Related to Nutritive Value of Bluestem Grass

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Highlight: *The influence of range burning and nitrogen fertilization on the nutritive value of big and little bluestem in Kansas True Prairie were studied. Late spring burning decreased dry matter, crude fiber, cell wall constituents, cellulose, and lignin, and increased crude protein, ether extract, nitrogen free extract, and ash. Nitrogen fertilization decreased nitrogen free extract and increased crude fiber, lignin, and ash. Big bluestem was higher than little bluestem in nitrogen free extract, and lower in crude fiber, cell wall constituents, lignin, and cellulose.*

Range burning is a widely used management tool in the True Prairie region of Kansas because of improved steer performance (Smith and Owensby, 1972). Aldous (1934) reported burning increased range forage protein levels. Smith and Young (1959) reported higher crude protein and ash levels in little bluestem following burning. Smith et al. (1960) noted that burning increased apparent digestibility of dry matter and crude fiber.

Although nitrogen fertilization of native True Prairie rangeland has not been widely used, recent attempts to increase carrying capacity have stimulated interest in the practice. Moser and Anderson (1964) reported a small linear increase in forage crude protein levels with 33 and 67 lb nitrogen applied per acre. Owensby et al. (1970) also reported higher plant nitrogen levels after fertilizing with 50 lb nitrogen per acre.

The purpose of this study was to determine the effects of annual late spring burning and nitrogen fertilization, separately and in combination, on big bluestem (*Andropogon gerardi* Vitman) and little bluestem (*Andropogon scoparius* Michx.).

Study Area and Methods

The study was conducted during the 1972 growing season on native, True Prairie rangeland near Manhattan, Kan. Elevation varies from 353 m (1,160 ft) to 406 m (1,335 ft) above sea level. Average annual precipitation is 85 cm (33.5 inches) of which 74% is received as rain during the growing season (May–October). Between May and October, 1972, there were 55.1 cm (21.7 inches) of rainfall; 87% of the normal for the period. The four pastures used varied from 17.8 ha (44 acres) to 24.3 ha (60 acres). Their soil type and vegetation have been described by Anderson and Fly (1955).

A two by two factorial design was used with two pastures burned April 28 and two not burned. Two pastures were fertilized May 17 with urea at 44.8 kg nitrogen per hectare (40 lb/acre) and two pastures were not fertilized.

Grass samples were clipped from three wire enclosures 7.6 m × 7.6 m, located on an ordinary upland site within each pasture on May 15 and the first of each month thereafter through November. Due to lack of growth on May 15, samples were not taken on all treatments. Plants were clipped at

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Table 1. Chemical composition (%, dry basis) of pooled bluestem grass samples at monthly intervals.

Constituent	May[1]	June	July	August	September	October	November
Dry matter	22.50	27.40 a[2]	32.92 b	–	37.74 c	43.53 d	74.99 e
Ether extract	2.86	2.54 a	2.40 ab	1.96 d	2.09 cd	2.35 b	2.24 bc
Protein	17.74	11.62 a	5.96 d	4.47 c	4.31 c	4.22 c	2.89 d
Nitrogen free extract	43.31	47.47 d	50.78 c	56.38 a	52.36 b	52.04 b	51.76 b
Crude fiber	25.92	30.48 d	32.82 c	30.80 d	33.98 b	33.36 c	34.90 a
Ash	10.17	7.90 a	8.04 a	6.40 b	7.25 c	8.04 a	8.22 a
Cell wall constituents	–	72.54 e	75.38 d	76.25 cd	77.77 b	76.99 bc	79.25 a
Hemicellulose	–	32.55 bc	33.18 ab	33.93 a	31.94 cd	31.43 d	28.26 e
Lignin	–	4.66 e	5.88 d	6.61 c	7.32 b	6.92 bc	8.49 a
Cellulose	–	32.28 d	33.37 c	32.30 d	34.25 b	33.51 bc	36.28 a

[1] May values were not statistically analyzed.
[2] Values within the same chemical constituent followed by the same letter are not significantly different at the .05 level.

ground level and stored frozen in plastic bags. Before analysis they were dried overnight at 90°C in a forced air oven and ground in a Wiley mill through a 1-mm screen.

Proximate analyses were determined according to A.O.A.C. (1970) procedures and cell wall constituents were estimated according to Goering and Van Soest (1970).

Data were analyzed by least square analysis of variance with the model including burning, fertilization, grass species, month of sampling, and all possible two-way interactions. Three- and four-way interactions remained in the error term. Data differing at the 5% level of probability have been considered significant.

Results and Discussion

As the growing season advanced, dry matter content (DM) increased from 22.5% in May to 75.0% in November (Table 1). Burning reduced dry matter as expected (Aldous, 1934). This lowered DM resulting from burning may indicate plants were not so mature and therefore more palatable and higher in nutritive value.

Percent ether extract (EE) ranged from 1.96 to 2.86 (Table 1). It decreased from May to August, increased during September and October, then dropped slightly in November. Burning increased EE of big and little bluestem, but little bluestem responded most (Table 3). Smith et al. (1960), sampling burned and unburned bluestem pasture forage, found EE increased in three out of four trials due to burning; digestibility of EE was increased by burning in three of four trials. In contrast, Smith and Young (1959) reported a decrease in EE of little bluestem due to mid-spring burning.

Percent crude protein ranged from 17.7 in May to 2.9 in November, decreasing as the plants matured. During August, September, and October, it remained relatively constant (4.2%-4.5%). Burning increased protein content (Table 2) with a greater effect on little bluestem (Table 3). This increase in protein by burning has been observed by others (Smith and Young, 1959; Hall., 1952). Aldous (1934) attributed the higher protein content of grass from late spring burned pasture to its immaturity. Nitrogen application failed to increase protein content contrary to other reports (Kelsey et al., 1973; Owensby et al., 1970; Moser and Anderson, 1964).

Percent crude fiber (CF) ranged from 25.9 in May to 34.9 in November. Burning lowered CF, nitrogen increased it; little bluestem contained the most CF.

Table 3. Effects of burning on the chemical constituents (%, dry basis) of big and little bluestem.[1]

	Big bluestem		Little bluestem	
Constituent	Not burned	Burned	Not burned	Burned
Ether extract	2.05[a] [2]	2.28[b]	2.10[a]	2.62[c]
Crude protein	5.54[a]	5.78[a]	5.06[b]	5.94[b]
Nitrogen free extract	51.24[ab]	53.28[c]	50.99[b]	51.68[a]
Ash	7.60[ab]	7.66[ab]	7.34[b]	7.95[a]
Cell wall constituents	76.38[b]	74.40[a]	79.10[c]	75.57[b]

[1] Least squares means for two-way interactions.
[2] Values in same row with different letters differ significantly ($P < .05$).

Percent nitrogen free extract (NFE) increased from 43.3 in May to 56.4 in August then declined to 51-52 for September, October, and November. Fertilization lowered NFE. Burning increased NFE in big and little bluestem (Table 3).

Percent ash ranged from 6.4 to 10.2. The larger amounts of ash found in the early growth stage (8.0-10.2) and again at maturity (8.0-8.2) agrees with Demarchi (1973) who reported lower ash content (Table 2). The lowest ash content occurred

Table 2. Effects of burning, nitrogen, fertilization, and grass species on chemical composition (%, dry basis) of bluestem grass.[1]

	Burning		Nitrogen fertilization		Species	
Constituents	Not burned	Burned	No	Yes	Big bluestem	Little bluestem
Dry matter	45.17 a[2]	41.46 b	43.78 a	42.85 a	43.71 a	42.92 a
Ether extract	2.07 a	2.45 b	2.28 a	2.25 a	2.16 a	2.36 a
Protein	5.30 a	5.86 b	5.57 a	5.59 a	5.66 a	5.50 a
Crude fiber	34.04 a	31.41 b	32.57 a	32.88 b	32.28 a	33.16 b
Nitrogen free extract	51.12 a	52.48 b	52.39 a	51.20 b	52.26 a	51.33 b
Ash	7.47 a	7.81 b	7.19 a	8.09 b	7.63 a	7.65 a
Cell wall constituents	77.74 a	74.99 b	76.35 a	76.38 a	75.39 a	77.34 b
Hemicellulose	31.80 a	31.97 a	32.01 a	31.76 a	31.76 a	32.00 a
Lignin	7.05 a	6.24 b	6.51 a	6.78 b	6.36 a	6.93 b
Cellulose	34.77 a	32.56 b	33.77 a	33.56 a	33.13 a	34.20 b

[1] All values are pooled across months.
[2] Values under the same major heading and chemical constituent followed by the same letter are not significantly different at the .05 level.

Table 4. Effects of nitrogen fertilization on the chemical constituents (%, dry basis) of big and little bluestem.[1]

	No nitrogen		Nitrogen	
Constituent	Not burned	Burned	Not burned	Burned
Crude protein	5.41^{bc} [2]	5.73^{ab}	5.19^{c}	5.98^{a}
Ash	6.84^{b}	7.54^{c}	8.10^{a}	8.08^{a}
Cell wall constituents	77.98^{a}	74.72^{b}	77.50^{a}	75.25^{b}
Lignin	7.13^{a}	5.89^{c}	6.97^{ab}	6.59^{b}

[1] Least squares means for two-way interactions.
[2] Values in same row with different letters differ significantly ($P < .05$).

under no burning and no nitrogen, followed by burning and no nitrogen; ash values were highest where nitrogen was applied regardless of burning (Table 4). Burning increased the ash content of little bluestem (Table 3), which agrees with Smith and Young (1959).

Percent cell wall constituents (CWC) ranged from 72.5 in June to 79.3 in November, generally increasing as the plants matured, which agrees with Rao et al. (1973). Burning decreased CWC, indicating burning enhances forage quality since CWC are considered lower in digestibility than cell contents. Big bluestem (burned) was lowest in CWC; little bluestem (unburned) was highest in CWC (Table 3).

Percent hemicellulose ranged from 32.6 in June to 28.3 in November, generally declining as the plants matured, which is in agreement with Rao et al. (1973). Hemicellulose should contribute to increased nutritive value according to Kamstra (1973).

Lignin generally increased as the plant matured. Burning lowered the lignin content which agrees with Rao et al. (1973). Nitrogen increased lignin content of the burned samples. The lowest lignin content was present where the grass was burned and not fertilized. Lignin is one of the more important indicators of digestibility; as it increases, digestibility declines. This would indicate forage from burned nonfertilized pastures would be higher in digestibility; however, Woolfolk et al. (1973) found no difference in digestibility, due to burning and nitrogen application. Smith et al. (1960) reported burning improved digestibility of bluestem forage.

Percent cellulose ranged from 32.3 in June to 36.3 in November. Burning reduced cellulose, and little bluestem contained more cellulose than big bluestem. Kamstra (1973) found that little bluestem, compared with four grasses, contained the most cellulose at maturity.

Conclusions and Recommendations

Late spring burning improved the quality of big and little bluestem grass in Kansas True Prairie, primarily by increasing the quality of plant carbohydrates. Chemical analysis detected decreases in crude fiber, cell wall constituents, cellulose, and lignin. These components are usually found at lower levels in grasses that are most productive in terms of animal products. Burning increased nitrogen free extract, protein, and ash.

Nitrogen fertilization lowered percent nitrogen free extract and increased the percent crude fiber lignin and ash. This would indicate a decrease in energy value due to nitrogen application.

Big bluestem was lower than little bluestem in crude fiber, lignin, cellulose, and cell wall constituents. It was higher in nitrogen free extract. Big bluestem contains more available energy for the animal than little bluestem based on analysis conducted here, and from this viewpoint is a more desirable grass for livestock production. Since late spring burning increases the amount of big bluestem, this species may account for part of the improved weight gain of steers.

Late spring burning is recommended for Flint Hills pastures for growing steers. Nitrogen fertilization does not improve nutrient content but may increase the carrying capacity of these pastures with adequate rainfall.

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