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HERBAGE GROWTH RATE, FORAGE INTAKE, AND FORAGE QUALITY IN 1971 ON HEAVILY- AND LIGHTLY-GRAZED BLUE GRAMA PASTURES

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ABSTRACT

Herbage growth rate, forage intake, and forage quality were measured on heavily and lightly grazed pastures during the summer of 1971. When a growth opportunity occurred, herbage growth rate was greater in the lightly grazed pasture than in the heavily grazed pasture. Total herbage growth was significantly greater ($P > .05$) in the lightly grazed pasture. Forage intake by individual heifers grazing the heavy- and light-use pastures did not differ significantly ($P > .05$). Forage quality in the heavily and lightly grazed pastures did not differ significantly ($P > .05$) when standing herbage was greater than 25 g/m^2.

INTRODUCTION

Herbage growth on ungrazed pastures can be estimated by taking clipping measurements periodically. The weight difference between clippings made at the beginning and end of a period is considered herbage growth for that period. This method does not account for herbage losses by weathering or disease or for herbage consumed by insects, domestic grazing animals, or wildlife. Kreitlow et al. (1953) found grass leaves to wither and die due to fungal leaf spots. App (1962) discussed insect attacks on roots, foliage, and seeds of forage plants that may influence pasture experiments. Vaughan (1967) found that rodents at the Central Plains Experimental Range preferred vegetation of sandy and loamy soils to vegetation of heavier soils. Forage consumed by wildlife is difficult to measure and is not accounted for by this method.

Several methods have been developed for estimating herbage growth on pastures being grazed by domestic livestock. Difficulty exists in estimating forage consumption by the livestock. The cage and exclosure method has been used to protect portions of a pasture from grazing. This method assumes that forage consumed equals herbage yield from the exclosed area minus herbage remaining ungrazed from an area of equal size. Bement (1968) explains that one of the main difficulties with the cage method is the different rates of herbage growth that occur within the two areas.

Bement and Klipple (1959) used a comparison method of estimating forage intake by clipping pastures before and after grazing by cattle. Cook et al. (1951) and Reid (1962*b*) noted that a digestion coefficient could be determined and forage intake calculated by natural plant indicators such as lignin. However, the digestibility of natural plant indicators is uncertain.

Wallace and Van Dyne (1970) noticed lignin digestibility as high as 46% in immature forage. Water-intake rates (gallons of water consumed per pound of dry matter eaten) at various air temperatures were calculated by Winchester and Morris (1956):

$$\text{free water consumption} = \text{total water} - \frac{\frac{\%\ \text{water in feed}}{\%\ \text{dry matter}} \times \text{daily dry matter intake}}{\text{weight of water (lb./cal)}}$$

Hyder et al. (1966) estimated forage intake by measuring water consumption of steers and solving the above equation for dry matter intake. The water-intake method requires measurements of forage moisture content, mean daily air temperature, and water consumption of grazing animals.

Forage quality has been measured by various means. Cook (1970) expressed forage quality on an energy basis on spring, summer, and winter ranges. By measuring the body weight changes of the grazing animal for each season, forage energy production can be measured in terms of digestible, metabolizable, and net energy. Reid (1962*a*) discussed measuring body weight changes of the foraging animal to estimate forage quality. The animal body weight changes may serve as an index of nutrient quality of forage and reflect nutrient value per unit of herbage consumed. Dry matter conversion rate is considered the best measure of forage quality in terms of what a given group of cattle did with a given amount of available forage at a given time according to Bement (1968).

The purpose of this study was to measure and compare herbage growth rate, forage intake, and forage quality on heavily and lightly grazed blue grama pastures during the summer of 1971. These adjacent pastures were

grazed at their respective intensities from May through October for 32 consecutive years prior to 1971.

SAMPLING PROCEDURE

Standing herbage was measured biweekly by the double sampling method on heavily (23E) and lightly (23W) grazed pastures at the Central Plains Experimental Range. Eight ½-mile-long transects, extending the width of the pastures, were systematically spaced along the length of the pastures. Ten plots were measured on each transect. A trained observer estimated standing herbage to the nearest 22.75 kg (50 lb./acre ovendry) on each plot. One plot on each transect was clipped after the estimate was made. The clipped samples were dried, a regression coefficient calculated, and all estimated plots were corrected. Confidence limits at the 95% level of probability were calculated for the corrected standing herbage.

Members of the Crow Valley Livestock Cooperative furnished 30 and 12 Hereford heifers for the heavily and lightly grazed pasture, respectively. These heifers were turned in to graze the pastures on May 3 and removed October 28.

Each herd drank from its own float-controlled water tank. Water drunk from each tank was measured daily to the nearest .4 liter by Neptune Triseal splitcase water meters. Evaporation losses were measured from a similar water tank from which cattle were excluded, and corrected water intake by heifers was calculated.

Moisture content of forage consumed by heifers was measured daily from hand-plucked forage samples collected by observers moving with the grazing

herds. Percent moisture content of forage was calculated from the fresh and dry forage sample weights.

Mean daily air temperatures were obtained by averaging maximum and minimum daily air temperatures.

Mean daily temperatures and percent moisture content of forage were used from the table "Food-intake Rates of European Cattle in Pounds of Herbage Dry Matter Consumed Per Gallon of Water Drunk" (Hyder et al., 1966) to estimate the pounds of dry matter consumed per day. Daily forage intake was calculated for each biweekly period.

Heifers were weighed biweekly after an overnight shrink (approximately 15 hr). Mean herd liveweight with 95% confidence limits and period animal gain were calculated.

Forage quality, expressed as kilograms daily forage intake by heifers per kilogram daily gain, or dry matter conversion rate, was calculated for each biweekly period.

RESULTS

Standing herbage in the heavily grazed pasture increased during the periods June 16 to June 29, July 28 to August 10, and August 25 to September 7, and decreased during the remaining periods (Table 1). Standing herbage in the lightly grazed pasture increased each period from June 2 to June 29 and decreased each period from June 30 to September 21 (Table 2). Standing herbage biomass was greater in the lightly grazed pasture than the heavily grazed pasture at all times during the study.

The highest rate of herbage growth occurred from July 28 to August 10 in the heavily grazed pasture and June 2 to June 15 in the lightly grazed

Table 1. Herbage growth (g/m^2) in 1971 in heavy-use pasture (23E).

Period		Standing Herbage	Difference	Herbage Eaten	Herbage Growth	
From	To				Period	Daily
	6/1	42.71 ± 1.70[a/]				
6/2	6/15	38.73 ± 2.68	-3.98	2.05	-1.93	-.14
6/16	6/29	38.99 ± 1.58	.26	2.44	2.70	.19
6/30	7/13	37.59 ± 1.50	-1.40	2.25	.85	.06
7/14	7/27	36.89 ± 2.73	- .70	2.45	1.75	.12
7/28	8/10	37.93 ± 0.86	1.04	2.10	3.14	.22
8/11	8/24	24.05 ± 1.76	-13.88	1.87	-12.01	-.86
8/25	9/7	24.64 ± 0.81	.59	1.80	2.39	.17
9/8	9/21	22.39 ± 0.78	-2.25	1.29	-.96	-.07
				Total	-4.07	

[a/] 95% confidence limits.

Table 2. Herbage growth (g/m^2) in 1971 in light-use pasture (23W).

Period From	Period To	Standing Herbage	Difference	Herbage Eaten	Herbage Growth Period	Herbage Growth Daily
	6/1	44.62 ± 1.74[a/]				
6/2	6/15	58.16 ± 4.05	13.54	.92	14.46	1.03
6/16	6/29	60.56 ± 3.36	2.40	.97	3.37	.24
6/30	7/13	60.27 ± 2.80	- .29	1.03	.74	.05
7/14	7/27	47.48 ± 2.57	-12.79	.95	-11.84	- .85
7/28	8/10	45.17 ± 1.88	- 2.31	.93	- 1.38	- .10
8/11	8/24	43.46 ± 2.51	- 1.71	.90	- .81	- .06
8/25	9/7	42.87 ± 1.85	- .59	.90	.31	.02
9/8	9/21	40.70 ± 2.01	- 2.17	.61	- 1.56	- .11
				Total	3.29	

[a/] 95% confidence limits.

pasture. Herbage growth in the heavily grazed pasture occurred at various periods throughout the June 2 to September 21 study period while all herbage growth in the lightly grazed pasture occurred from June 2 to July 13 and August 25 to September 7. The period of greatest herbage loss was August 11 to August 24 in the heavily grazed pasture and July 14 to July 27 in the lightly grazed pasture. Total seasonal growth was 3.29 g/m^2 and -4.07 g/m^2 for the lightly and heavily grazed pastures, respectively (Tables 1 and 2). Total seasonal growth is significantly different ($P > .05$) for the two pastures.

Average daily dry matter intake (kg/head/day) was 6.97 and 6.28 by heifers in the lightly and heavily grazed pastures, respectively (Tables 3 and 4). This difference in dry matter intake was not significant ($P < .05$). Maximum dry matter intake of 7.96 kg per heifer per day was measured from June 30 to July 13 on heifers grazing the light-use pasture. Minimum dry matter intake of 4.11 kg per heifer per day occurred during the period September 8 to September 21 by heifers grazing the heavy-use pasture.

Heifer gain per head during the period June 2 to September 21 was 90 kg and 54 kg in the lightly and heavily grazed pastures, respectively (Tables 5 and 6). This difference in gain per head between the two pastures was significant ($P < .01$).

In the heavily grazed pasture, forage quality, as measured by the dry matter conversion rate, was low during the period June 2 to June 15. During the period June 16 to June 29, forage quality was highest when the dry matter conversion rate reached 4.82 (Table 7). During the periods June 30 to July 13 and July 14 to July 27 forage quality decreased when the dry matter conversion rate was 14.77 and 13.03, respectively. Forage

Table 3. Amount of ovendry forage eaten by yearling heifers on heavily grazed pasture (23E) in 1971 as estimated by the water intake method.

Period		Moisture Content of Forage	Mean Air Temp.	Mean Daily Water Drunk	Dry Matter Intake/Liter Water Drunk	Dry Matter Intake	Number Days	Number Heifers	Forage Grazed
From	To	(%)	(^{o}C)	(liter)	(kg)	(kg/head/day)			(g/m^2)
6/2	6/15	56	16.7	17.1	0.37	6.32	14	30	2.05
6/16	6/29	50	21.2	26.2	0.29	7.52	14	30	2.44
6/30	7/13	45	21.0	25.4	0.27	6.94	14	30	2.25
7/14	7/27	38	19.9	28.4	0.27	7.56	14	30	2.45
7/28	8/10	34	18.9	23.9	0.27	6.49	14	30	2.10
8/11	8/24	26	22.7	25.0	0.23	5.77	14	30	1.87
8/25	9/7	21	21.4	23.3	0.24	5.54	14	30	1.80
9/8	9/21	34	10.7	11.8	0.35	4.11	14	29	1.29
					Average	6.28			

Table 4. Amount of ovendry forage eaten by yearling heifers on lightly grazed pasture (23W) in 1971 as estimated by the water intake method.

Period		Moisture Content of Forage	Mean Air Temp.	Mean Daily Water Drunk	Dry Matter Intake/Liter Water Drunk	Dry Matter Intake	Number Days	Number Heifers	Forage Grazed
From	To	(%)	(°C)	(liter)	(kg)	(kg/head/day)			(g/m^2)
6/2	6/15	59	16.7	17.8	0.40	7.10	14	12	.92
6/16	6/29	50	21.2	26.2	0.29	7.52	14	12	.97
6/30	7/13	46	21.0	28.8	0.28	7.96	14	12	1.03
7/14	7/27	30	19.9	28.8	0.25	7.33	14	12	.95
7/28	8/10	30	18.9	27.3	0.26	7.21	14	12	.93
8/11	8/24	25	22.7	30.3	0.23	6.97	14	12	.90
8/25	9/7	24	21.4	28.8	0.24	6.94	14	12	.90
9/8	9/21	39	10.7	13.0	0.36	4.74	14	12	.61
					Average	6.97			

Table 5. Cattle gains on the heavily grazed pasture (23E) in 1971.

Date	No. Head	No. Days	Liveweight	Total Gain	Gain/ Head	Daily Gain/ Head
			(kg)	(kg)	(kg)	(kg)
6/2	30		6734.2			
6/16	30	14	6898.5	164.3	5.48	0.39
6/30	30	14	7554.6	656.1	21.87	1.56
7/14	30	14	7751.1	196.5	6.55	0.47
7/28	30	14	7994.0	242.9	8.10	0.58
8/11	30	14	8283.7	289.7	9.66	0.69
8/25	30	14	8466.6	182.9	6.10	0.44
9/8	30	14	8424.9	-41.7	-1.39	-0.10
9/22	29	14	8087.6	-58.5	-1.95	-0.14
			Total	1632.2	54.42	

Table 6. Cattle gains on the lightly grazed pasture (23W) in 1971.

Date	No. Head	No. Days	Liveweight	Total Gain	Gain/ Head	Daily Gain/ Head
			(kg)	(kg)	(kg)	(kg)
6/2	12		2636.8			
6/16	12	14	2909.2	272.4	22.70	1.62
6/30	12	14	3077.2	168.0	14.00	1.00
7/14	12	14	3198.9	121.7	10.14	.72
7/28	12	14	3331.0	132.1	11.01	.79
8/11	12	14	3435.4	104.4	8.70	.62
8/25	12	14	3602.5	167.1	13.92	.99
9/8	12	14	3691.5	89.0	7.42	.53
9/22	12	14	3716.4	24.9	2.08	.15
			Total	1079.6	89.97	

Table 7. Quantity and quality of forage eaten by yearling heifers on heavily grazed pasture (23E) in 1971.

Period		Mean Liveweight Start of Period	Daily Gain	Dry Matter Intake[a]	Dry Matter Conversion Rate
From	To	(kg)	(kg)	(kg/head/day)	(kg DM/kg gain)
6/2	6/15	224.5 ± 7.82[b]	0.39	6.32	16.21
6/16	6/29	230.0 ± 8.09	1.56	7.52	4.82
6/30	7/13	251.8 ± 8.55	0.47	6.94	14.77
7/14	7/27	258.4 ± 8.18	0.58	7.56	13.03
7/28	8/10	266.5 ± 8.36	0.69	6.49	9.41
8/11	8/24	276.1 ± 8.33	0.44	5.77	13.11
8/25	9/7	282.2 ± 8.79	-0.10	5.54	∞
9/8	9/21	280.8 ± 8.18	-0.14	4.11	∞
9/22		278.8 ± 7.55			

a/ Oven-dry forage.

b/ 95% confidence limits.

quality improved during July 28 to August 10 when the dry matter conversion rate went to 9.41. The dry matter conversion rate rose to infinity the last two periods when standing herbage dropped to 24.64 g/m^2 and the heifers lost weight.

In the lightly grazed pasture forage quality was highest from June 2 to June 15 when it took 4.38 kg of dry matter to produce 1 kg of heifer gain. Forage quality decreased continually from June 16 to July 13 and improved during the period July 14 to July 27 when dry matter conversion rate was 9.29 (Table 8). During the period July 28 to August 10 forage quality decreased, and from August 11 to August 24 it improved when the dry matter conversion rate was 11.63 and 7.04, respectively. During the period September 8 to September 21 forage quality was lowest when it took 31.60 kg dry matter to produce 1 kg of heifer gain.

Cattle liveweight biomass is given in Table 9 for the heavily and lightly grazed pastures in 1971.

CONCLUSION AND DISCUSSION

Herbage growth in the heavily grazed pasture had greater response to summer rain showers than herbage growth in the lightly grazed pasture except during the two periods from July 14 to August 10. During this time it is believed that herbage consumed by insects was greatest. However, herbage consumption by insects is not measured by this method of estimating herbage growth rate.

The fluctuations in dry matter intake in the heavily and lightly grazed pastures were not correlated with herbage growth rate. Dry matter intake by hiefers on the heavily and lightly grazed pastures decreased the last period when snow covered the forage.

Table 8. Quantity and quality of forage eaten by yearling heifers on lightly grazed pasture (23W) in 1971.

Period		Mean Liveweight Start of Period	Daily Gain	Dry Matter Intake[a]	Dry Matter Conversion Rate
From	To	(kg)	(kg)	(kg/head/day)	(kg DM/kg gain)
6/2	6/15	219.7 ± 20.60[b]	1.62	7.10	4.38
6/16	6/29	242.4 ± 21.18	1.00	7.52	7.52
6/30	7/13	256.4 ± 20.92	0.72	7.96	11.06
7/14	7/27	266.6 ± 20.15	0.79	7.33	9.29
7/28	8/10	277.6 ± 20.12	0.62	7.21	11.63
8/11	8/24	286.3 ± 20.52	0.99	6.97	7.04
8/25	9/7	300.2 ± 20.07	0.53	6.94	13.09
9/8	9/21	307.6 ± 19.56	0.15	4.74	31.60
9/22		309.7 ± 20.11			

[a] Oven-dry forage.

[b] 95% confidence limits.

Table 9. Cattle liveweight biomass, 1971.

Date	23E Heavy-use	23W Light-use
	- - - - - - - g/m^2 - - - - - - -	
5/3	4.83 ± .19[a/]	1.94 ± .19[a/]
6/2	5.20 ± .18	2.03 ± .19
6/16	5.32 ± .19	2.24 ± .20
6/30	5.83 ± .20	2.37 ± .19
7/14	5.98 ± .19	2.47 ± .19
7/28	6.17 ± .19	2.57 ± .19
8/11	6.39 ± .19	2.65 ± .19
8/25	6.53 ± .20	2.78 ± .19
9/8	6.50 ± .19	2.85 ± .18
9/22	6.24 ± .17	2.87 ± .19

[a/] 95% confidence limits.

Heifers in the heavily grazed pasture lost weight the last two periods when standing herbage dropped to 25 g/m^2 and adequate forage was not available.

When standing herbage was greater than 25 g/m^2 from June 2 to August 24, forage quality did not differ significantly ($P > .05$). When standing herbage decreased to 25 g/m^2 from August 25 to September 21, heifers grazing the heavy-use pasture lost weight, and forage quality as measured by the dry matter conversion rate could not be measured quantitatively. When standing herbage decreases to 25 g/m^2 dry matter conversion rate is no longer a measure of forage quality.

LITERATURE CITED

App, B. A. 1962. Pasture insect pests. Pasture and range research techniques. Comstock Publ. Ass., Ithaca, New York. 242 p.

Bement, R. E. 1968. Herbage growth rate and forage quality on shortgrass range. Ph.D. Diss. Colorado State Univ., Fort Collins. 53 p.

Bement, R. E., and G. E. Klipple. 1959. A pasture-comparison method of estimating utilization of range herbage on the Central Great Plains. J. Range Manage. 12:296.

Cook, C. W. 1970. Energy budget of range and range livestock. Colorado State Exp. Sta. Bull. 109. 28 p.

Cook, C. W., L. A. Stoddard, and L. E. Harris. 1951. Measuring consumption and digestibility of winter plants by sheep. J. Range Manage. 4:335.

Hyder, D. N., R. E. Bement, J. J. Norris, and M. J. Morris. 1966. Evaluating herbage species by grazing cattle. Part I. Food intake, p. 970. *In* X Int. Grassland Congr., Proc.

Kreitlow, K. W., J. H. Graham, and R. J. Garber. 1953. Diseases of forage grasses and legumes in northeastern states. Pennsylvania Agr. Exp. Sta. Bull. 573 p.

Reid, J. T. 1962*a*. Animal performance. Pasture and range research techniques. Comstock Publ. Ass., Ithaca, New York. 242 p.

Reid, J. T. 1962*b*. Indicator methods in herbage quality studies. Pasture and range research techniques. Comstock Publ. Ass., Ithaca, New York. 242 p.

Vaughan, T. A. 1967. Food habits of the northern pocket gopher on shortgrass prairie. Amer. Midland Natur. 77:176-189.

Wallace, J. D., and G. M. Van Dyne. 1970. Precision of indirect methods for estimating digestibility of forage consumed by grazing cattle. J. Range Manage. 23(6):424-430.

Winchester, C. F., and M. J. Morris. 1956. Water-intake rates of cattle. J. Anim. Sci. 15:722.