Nutritive Quality of Nitrogen Fertilized and Unfertilized Blue Grama

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Highlight: *Fertilization with 40 lb of nitrogen per acre generally increased crude protein content of blue grama plants during the growing season but not during the dormant season. However, because of increased dry matter yield under fertilization, total protein on the fertilized area exceeded that on the unfertilized area by 37 lb/acre during the dormant season. Fertilization decreased content of ash, silica and acid detergent fiber and had little effect on ether extract, cell wall constituents, acid detergent lignin, carotene content or in vitro dry matter digestibility or content of individual mineral elements of blue grama. Results indicated very little improvement in nutritive quality of blue grama during early spring stress period when cows are lactating and forage quality and quantity are low.*

Many studies have shown that nitrogen fertilization increases herbage production under conditions throughout the Great Plains where precipitation is sufficient for plants to utilize the added nitrogen. In New Mexico Dwyer (1971) reported that grass production was increased from about 500 lb/acre on the control to over 1200 lb/acre on plots fertilized annually with 60 lb N/acre over a 6-year period.

Nitrogen fertilization may also have additional benefits in improving the nutritional qualities of range forage. Dee and Box (1967) reported that all rates of nitrogen fertilizer, from 33 to 300 lb/acre, increased the protein content of blue grama growing in the Texas panhandle even in the dormant period. With the cost of supplemental feed climbing steadily, an improvement in nutritive content of blue grama could have widespread economic benefit.

The objective of this study was to compare chemical composition of fertilized and unfertilized blue grama collected over a three-year period at four stages of maturity.

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Procedures

Samples of blue grama (*Bouteloua gracilis* (H.B.K.) Lag.) were collected randomly from nitrogen-fertilized (40 lb of urea nitrogen/acre applied in June) and unfertilized native range pastures at the Fort Stanton Cooperative Range Research Station near Capitan, New Mexico. Vegetation consists of open grasslands dominated by blue grama on mesas and pinyon-juniper and wavy leaf oak (*Quercus undulata*) on slopes and ridges. Average annual precipitation is just over 15 inches with about 60% falling from June through September.

Samples were collected by clipping plants approximately 1 inch above ground at four stages of maturity as described by Harris (1970). These stages were late vegetative, which was from beginning of stem elongation to period when heads were just emerging from boot; full bloom to dough; ripe seed; and stem cured, when seeds had been cast. Samples were deposited in air-tight plastic bags, placed in a cooler containing dry ice, and transported to the Animal Nutrition Laboratory at New Mexico State University. One portion of each sample was oven dried at 65°C and ground through a 20-mesh screen in a micro-Wiley mill. The second portion was freeze dried and ground through a 20-mesh screen in a micro-Wiley mill while frozen with liquid nitrogen. This portion was analyzed for carotene, acid detergent lignin, and acid detergent fiber.

Chemical analyses were made using the following procedures: dry matter, ash, ether extract, carotene, and Kjeldahl nitrogen by methods of the A.O.A.C. (1965); cell wall constituents by the method of Van Soest and Wine (1967); silica by the method of A.O.A.C. (1965) with modifications as described by Boggino (1970); acid detergent fiber and lignin by the method of Van Soest (1963); and in vitro dry matter disappearance by the method of Tilley and Terry (1965) with modifications described by Boggino (1970).

Statistical analysis of data included an analysis of variance using a mixed model to determine significance of differences among years, dates, and fertilizer levels as main effects. When a significant difference was found, individual means were compared using Duncan's Multiple Range Test (Steel and Torrie, 1960). All statistical comparisons are at the 5% level of significance unless otherwise stated.

Results

The ash content of unfertilized blue grama was significantly less ($P < 0.01$) than that of fertilized blue grama when averaged across maturity stages, but the stem cured stage was the only individual comparison which showed a significance difference. There appeared to be little seasonal trend in ash content of either fertilized or unfertilized blue grama. The silica content was also significantly lower for fertilized plants compared to unfertilized plants, and was significantly lower at all maturity stages except for the full bloom to dough stages (Table 1).

Fertilization apparently had little influence on ether extract content of blue grama. The content of fertilized plants was 2.3% compared to 2.1% for unfertilized plants averaged over maturity stages.

Fertilization increased the crude protein content of blue grama col-

Table 1. Average chemical composition of fertilized and unfertilized blue grama at four stages of maturity collected over a 3-year period at the Fort Stanton Cooperative Range Research Station, New Mexico.

	Stages of maturity and fertilization treatments									
	Late vegetative		Full bloom to dough		Ripe seed		Stem cured		Mean	
Constituent	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.
Ash (%)	9.6 a[1]	10.4 a	9.8 a	11.0 a	10.9 a	11.5 a	9.6 a	14.1 b	10.0 a	11.8 b
Silica (%)	5.0 a	6.4 b	6.3 a	7.1 a	7.2 a	8.3 b	8.5 a	12.9 b	6.7 a	8.7 b
Ether extract (%)	2.8 a	2.3 a	2.5 a	2.4 a	2.2 a	2.1 a	1.6 a	1.6 a	2.3 a	2.1 a
Crude protein (%)	15.7 a	10.6 b	10.9 a	8.2 b	6.8 a	5.6 a	4.1 a	3.3 a	9.4 a	6.9 b
Cell wall constituents (%)	69.7 a	72.1 a	71.5 a	71.8 a	72.1 a	70.7 a	78.7 a	73.5 a	73.0 a	72.0 a
Acid detergent fiber (%)	36.8 a	39.2 a	39.6 a	41.1 a	43.1 a	48.6 a	49.0 a	51.2 a	42.1 a	44.3 b
Acid detergent lignin (%)	4.9 a	4.7 a	4.9 a	5.1 a	5.9 a	5.6 a	6.7 a	6.6 a	5.6 a	5.5 a
Carotene (Mg/Kg)	163.0 a	140.0 a	141.0 a	121.0 a	23.0 a	19.0 a	5.0 a	2.0 a	83.0 a	70.0 a

[1] Means with same letter are not significantly different ($P < 0.05$) within a maturity stage.

lected during the growing season (late vegetative to dough stage) but not in the ripe seed or stem cured stage (Fig. 1). Crude protein contents declined ($P < 0.01$) with advancing maturity for both fertilized and unfertilized plants as many other studies have shown.

At any stage of maturity there were no significant differences between fertilizer treatments in either content of cell wall constituents, acid detergent lignin or fiber. The fertilized plants contained significantly less acid detergent fiber than unfertilized plants (Table 1). Acid detergent lignin increased in a stepwise fashion with advancing stage of maturity. Cell wall constituents and acid detergent fiber showed no trend during the growing season although they were higher at the stem-cured stage than in earlier stages.

The carotene content of both fertilized and unfertilized blue grama declined sharply with advancing stage of maturity (Table 1). However, there was no significant difference in carotene content between fertilized and unfertilized blue grama.

The differences in dry matter digestibility between fertilized and unfertilized plants at every stage of maturity were not statistically significant (Fig. 1). Dry matter disappearance decreased markedly from the full bloom stage to the stem-cured stage for both fertilized and unfertilized plants.

Nitrogen fertilization did not influence the levels of phosphorus, potassium, magnesium, sodium, manganese, iron, boron, zinc, strontium, barium, or molybdenum (Table 2).

The copper content of nitrogen-fertilized blue grama was greater than that of unfertilized, whereas the calcium and aluminum content of the unfertilized blue grama exceeded that of the fertilized blue grama.

Differences in mineral composition at different stages of maturity were significant only for phosphorus ($P < 0.01$) and potassium ($P < 0.001$). Although there was considerable variation for the other minerals at different stages of maturity none of the differences betwen fertilized and unfertilized plants were significant. For both phosphorus and potassium, highest levels were at the late vegetative stage, thereafter decreasing with advancing maturity. Levels of both minerals were lowest at the ripe seed stage of maturity. The full-bloom to dough and the stem cured stages were intermediate in both cases.

Discussion

From a nutritional standpoint, range fertilization would be most beneficial if increases in protein content were maintained during dormancy since other studies (Thetford et al., 1971) show that cattle diets are adequate in protein content during the

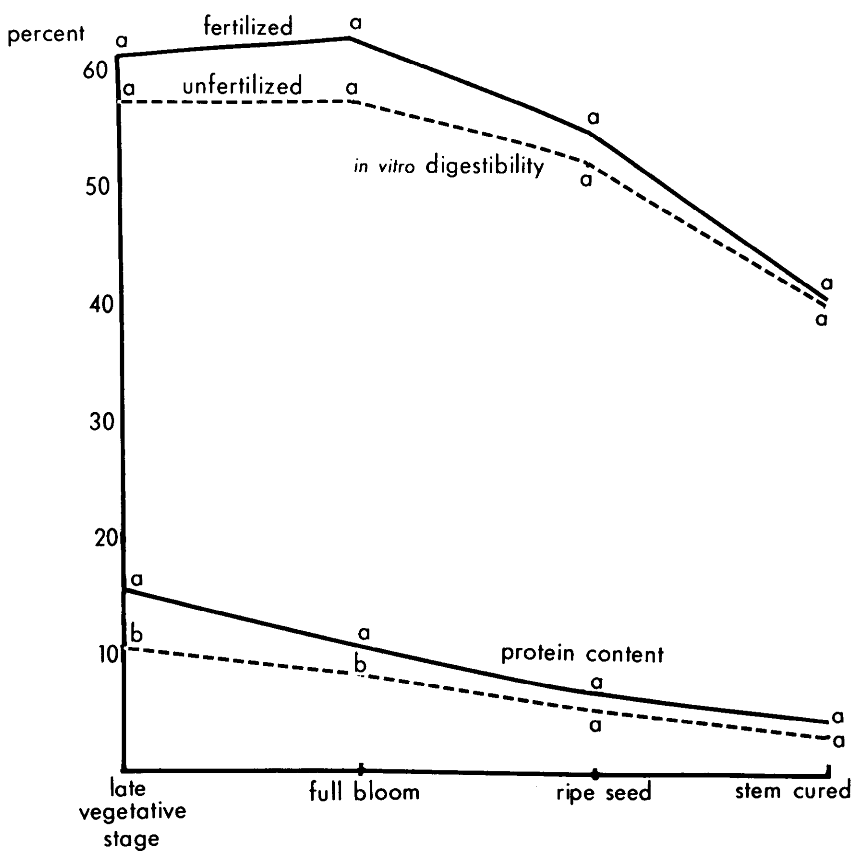

Fig. 1. *In vitro dry matter disappearance and protein content of fertilized and unfertilized blue grama at four stages of maturity. Means with same letter are not significantly (P < 0.05) different within a maturity stage for either protein content or in vitro dry matter disappearance.*

Table 2. Average mineral composition at different stages of maturity for unfertilized blue grama (across years).

	Stages of maturity and fertilization treatments									
	Late vegetative		Full bloom to dough		Ripe seed		Stem cured		Mean	
Mineral	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.
Percent of dry matter										
Phosphorus	0.38	0.34	0.31	0.31	0.25	0.26	0.17	0.18	0.28	0.27
Potassium	1.12	1.26	0.78	0.96	0.58	0.69	0.31	0.39	0.70	0.83
Calcium	0.38	0.38	0.40	0.36	0.37	0.39	0.35	0.24	0.38*	0.34
Magnesium	0.14	0.11	0.14	0.16	0.07	0.09	0.12	0.05	0.12	0.10
Sodium	0.015	0.007	0.018	0.028	0.005	0.007	0.010	0.007	0.012	0.012
mg/kg of dry matter										
Manganese	39	39	41	45	45	54	49	44	44	46
Iron	280	202	221	200	241	246	285	159	257	202
Boron	23	21	24	19	26	21	23	14	24	19
Copper	6	8	6	7	6	7	6	7	6	7*
Zinc	22	22	28	27	26	28	21	22	25	24
Aluminum	671	425	550	470	565	495	533	271	580*	415
Strontium	47	49	47	39	39	44	33	33	41	41
Barium	40	24	28	22	30	27	35	26	33	25
Molybdenum	1.37	1.07	1.16	1.31	1.17	1.28	1.59	1.03	1.32	1.18

*Corresponding means for treatment groups are significantly different, $P < 0.05$.

growing season and early part of the dormant season. In much of the Southwest, the period of stress for cattle is spring, when both quantity and quality of forage is low and cows are often nursing calves. Although measurements of protein content were not precise enough in this study to show real differences between fertilized and unfertilized blue grama during dormancy, other studies show a distinctly higher protein content in fertilized blue grama compared to unfertilized plants during the dormant season (Dee and Box 1967; Adi, 1969). Convergence of protein curves for fertilized and unfertilized blue grama (Fig. 1) can be explained partially by the greater contribution of culms on fertilized plants (Banner, 1969; Kelsey et al., 1971; Pieper et al., 1973).

Effects of nitrogen fertilization cannot be evaluated entirely in terms of percentage composition figures. At the time of peak standing crop, over 73 lb of protein/acre were present in fertilized blue grama compared to less than 50 lb/acre for unfertilized blue grama. During the late dormant period, about 50 lb of protein/acre were available in fertilized blue grama compared to only 13 in unfertilized blue grama (Pieper, 1973). These figures reflect production differences as well as differences in protein composition on ungrazed herbage. Other studies have also indicated increased herbage production as well as intake of digestible and metabolizable energy by sheep fed hay from fertilized pastures (Kelsey et al., 1973). Additional studies are needed to determine intake and digestibility of nitrogen fertilized blue grama rangeland under range conditions. In this regard limited data indicated that beef heifers may not lose as much weight during the winter on fertilized rangeland as on unfertilized (Dwyer and Schickedanz, 1971).

The phosphorus and calcium contents of blue grama were sufficient to meet the requirements of dry pregnant or lactating beef cows except for the phosphorus content during the ripe seed stage (N.R.C., 1970). For lactating cows the phosphorus content was slightly deficient and the calcium content was borderline at the ripe seed stage. This would indicate the need for phosphorus and calcium mineral supplement after blue grama has reached maturity if the content in the grazing animal's diet approximates these amounts.

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