GRAZING BEHAVIOR OF RANGELAND BEEF CATTLE DIFFERING IN BIOLOGICAL TYPE[1]

R. N. Funston[2], D. D. Kress[3], K. M. Havstad[4] and D. E. Doornbos[5]

Northern Agricultural Research Center, Havre, MT 59501 and Montana State University, Bozeman 59717

ABSTRACT

Grazing behavior exhibited by different biological types (breed groups) of lactating beef cows was evaluated during the summers of 1985 (Trial 1) and 1986 (Trial 2). Animals grazed native Montana foothill grassland. In Trial 1, breed groups consisted of Hereford (HH), 50% Angus-50% Hereford (AH), 50% Simmental-50% Hereford (SH), and 75% Simmental-25% Hereford (3S1H) with six cows per breed group. Daily grazing hours were 11.8 ± .2, 12.3 ± .2, 11.6 ± .2, and 11.6 ± .5 h/d for HH, AH, SH, and 3S1H, respectively. There was a tendency for AH cows to graze longer than HH and SH cows (P = .10). Bite rates were 52.7 ± 1.5, 56.2 ± 1.5, 53.2 ± 1.4, and 59.0 ± 1.6 bites/min for HH, AH, SH, and 3S1H, respectively. The AH and 3S1H cows had higher bite rates (P < .05) than the HH and SH cows. Means for distance traveled were 3.1 ± .2, 3.4 ± .2, 4.0 ± .2, and 2.8 ± .2 km/d for HH, AH, SH and 3S1H, respectively. The SH cows tended to travel farther (P < .10) than cows of other breed groups. The AH traveled farther than the 3S1H but did not differ from the HH. In Trial 2, breed groups were Hereford (HH), Tarentaise-Hereford (TH), Tarentaise-Simmental-Hereford (T(SH)), and Charolais-Simmental-Hereford(C(SH)); each group included six lactating cows. Means for bite rate were 56.9 ± 1.1, 58.7 ± 1.1, 60.9 ± 1.0, and 59.0 ± 1.1 bites/min for HH, TH, T(SH), and C(SH), respectively. The T(SH) cows had a higher bite rate than the HH cows (P < .10), but bite rates did not differ between T(SH) and TH or C(SH) cows. Breed group means were not different (P > .10) for grazing time and distance traveled. Thus, bite rate was the only behavioral expression that was consistently different among breed groups and may be a response that allows different biological types to achieve different levels of intake.

Key Words: Beef Cattle, Grazing Behavior, Rangelands, Breeds, Groups

J. Anim. Sci. 1991. 69:1435–1442

Introduction

Rangelands are one of the largest renewable resources of the Northern Great Plains. Research addressing the interface of beef cattle and rangelands is of great importance to those who use rangeland for beef production. Identification of the biological types that exhibit grazing behaviors favorable to the efficient use of range forage warrants further investigation. Squires (1978) emphasized that data on general range livestock behavior are available, but little attention has been given to the relationships between free-range activities and subsequent animal performance. The objective of this study was to evaluate the grazing behavior and production characteristics of different biological types of beef cattle grazing summer rangeland.

[1]Montana Agric. Exp. Sta., Journal Ser. No. J-2443.
[2]754 Custer St., Dickinson, ND 58601.
[3]Dept. of Anim. and Range Sci.
[4]USDA-ARS, Las Cruces, NM 88003.
[5]Northern Agric. Res. Center, Star Route 36-Box 43, Havre, MT 59501.

Received May 4, 1990.
Accepted October 19, 1990.

Materials and Methods

The study was conducted during the summers of 1985 and 1986 on mountain foothill rangeland in the Bear Paw Mountains, 32 km southeast of Havre, Montana. The study site had an average elevation of 1,300 m with slopes ranging from 5 to 40% and average annual precipitation of 48 cm. The major grasses on the study site were rough fescue (*Festuca scabrella*), Idaho fescue (*Festuca idahoensis*), and bluebunch wheatgrass (*Agropyron spicatum*) on the upland areas and Kentucky bluegrass (*Poa pratensis*) on the lowland areas. The pasture used in 1985 was approximately 320 ha in size and contained 250 lactating cows from July 22 to September 16, for a stocking rate of .67 ha/Animal Unit Month (AUM). The pasture in 1986 was approximately 276 ha and contained 56 cows from June 1 to October 1, for a stocking rate of 1.2 ha/AUM.

In 1985 (Trial 1), 24 cows of four breed groups were used with six cows each of Hereford (HH), 50% Angus-50% Hereford (AH), 50% Simmental-50% Hereford (SH), and 75% Simmental-25% Hereford (3S1H). Cows ranged in age from 6 to 9 yr old and were selected at random within breed type. All cows were nursing calves sired by Hereford bulls and were from a common management background.

Cows were equipped with vibracorders from July 22 to September 16, as described by Stobbs (1970), to estimate grazing time. Vibracorders remained on the animals for the entire trial. Charts were changed and clocks were rewound at approximately 9-d intervals. Portable corrals at watering areas were used to minimize animal disturbance when vibracorders were changed. Animals were restrained by a halter and rope tied to corral corners. Grazing times were disregarded on days when equipment was changed. Each day's grazing time was divided into eight 3-h periods (2400 to 0300, 0300 to 0600, 0600 to 0900, 0900 to 1200, 1200 to 1500, 1500 to 1800, 1800 to 2100, and 2100 to 2400).

Distance traveled by each cow was estimated by the use of pedometers (Anderson and Kothmann, 1977). Pedometers were read and reset each time vibracorders were changed. Instrument loss or failure was minimal. Calibration factors were not calculated in 1985, but in 1986 the cows were walked a known distance to calibrate the pedometers. Because the same type of pedometer was used both years, the calibration factors for 1986 were averaged and used in 1985. This factor (.894) was multiplied by the actual pedometer readings and then divided by the number of days the pedometer was on the animal to estimate the distance per day. An average of six pedometer readings per cow was recorded in Trial 1 and four per cow in Trial 2.

Bite rate was calculated by counting the number of bites during a 5-min period. A watch with an independent 5-min timer and stopwatch was used. The stopwatch was stopped when an animal stopped biting (raised her head), and the observation was concluded when the 5-min alarm sounded. A hand-held counter was used to record the number of bites. The number of bites was then divided by the stopwatch time to calculate bites/minute. A telescope was used to watch the cows early in the season until they could be approached on horseback without disturbance. Bite rates were taken from 0600 to 0900 and 1800 to 2100 because these intervals were identified by Lathrop et al. (1988) as the two major diurnal grazing periods. The average number of bite rate observations per cow was eight in Trial 1 and 21 in Trial 2.

Milk production, calf weights, and cow weights were taken twice in 1985 (August 2 and 29) and three times in 1986 (July 18, August 22, and September 30). Milk production was estimated using the weigh-suckle-weigh technique (Williams et al., 1979). A 9- or 10-h separation interval was used before measuring milk production and cow and calf weights. Milk production was then converted to a 24-h basis.

In 1986 (Trial 2), 24 lactating cows representing four breed groups were used: Hereford (HH), Tarentaise-Hereford (TH), Tarentaise-Simmental-Hereford (T(SH)), and Charolais-Simmental-Hereford (C(SH)). The TH were six 50% Tarentaise-50% Hereford cows, the T(SH) consisted of three 50% Tarentaise-25% Simmental-25% Hereford and three 50% Tarentaise-37.5% Simmental-12.5% Hereford cows, and the C(SH) group contained five 50% Charolais-25% Simmental-25% Hereford cows and one 50% Charolais-37.5% Simmental-12.5% Hereford cow. Cows were all 3 yr old and calves were sired by Hereford bulls.

TABLE 1. LEAST SQUARES MEANS FOR GRAZING TIME (GT), BITE RATE (BR), DISTANCE TRAVELED (DT), COW BODY WEIGHT (BW), CALF WEIGHT (CW), AND MILK PRODUCTION (MP) (TRIAL 1)

Breed group[a]	GT, h/d	BR, bites/min	DT, km/d	BW, kg	CW, kg	MP, kg/d
HH	11.8 ± .2[b]	52.7 ± 1.5[b]	3.1 ± .2[bd]	570 ± 28[b]	166 ± 7[b]	7.6 ± 1.2[b]
AH	12.3 ± .2[c]	56.2 ± 1.5[c]	3.4 ± .2[b]	586 ± 22[b]	171 ± 7[bc]	9.6 ± 1.0[bc]
SH	11.6 ± .2[b]	53.2 ± 1.4[b]	4.0 ± .2[c]	608 ± 22[b]	184 ± 7[cd]	11.8 ± 1.0[c]
3S1H	11.6 ± .5[bc]	59.0 ± 1.6[c]	2.8 ± .2[d]	623 ± 28[b]	197 ± 7[d]	11.4 ± 1.2[c]

[a]HH = Hereford; AH = 50% Angus, 50% Hereford; SH = 50% Simmental, 50% Hereford; and 3S1H = 75% Simmental, 25% Hereford.

[b,c,d]Means in columns with different superscripts differ ($P < .10$).

In addition to grazing time, distance traveled, and bite rate, forage availability was measured periodically from August 5 to September 12, 1986. At the time bite rate observations were taken, cows were randomly chosen and forage availability was estimated in the area where bite rate was observed. Availability was estimated by clipping four .18-m rings thrown from the center of the grazing area. Forage was clipped 2 cm from the ground and grasses, forbs, and shrubs were bagged separately. The samples were then dried in a 500-W microwave oven and forage availability was converted to a kilogram/hectare basis.

Data were analyzed by least squares analysis of variance using GLM procedures of SAS (1985). Differences among treatment means were tested using least significant difference (SAS, 1985).

A mixed model was used for analysis of grazing time, distance traveled, and bite rate. The linear mathematical model was as follows:

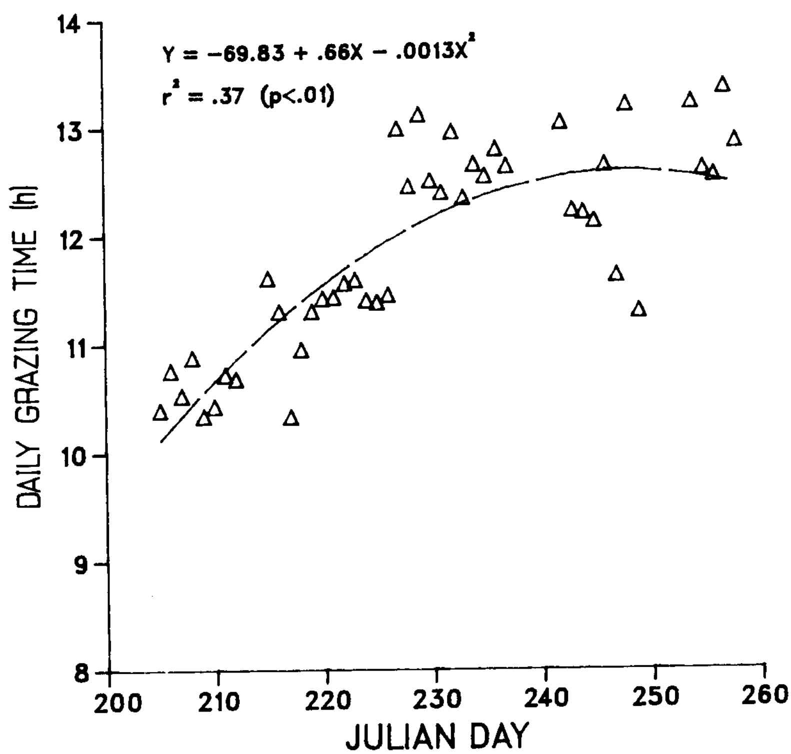

Figure 1. Effect of day of the year on daily grazing time during Trial 1. Triangles indicate daily grazing means. $SE_{b1} = .152$, $SE_{b2} = .00033$.

TABLE 2. LEAST SQUARES MEANS FOR GRAZING TIME (GT), BITE RATE (BR), DISTANCE TRAVELED (DT), COW BODY WEIGHT (BW), CALF WEIGHT (CW), AND MILK PRODUCTION (MP) (TRIAL 2)

Breed group[a]	GT, h/d	BR, bites/min	DT, km/d	BW, kg	CW, kg	MP, kg/d
HH	11.3 ± .2[b]	56.9 ± 1.1[b]	3.5 ± .4[b]	535 ± 16[b]	154 ± 7[b]	6.4 ± .5[b]
TH	11.3 ± .2[b]	58.7 ± 1.1[bc]	3.8 ± .4[b]	532 ± 15[b]	168 ± 7[bc]	8.5 ± .5[c]
T(SH)	11.4 ± .2[b]	60.9 ± 1.0[c]	3.6 ± .4[b]	530 ± 16[b]	185 ± 7[c]	8.5 ± .5[c]
C(SH)	11.2 ± .2[b]	59.0 ± 1.1[bc]	3.6 ± .4[b]	572 ± 16[c]	179 ± 7[c]	7.5 ± .5[bc]

[a]HH = Hereford; TH = 50% Tarentaise, 50% Hereford; T(SH) = 50% Tarentaise, 25% Simmental, 25% Hereford or 50% Tarentaise, 37.5% Simmental, 12.5% Hereford; and C(SH) = 50% Charolais, 37.5% Simmental, 12.5% Hereford.

[b,c]Means in columns with different superscripts differ ($P < .10$).

$Y_{ijkl} = \mu + B_i + I_j + BI_{ij} + C(BI_{ij})_k + e_{ijkl}$, where Y_{ijkl} = an individual observation (grazing time, distance traveled, or bite rate), μ = the overall mean, B_i = the fixed effect of the i^{th} breed group, I_j = the fixed effect of the j^{th} sex of calf, BI_{ij} = the interaction between the i^{th} breed type and the j^{th} calf sex, $C(BI_{ij})_k$ = the random effect of the k^{th} cow within the ij^{th} BI interaction, and e_{ijkl} = random error.

The random effect of $C(BI_{ij})_k$ was used as the error term to test the fixed effects of breed, calf sex, and breed × calf sex interaction because of repeated measurements taken on each animal (Gill and Hafs, 1971).

The linear and quadratic effects of day of year were added to the model and tested for importance. Measures of production (cow weight, weight:height ratio, calf weight, milk

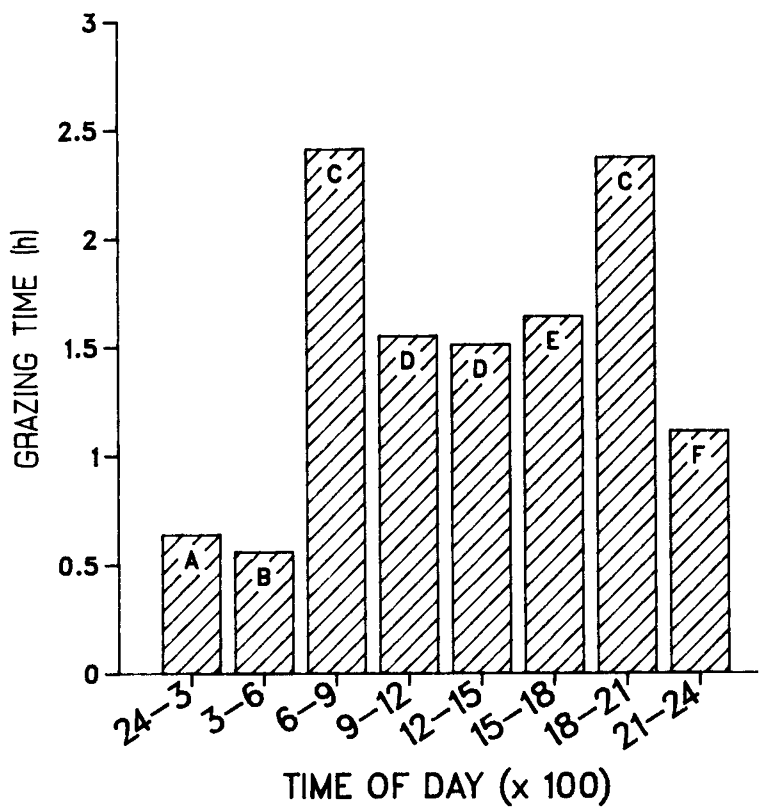

Figure 2. Time of day grazing during Trial 1. Bars with different letters differ ($P < .05$). Standard errors of means ranged from .04 to .05 h.

production, cow condition score, calf condition score, and calf age) were added to the model as covariates to determine their effect on grazing time, distance traveled, and bite rate. In the analysis of bite rate, time of observation (am or pm), observer, observer × breed interaction, and time × breed interaction were added to the model as independent variables.

Cow weight, milk production, and calf weight were analyzed according to the first model described with test day and breed × test day interaction added.

Results and Discussion

Trial 1. Means for the grazing behavior traits and production characteristics of each breed group are shown in Table 1. The overall mean for daily grazing time was 11.9 h/d with a standard deviation of 1.1 h/d (649 observations with an average of 27 daily grazing observations per cow). There was a tendency for AH cows to graze longer than HH and SH cows ($P < .10$), but they did not differ from the 3S1H cows. These differences were small and may not be biologically important. Lathrop et al. (1988) found few significant differences in daily grazing time using the same four breed types at the same location, but AH cows grazed longer for three of the four periods.

Production covariates and calf sex were not significant in explaining variation in grazing time. Lathrop et al. (1988) found that cow milk production had a positive effect on grazing time, whereas other researchers have reported no effect of milk production on grazing time (Johnstone-Wallace and Kennedy, 1944; Hancock, 1950; Johnstone-Wallace, 1951).

Figure 1 illustrates the effect of day of the year on daily grazing time. As season progressed from d 200 to 260 grazing time increased to a maximum of approximately 12.5 h and then leveled off. Precipitation in 1985 was 12.4 cm, compared with the long-term average precipitation of 48 cm, and observed forage growth during the grazing season was minimal. Research has shown that under declining forage availability grazing time increases (Allden, 1970; Chacon and Stobbs, 1976; Jamieson and Hodgson, 1979; Zoby and

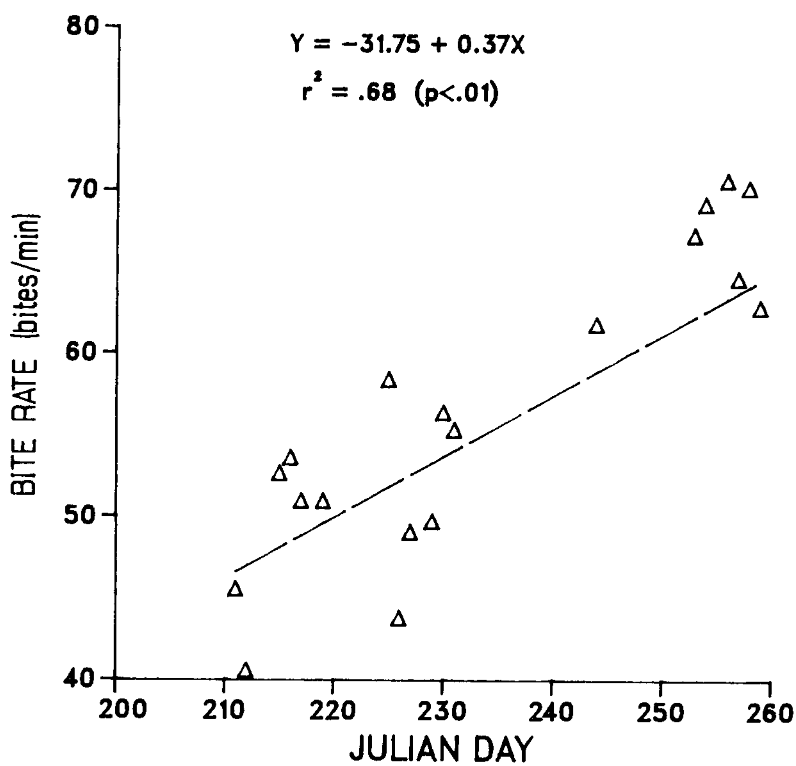

Figure 3. Effect of day of the year on bite rate during Trial 1. Triangles indicate daily bite rate means. $SE_b = .059$.

Holmes, 1983; Scarnecchia et al., 1985). Stobbs (1975) estimated that grazing time is limited by fatigue. Fatigue limit was estimated at approximately 12 h/d grazing; this is supported by the maximum grazing time in Figure 1.

Figure 2 shows the overall means for time of day grazing. The major periods of grazing occurred from 0600 to 0900 and 1800 to 2100. Other researchers have found similar grazing patterns for cattle on summer pasture (Dwyer, 1961; Kropp et al., 1973; Arnold and Dudzinski, 1978; Zoby and Holmes, 1983; Lathrop et al., 1988). Breed group did not significantly influence time of day grazing.

Breed group was a significant source of variation for bite rate, and the means are presented in Table 1. The AH and 3S1H cows had higher bite rates ($P < .05$) than the HH and SH cows.

Bite rate measurements taken from 1800 to 2100 were higher ($P < .05$) than those taken from 600 to 900 (56.3 ± .7 and 54.3 ± .7 bites/min, respectively). The observer influenced bite rate counts (59.3 vs 51.3 bites/min; $P < .01$), but the observer × breed group interaction was not significant.

Figure 3 shows the effect of day on bite rate. As the season progressed from d 210 to 260, the bite rate increased linearly. Other researchers have shown that as forage availability declines bite rate increases (Chacon and Stobbs, 1976; Jamieson and Hodgson, 1979; Zoby and Holmes, 1983; Scarnecchia et al., 1985). Therefore, declining forage availability could have caused the increase in bite rate. None of the production covariates was significant in the bite rate analysis, nor was calf sex.

Breed group was significant for distance traveled (Table 1). The SH cows traveled farther ($P < .10$) than the three other breed types. The AH cows traveled farther than the 3S1H cows but did not differ from the HH cows. However, Lathrop et al. (1988) found that SH cows traveled less than the three other breed groups. None of the production covariates, calf sex, or linear or quadratic regressions on day was significant for distance traveled.

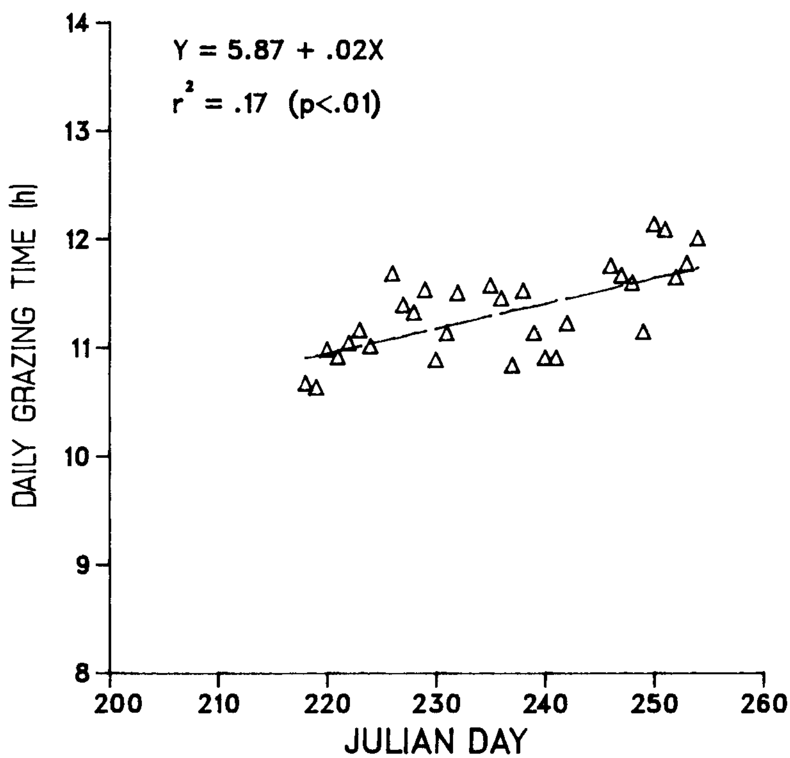

Figure 4. Effect of day of the year on daily grazing time during Trial 2. Triangles indicate daily grazing means. SE_b = .008.

Trial 2. Means for grazing behavior and production traits are shown in Table 2 for each breed group. The overall mean for daily grazing time was 11.3 h/d with a standard deviation of 1.0 h/d (606 observations with an average of 25 daily grazing measurements per cow). Breed groups did not differ significantly in daily grazing time (Table 2). The production covariates and calf sex were not significant in explaining variation in grazing time. Figure 4 illustrates the effect of day on daily grazing time. As the season progressed from d 215 to 260 daily grazing time increased from approximately 11 to 11.5 h/d, which is below the 12-h fatigue limit proposed by Stobbs (1975).

The major periods of grazing occurred from 0600 to 0900 and from 1800 to 2100, and the trend was similar to that observed in Trial 1 (Figure 2). The forage availability estimates for 1986 are presented in Table 3. Forage availability of grasses, which were observed to be the primary component of cow diets, remained fairly constant during the study. This was probably the reason that there was no large increase in grazing time, as was observed in Trial 1. Forage availability was probably adequate to meet intake demands, so fatigue limits were not reached.

TABLE 3. FORAGE AVAILABILITY FOR GRASSES, FORBS, AND SHRUBS (TRIAL 2)

Julian day	Grasses, kg/ha	Forbs, kg/ha	Shrubs, kg/ha
218 to 225	890	455	59
237 to 241	853	240	14
246 to 254	967	215	10

Breed group was important for bite rate (Table 2). The bite rate of T(SH) cows was higher ($P < .10$) than that of HH cows ($P < .10$) but did not differ from that of the TH or C(SH) cows. Bite rates of the TH and C(SH) cows did not differ from those of the HH cows ($P > .10$). The T(SH) breed type had higher milk production and calf weights (Table 2) than the HH breed type and probably had higher intake as well, which could explain the bite rate difference.

Time of day in which the bite rate observations were taken was not a significant source of variation, as it was in Trial 1.

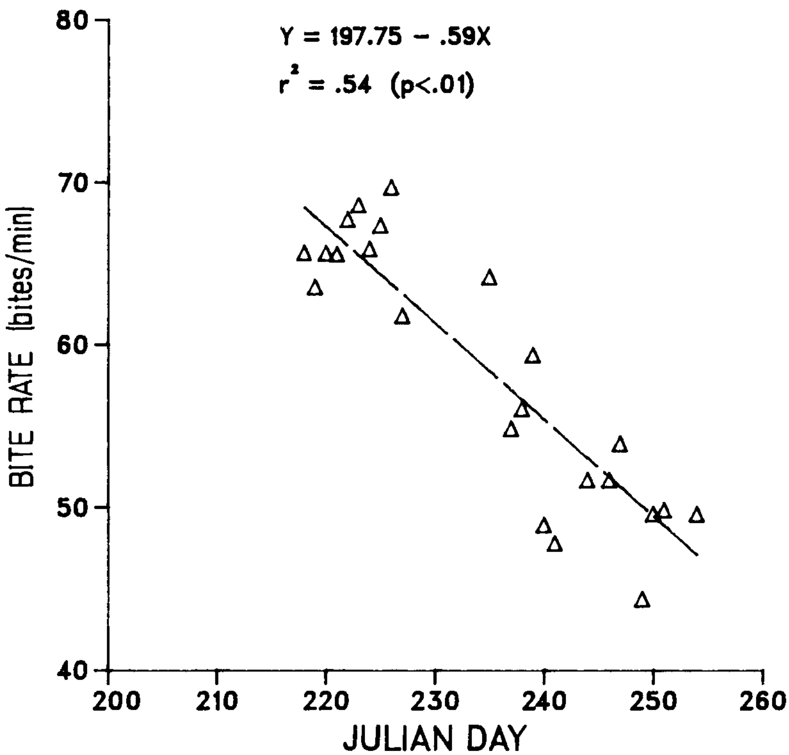

Figure 5. Effect of day of the year on bite rate during Trial 2. Triangles indicate daily bite rate means. $SE_b = .067$.

Observers differed ($P < .01$) in bite rate observations (59.7 vs 58.1 bites/min), but there was no significant observer × breed group interaction.

Figure 5 shows the effect of day on bite rate. As the season progressed from d 210 to 255, the bite rate linearly decreased. Available forage was fairly consistent during this grazing season. It has been shown that bite rate increases with declining forage availability, and this year there was a consistent and adequate quantity of available forage, so bite rate may have the opposite response. Bite rate may also have declined in response to observed regrowth of cool-season grasses during the late summer of Trial 2. The production covariates and calf sex were tested for their effect on bite rate, but none was found to be significant ($P > .10$).

Breed group was not significant for distance traveled (Table 2). None of the production covariates, calf sex, or linear or quadratic regressions on day was significant for distance traveled.

Implications

These results suggest that different biological types of beef cattle do not differ greatly in time spent grazing and distance traveled when grazing rangeland. Grazing time tended ($P =$ .10) to differ among breed groups in Trial 1 but not in Trial 2. Distance traveled differed among breed groups in Trial 1 but not in Trial 2. In both trials biological types differed significantly in production characteristics, so the opportunity existed to observe grazing behavior differences. The only measured behavioral characteristic that differed consistently among breed groups in both trials was bite rate; the larger, higher-producing biological types had a higher bite rate.

Literature Cited

Allden, W. G. 1970. Rate of herbage intake and grazing time in relation to herbage availability. Aust. Soc. Anim. Prod. 4:163.

Anderson, D. M. and M. M. Kothmann. 1977. Monitoring animal travel with digital pedometers. J. Range Manage. 30:316.

Arnold, G. W. and M. L. Dudzinski. 1978. Ecology of free-ranging domestic animals. Elsevier Scientific Publishing Co., Amsterdam, The Netherlands.

Chacon, E. and T. H. Stobbs. 1976. Influence of progressive defoliation of a grass sward on the eating behavior of cattle. Aust. J. Agric. Res. 27:709.

Dwyer, D. E. 1961. Activities and grazing preferences of cows with calves in northern Osage County, Oklahoma. Oklahoma Agric. Exp. Sta. Bull. B-588, Stillwater.

Gill, J. L. and H. D. Hafs. 1971. Analysis of repeated measurements of animals. J. Anim. Sci. 33:331.

Hancock, J. 1950. Grazing habits of dairy cows in New Zealand. Emp. J. Exp. Agric. 18:249.

Jamieson, W. S. and J. Hodgson. 1979. The effects of variation in sward characteristics upon the ingestive behaviour and herbage intake of calves and lambs under a continuous stocking management. Grass Forage Sci. 34:273.

Johnstone-Wallace, D. B. 1951. Grazing behaviour in relation to pasture management. Assoc. for the Study of Animal Behaviour, London.

Johnstone-Wallace, D. B. and K. Kennedy. 1944. Grazing management practices and their relationship to the behavior and grazing habits of cattle. J. Agric. Sci. (Camb.) 34:190.

Kropp, J. R., J. W. Holloway, D. F. Stephens, L. Knori, R. D. Morrison and R. Totusek. 1973. Range behavior of Hereford, Hereford × Holstein and Holstein non-lactating heifers. J. Anim. Sci. 36:797.

Lathrop, W. J., D. D. Kress, K. M. Havstad, D. E. Doornbos and E. L. Ayers. 1988. Grazing behavior of rangeland beef cows differing in milk production. Appl. Anim. Behav. Sci. 21:315.

Scarnecchia, D. L. A. S. Nastis and J. C. Malechek. 1985. Effects of forage availability on grazing behavior of heifers. J. Range Manage. 38:177.

Squires, V. R. 1978. Distance trailed to water and livestock response. Proc. Int. Rangeland Cong. 1:431.

Stobbs, T. H. 1970. Automatic measurement of grazing time by dairy cows on tropical grass and legume pastures. Trop. Grassl. 4:237.

Stobbs, T. H. 1975. Factors limiting the nutritional value of grazed tropical pastures for beef and milk production. Trop. Grassl. 9:141.

SAS. 1985. SAS User's Guide: Statistics. SAS Inst., Inc., Cary, NC.

Williams, J. H., D. C. Anderson and D. D. Kress. 1979. Milk production in Hereford cattle. II. Physical measurements: repeatabilities and relationships with milk production. J. Anim. Sci. 49:1443.

Zoby, J.L.F. and W. Holmes. 1983. The influence of size of animal and stocking rate on the herbage intake and grazing behaviour of cattle. J. Agric. Sci. (Camb.) 100: 139.