Cattle Diets on a Fertilized Blue Grama Upland Range Site

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Abstract

Botanical composition of cattle diets was similar for cattle grazing a nitrogen- fertilized and unfertilized upland range site. Sand dropseed and blue grama were the major dietary components on both fertilized and unfertilized treatments. Fertilization did not influence the content of these two species in the diet. Galleta made up a larger portion of the diet on the unfertilized pasture than on the fertilized pasture during the spring and had a higher preference index on the unfertilized pasture. Scarlet globemallow comprised a greater proportion of the diet of cattle grazing on the fertilized pasture than for those grazing on the unfertilized pasture during the summer. Diversity indices indicated that diets of cattle grazing the unfertilized pasture were more diverse than those of cattle grazing on the fertilized pasture.

General, widespread acceptance of rangeland nitrogen fertilization is moderated by two factors. First, indications are that the effects of fertilizer depend upon soil, plant, climate, and management characteristics, and each combination should be evaluated separately (Heady 1975). Second, the inflated cost of N fertilizer dictates an accurate assessment of the benefits accrued by the grazing animal.

In New Mexico, nitrogen fertilization of blue grama rangeland has been extensively investigated. In general, nitrogen additions have increased total yearly production, leaf surface area, culm weights, seed head numbers and density, crude protein content, and in vitro digestibility of blue grama (*Bouteloua gracilis*) (Banner 1969; Kelsey et al. 1973; Pieper et al. 1974).

Examination of chemical content of steer diets at Ft. Stanton, New Mexico, indicated that nutritive constituents (crude protein, in vitro organic matter digestibility, and acid detergent fiber) were closely related to stage of maturity of both nitrogen fertilized and nonfertilized plants (Cordova 1977). Voluntary forage intake levels were similar across treatments. Nitrogen fertilization did not appear to improve nutritive content of steer diets other than to maintain dietary crude protein content at a maintenance level during the winter dormant season (Cordova 1977).

Examination of botanical composition of steer diets at Ft. Stanton indicated that nitrogen addition (45 kg N/ha) decreased the proportion of grass content in diets (Allison et al. 1977). However, drought reduced availability of grass for the steers. Deficient precipitation severely reduces blue grama cover, and decreases are greater on nitrogen-fertilized treatments (Hyder et al. 1975; Donart and Pieper 1974).

This experiment was conducted during years of nearly average precipitation. The purpose of the study was to compare botanical content of cattle diets on a nitrogen-fertilized and nonfertilized upland blue grama range site.

Experimental Procedures

The study was conducted on the Fort Stanton Experimental Ranch in the foothills beween Sierra Blanca and the Capitan Mountains in southern Lincoln County, New Mexico. Allison et al. (1977) have discussed the study area, climatic patterns, the esophageal-fistulation collection procedure, and the procedure for determination of dietary botanical composition by the microhistological method adopted from Sparks and Malechek (1968). This study was restricted to the upland portions of the pastures studied by Allison et al. (1977).

The unnamed soil series of the upland site is a member of the mesic family of Typic Haplustolls. These soils are generally calcareous below 15 cm, are not stony or gravelly, and are well drained.

In mid-June 1975 urea (45% N) was broadcast with a tractor-drawn spreader across a 55-ha pasture at a rate of 45 kg N/ha. The fertilizer application was repeated in mid-June of 1976 at a rate of 50 kg N/ha. This marked the tenth consecutive year this pasture has been fertilized with urea. An adjacent 63-ha pasture served as the nonfertilized control.

Six esophageally fistulated steers were utilized for diet determination. Three steers were initially assigned to each treatment for the duration of the study. During the 4-day collection periods, the steers were rotated daily to different collection locations on the upland site on each treatment. Periods of collection were June, July, August, September 1975, and January, March, June-July, August, and September 1976.

A dietary diversity index (Shannon's information function H' Shannon and Weaver 1948) was calculated for each sampling period for diets resulting from each nitrogen treatment. Peet (1974) expressed H' as:

$$H' = -\Sigma_{i=1}^{s} P_i \log P_i$$

where P_i is the percentage of importance for each species. P_i is estimated by: $P_i = ni/N$ where ni is the number particles per species and N is the total number of all species. The probability-based index provides insight into seasonal shifts in botanical compositions of cattle diets (Hurturbia 1973; Hansen and Reid 1975). Relative preference indices were calculated in the ratio of % composition by weight of a species in the available herbage to the % composition by weight in the diet (Krueger 1972).

Heterogeneity of variances for dietary composition required use of an approximation procedure instead of analysis of variance. The approximation associated with this procedure reduced the sensitivity of the statistical tests. Statistical tests between treatment means at each date were made by the use of the Student t test approximation (t') (Lentner 1972).

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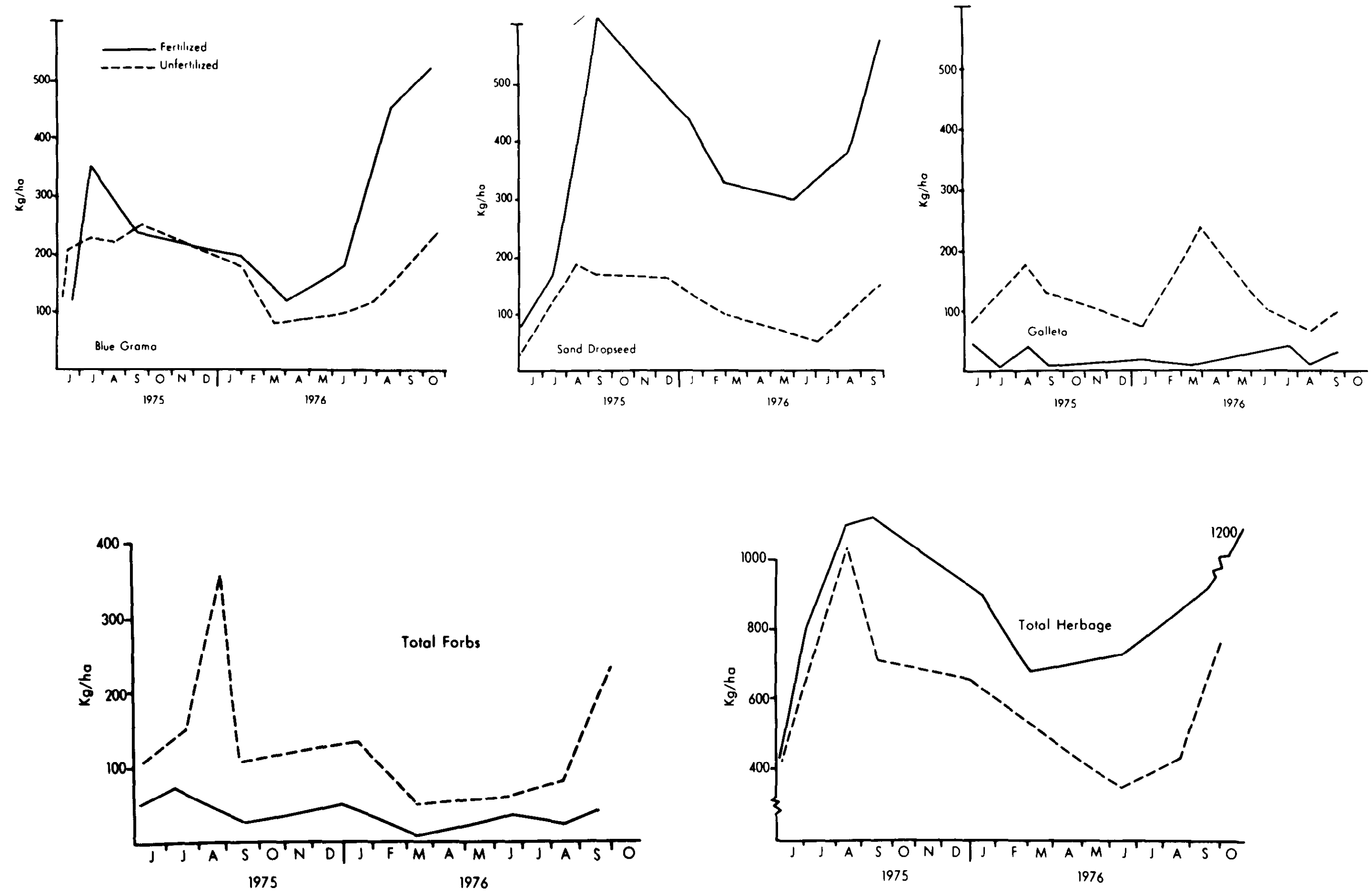

Fig. 1. *Standing crop of three perennial grass species, total forbs, and total herbage on the fertilized and unfertilized pastures during 1975 and 1976.*

Results and Discussion

Available Herbage

Total available herbage was considerably greater on the fertilized pasture than on the unfertilized pasture during the fall of 1975 and all of 1976 (Fig. 1). Herbage weight of the important perennial grasses, blue grama and sand dropseed (*Sporobolus cryptandrus*), was also much higher on the fertilized pasture than on the unfertilized pasture. However, galleta (*Hilaria jamesii*) and total forb production was greater on the unfertilized pasture.

Herbage weight increased during the growing season despite grazing by cattle and declined during the dormant season because of physical losses and cattle utilization.

Botanical Composition of Diet

Numerous species were identified during analysis of the botanical composition of cattle diets, but only five species were highly important components of these diets. These species were galleta, Carruth sagewort (*Artemisia caruthii*), scarlet globemallow (*Sphaeralcea coccinea*), sand dropseed, and blue grama. The seasonal occurrence of these species as major dietary components is presented in Table 1.

Seasonal trends in diet composition during summer and winter were similar under the two treatments. Scarlet globemallow was a major dietary component during early summer, before warm-season grasses initiated summer growth. There were no differences ($P>0.05$) in dietary content of scarlet

Table 1. Means and standard errors for dietary composition (%) of major species on the upland site.

	Species									
	Blue grama		Sand dropseed		Galleta		Scarlet globemallow		Carruth sagewort	
Season	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.	Fert.	Unfert.
1975										
June	9±5	10±3	20±13	26±14	0	0	36±23	30±13	4±2	5±0
July	14±6	22±0	26±10	26±10	0	3±0	24±13	14±3	3±1	3±1
August	20±5	29±10	42±1	24±1	1±3	3±1	4±0	4±2	1±0	1±1
September	20±2	24±0	40±4	38±5	2±0	1±1	1±1	1±0	7±0	9±1
1976										
January	24±0	20±6	42±4	30±3	6±6	6±2	0	0	8±4	17±1
March	25±3	12±6	40±3	14±3	11±7	37±2	0	0	6±1	12±2
June-July	23±1	12±0	24±2	20±7	3±2	11±2	21±2	27±11	3±0	8±1
August	18±0	18±0	41±3	25±5	3±1	7±2	6±0	6±0	0	4±0
September	14±2	14±0	33±3	27±7	2±1	6±2	18±10	6±0	4±1	22±5

globemallow between treatments on any date (Table 1). Forage availability of this species was below 100 kg/ha at this time (Havstad 1977).

The warm-season grass species blue grama and sand dropseed were the main dietary components during all seasons except early summer for the fertilized treatment. These two species comprised 40-50% of the available herbage on this treatment (Fig. 1). Seasonal forage availability of blue grama and sand dropseed varied between 200 kg/ha and 1,100 kg/ha. Occasionally, mat muhly (*Muhlenbergia richardsonis*) exhibited greater seasonal forage availability than either blue grama or sand dropseed (Havstad 1977). However, mat muhly comprised less than 5% of the plant ground cover and did not constitute a major portion of the diet during any season of the year.

Similar seasonal trends in botanical dietary composition occurred on the unfertilized treatment with one exception. During mid-spring, the cool-season grass galleta constituted 37% of cattle diets. Forage availability of this species at this time was 235 kg/ha (Fig. 1). Abundance of this species on the fertilized treatment was slight, less than 2% of the plant composition. However, the difference in galleta herbage availability was probably a function of its greater abundance in the unfertilized pasture and not because of a reduction resulting from nitrogen addition on the fertilized pasture (Havstad 1977).

Seasonal dietary content of sand dropseed and blue grama on the unfertilized treatment was similar to that of the fertilized treatment. The relatively low amounts of sand dropseed in the diet during mid-summer, late winter, and mid-winter on the control treatment were attributed to (1) lower sand dropseed forage availability, and (2) palatability and greater availability of grasses of secondary dietary importance. Both factors may be attributed to the absence of nitrogen.

Preference Indices

Preference indices for blue grama varied considerably on both pastures during all sampling dates and were not consistently higher or lower on either pasture (Table 2). Preference indices for this species were highest during the winter (January) and spring (March) period. Sand dropseed, on the other hand, seemed to have slightly higher indices on the unfertilized pasture, but was highly preferred during the summer on both treatments. The only time that the preference index fell below 1.0 was during March 1976 (Table 2).

Table 2. Relative preference indices for major components of the diet on fertilized (F) and unfertilized (U) blue grama rangeland.

	Blue grama		Sand dropseed		Galleta		Scarlet globe-mallow		Carruth sagewort	
Date	F	U	F	U	F	U	F	U	F	U
6/75	d[1]	d	a	a	—[2]	—	—	a	—	—
7/75	d	c	a	a	—	d	a	a	—	—
8/75	b	a	a	a	c	d	a	b	—	c
9/75	b	c	c	a	—	—	b	—	—	a
1/76	a	a	b	a	—	b	—	—	—	—
3/76	b	b	c	b	—	c	—	—	a	a
6/76	b	c	a	a	c	c	a	—	—	a
8/76	d	c	b	a	—	c	a	b	—	—
9/76	d	c	b	a	a	c	a	a	a	a

[1] Preference indices were ranked as follows:
a 1.8 or greater—definite preference
b 1.3–1.7—some preference
c 0.8–1.2—no preference
d 0.3–0.7—avoidance

[2] Indicates species was not sampled during this period

Preference indices for the forbs scarlet globemallow and Carruth sagewort were consistently high when enough herbage of these species was present to graze. There is little evidence to suggest that fertilization changed the preference for these species.

Dietary Diversity

The information theory diversity index (H') expresses the richness (number of species) or abundance of species in the diets. Seasonal values for dietary diversity are presented in Table 3. Values of H' illustrate the greater diversity of plant species in diets selected on the unfertilized treatment. The high diversity value for mid-summer reflected similar forage availability for many plant species. The low diversity value for the mid-winter period reflected low forage availability for many plant species. On the fertilized treatment, the relatively low diversity index for January—March and August reflected the dietary importance of the two main forage-producing species blue grama and sand dropseed.

Table 3. Diversity indices (H=) of cattle diets on upland site.

Season	Fertilized	Unfertilized
1975		
June	.755a[1,2]	.80 b
July	.785a	.905b
August	.79 a	.915b
September	.81 a	.805a
1976		
January	.715a	.88 b
March	.76 a	.82 b
June-July	.855a	.89 b
August	.79 a	.965b
September	.86 a	.895b

[1] Means in the same row followed by the same lower case letter are not significantly different ($P<.1$).
[2] Differences between means tested using a pooled T-test.

Discussion

Under nitrogen fertilization diets were generally less diverse, but seasonal trends in diversity were similar between treatments for the major dietary species. The major effect of nitrogen addition was upon herbage standing crop, and this factor slightly influenced dietary botanical composition for individual species.

Examination of seasonal trends in dietary content of individual species indicated three major points. First, forbs play an important role in botanical dietary composition, especially during periods when the major perennial grass species have not yet initiated growth. Forbs such as scarlet globemallow and Carruth sagewort were preferred when they were available. There was some indication that nitrogen fertilization increased preference and palatability of scarlet globemallow. Second, the bulk of diets is comprised of major perennial grass species. These species, such as blue grama, should be the focal point for determining and evaluating current utilization and stocking rates. Third, seral species, such as sand dropseed, can provide a high-quantity feed source that will be preferred by the grazing animal during specific seasons of the year. However, although fertilization increased sand dropseed herbage considerably, preference indices were sometimes higher on the unfertilized pasture (Table 2). In summary, the shortgrass rangeland of central New Mexico is a heterogeneous vegetation type and livestock grazing can exploit many components of the vegetation complex. Nitrogen fertilization of these rangelands reduces the extent to which the vegetation is exploited by the grazing animal.

Nitrogen fertilization increased grass production and enabled stocking rates to be increased providing increased livestock gains per unit area (Dwyer and Schickedanz 1971). No major differences in botanical composition of the diet selected by the grazing animals on fertilized and unfertilized blue grama rangeland were realized. The use of nitrogen on these rangelands would be dependent upon the amount of increased beef production realized and its relation to the costs of nitrogen fertilizer and its application.

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