Vegetational response to short-duration and continuous grazing in southcentral New Mexico

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Abstract

Vegetational response of a nine-paddock, short-duration grazing cell was compared to that of a continuous pasture for a 5-year period in southcentral New Mexico. Differences in vegetational response to short-duration and continuous grazing on blue grama rangeland were small. Basal plant cover was slightly higher for the short-duration pastures, but end-of-season standing crop of all species was similar for both systems. Blue grama aboveground productivity and basal cover were higher for the short-duration pastures than for the continuously-grazed pasture. Possible short-term results from short-duration grazing include slightly higher stocking rates and a positive response of blue grama.

Key Words: primary production, defoliation, *Bouteloua gracilis*

Interest in short-duration grazing in the United States has peaked since these ideas were introduced by Goodloe (1969) and elaborated by Savory (1978, 1979, 1983, 1988) and Savory and Parsons (1980). This grazing strategy has been promoted as a means of utilizing livestock grazing and associated activities to increase primary production and improve conditions for many other uses of rangelands.

While many ranchers have adopted some form of short-duration grazing (e.g., Armijo 1982, Kelton 1982, Tiedeman and Ecret 1986, and Sparks 1987), long-term research results are scarce. Researchers have been intrigued by the possibilities offered by short-duration grazing and research has been conducted in several states and 2 symposia have been convened (Briske and Kothmann 1982, Tiedeman 1986).

Short-term results comparing some form of short-duration grazing with continuous grazing have shown mixed results from the standpoint of livestock and vegetational responses. Early studies in Texas indicated primary productivity increased under short-duration grazing compared to ungrazed controls in some years (Heitschmidt et al. 1982). Other studies have shown increases in composition of grass species considered valuable from a grazing standpoint (Corbett 1984, Dahl et al. 1982). Several studies showed only slight, or inconsistent, differences in vegetational response to short-duration grazing (Pitts and Bryant 1983, Reece et al. 1984, Reece 1986, Hart et al. 1988, Heitschmidt et al. 1987, and Anderson 1988). Other studies have shown heavy stocking could not be maintained with short-duration grazing (Ralphs et al. 1980, Thurow et al. 1988).

Short-duration grazing trials have been underway in southern Africa for some time. Skovlin (1987) reviewed results from these studies and concluded there is no improvement in range condition attributable to short-duration grazing. In northern Mexico, short-duration grazing did not reduce standing crop gradients induced by grazing away from water (Soltero et al. 1989). The hypothesis that short-duration grazing would allow substantial stocking increases has not been supported by these studies.

However, blue grama-dominated rangeland is fairly resistant to heavy grazing (Branson 1953, Smoliak 1974) and might respond to short-duration grazing strategies. Consequently, a short-duration cell was added to the other systems being studied at Ft. Stanton in southcentral New Mexico (Pieper et al. 1978). The objective was to compare vegetational response to short-duration grazing at a heavy stocking rate with continuous grazing at a moderate stocking rate.

Description of Area

Field research for this study was conducted at the 10,552-ha Fort Stanton Cooperative Experimental Ranch. The ranch is in southcentral New Mexico, about 20 km northeast of Ruidoso. The climate is characterized by cool winters and warm summers. The

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mean annual temperature is 11.1° C. Mean minimum is -6.7° C in January and mean maximum 28.9° C in July (Pieper et al. 1971). The 91-year average annual precipitation is 389 mm, the majority falling between June and October. Most precipitation occurs in summer months, the result of convectional thunderstorms that are often localized, of high intensity and short duration. Topography of the ranch is characterized by steep canyons and arroyos that bisect extensive, relatively level mesas. Ranch elevations range from 1,880 to 2,460 m.

Open grassland vegetation is found on mesas and in canyon bottoms. Blue grama (*Bouteloua gracilis* [H.B.K.] Lag. ex steud. dominates all sites. Other grass species include wolftail (*Lycurus phleoides* H.B.K.), sideoats grama (*Bouteloua curtipendula* [Michx.] Torr.), sand dropseed (*Sporobolus cryptandrus* [Torr.] Gray), and creeping muhly (*Muhlenbergia repens* Presl.] Hitch). Important forb species include scarlet globemallow (*Sphaeralcea coccina* [Pursh] Rydb.), Carruth sagewort (*Artemisia carruthii* Wood), zinnia (*Zinnia grandiflora* Nutt.), Dakota verbena (*Verbena bipinnatifida* Nutt), and broom snakeweed (*Gutierrezia sarothrae* [Pursh.] Britt. & Rusby)[1].

All vegetational data for this research were collected from the open grasslands (mesa tops) and canyon bottoms. The study area encompasses portions of a 922-ha SDG cell and portions of a single pasture of 567 ha that was moderately stocked and continuously grazed. The SDG cell was composed of 9 paddocks varying in size from 45 to 210 ha. It was established in 1980, originally divided into 7 paddocks, and further subdivided to create 9 paddocks in 1982. Before implementation of the SDG cell, the area was grazed moderately on a seasonal basis. The continuously grazed pasture was established in 1969. Study site elevations ranged from 1,930 to 2,078 m. The treatments were not replicated in space.

Stocking rates in the short-duration cell ranged from a low of 1.1 times that of the continuously grazed pasture in 1981 and 1982 to a high of 2 times greater in 1985. Stocking rates were always greater in the SDG treatment than in the CG treatment, with one exception. In fall 1982, both grazing treatments were destocked of all cows due to drought conditions, and only the heifer calves were left until the following year.

Table 1. Annual precipitation (mm) by year and season[1] for the continuous and short duration grazing treatments.

Grazing treatment	1980	1981	1982	1983	1984	1985
Continuous						
Growing season	373	429	250	220	293	264
Dormant season	99	46	148	253	156	132
Total	472	475	398	473	449	455
Devition from the mean (%)	+21	+22	+2	+22	+15	+17
Short Duration						
Growing season	294[2]	358	220	219	317	240
Dormant season	20[2]	49	114	200	120	170
Total	314[2]	407	334	419	437	410
Deviation from the mean (%)	--	+5	−14	+8	+12	+5

[1]Growing season: May through September.
[2]SDG rain gauge was not established until mid-July, figures are less than total received.

Table 1 shows annual precipitation received over the course of the study. The amount of total precipitation received was always greater in the continuously grazed pasture than in the SDG cell. Growing season precipitation was greater in the continuously grazed pasture as well, except during 1984, when it was greater in the SDG cell by 24 mm. The amount of precipitation occurring in the continuously grazed pasture varied from 2 to 22% above the ranch mean, while, the precipitation received in the SDG cell varied from 14% lower than to 12% more than the ranch mean. However, there may still be precipitation variation within pastures which were not measured by these gauges.

The soils within the study area are classified as loams. All 3 soil series found on the study area are deep, well drained and formed in alluvium derived from mixed sources (Bailey et al. 1982). The Dioxice loam is found on the mesa top and makes up the greatest proportion of the soils within the study area. The Manzano loam is found in the swales, while the Pena-Dioxice loam is on the ridges and side-slopes of the study area.

Methods

In 1984 and 1985, herbaceous vegetation composition, basal plant cover, and litter cover data were collected by the point-step method described by Evans and Love (1957). This method consists of recording whatever occurs at the boot tip when pacing along a transect. A 2-mm diameter metal rod was used to define the sampling point at the boot tip. When a plant base was directly hit, the species was recorded; when the rod tip hit bare ground, rock or litter, the species of the nearest plant was recorded. Forty 100-point transects were used to collect composition and cover data in both the SDG cell and the continuously grazed pasture. All transects were randomly located within the grassland portion of each grazing treatment. Transects were located within 4 paddocks of the SDG cell. From data collected, percentage plant composition, basal plant cover and litter cover, as well as percentage bare ground/rock, were calculated using methods described by Levy and Madden (1933).

Clipping was used to determine end-of-season herbaceous production. Four sampling points were randomly established in the continuously grazed pasture. In the SDG cell, comparable sampling points (in terms of composition and production potential) were randomly located, 1 in each of the 4 paddocks. Six 91 × 61 cm cages were located near each sampling point to ensure the herbaceous vegetation was protected from grazing. A 61 × 30.5-cm quadrat was clipped to ground level within each cage. All clipped plant material was separated into the categories of blue grama, other grasses, and forbs. The plant material was bagged, oven-dried, and weighed to the nearest one-tenth gram. Clipping took place during late September and early October of each year. The cages were relocated near the sampling points after each clipping. Comparisons of end-of-season standing crop did not include the impact of grazing during the year in which the data were collected.

Aboveground net primary productivity between grazing treatment was examined during the 1985 growing season. In 2 paddocks of the short-duration cell, 12 sampling points were randomly located. In the continuously grazed pasture, 24 sampling points were randomly located, half of which corresponded to the 12 sampling points in each of the 2 sampled paddocks. The plants were first clipped at the end of a grazing cycle. All current production (by individual species) was clipped within a 61 × 30.5-cm quadrat at each of the 12 sampling points. The second clipping was made at the start of the next grazing cycle and the same procedure was followed. The difference in oven-dry weight represented growth for this period. First and second clippings were always within 1.5 m of one another at each sampling point; this helped ensure similarity of composition and production potential. To ensure that growth in the continuously grazed pasture was not removed by grazing, cages were placed over each of the 24 sampling points. This was not a concern in the SDG paddocks because cattle were not in the respective paddocks during the intervening growth period. Consumption by other herbivores was not considered.

[1]Nomenclature follows Lebgue and Allred (1985).

It was not possible to isolate treatment effects from pasture effects because the treatments were not replicated in space (Brown and Waller 1986, Hurlbert 1984, and Walker and Richardson 1986). Means and standard errors are reported. In addition, analysis of variance and least significant differences were used with locations within pastures as replications to assist in interpretation of results.

Results

Cover and Composition

Mean basal cover of all species was slightly higher on the short-duration pasture compared to the continuously grazed pasture for both 1984 and 1985 (Table 2). However, litter cover and bare ground were inconsistent on the 2 sets of pastures for the 2 years. Litter cover was higher on the continuously grazed pasture in 1984, and bare ground lower, but the reverse occurred in 1985.

Table 2. Mean ground cover (%) ± standard error of the mean by component and year for the continuous and short duration grazing treatments.

Component Grazing treatment	Year 1984	1985
Basal Plant Cover		
Continuous	12.9 ± 0.46	11.6 ± 0.37
Short duration	13.3 ± 0.81	12.4 ± 0.56
Litter		
Continuous	31.5 ± 1.05	28.2 ± 1.36
Short duration	26.5 ± 0.91	33.2 ± 1.38
Rock		
Continuous	9.3 ± 0.85	5.3 ± 0.53
Short duration	5.4 ± 0.78	3.7 ± 0.47
Bareground		
Continuous	46.3 ± 1.32	54.9 ± 1.36
Short duration	54.8 ± 1.39	50.7 ± 1.37

Basal cover of blue grama was higher ($P = 0.05$, LSD comparison) on the short-duration pastures than on the continuously grazed pasture for both years (Table 3). However, cover of blue grama declined from 1984 to 1985 under SDG but increased under continuous grazing. Basal cover of sideoats grama, creeping muhly, wolftail, and total grasses were higher on the continuously grazed pasture than on the short-duration pastures. Other grasses and forb species were present in rather small quantities in all pastures and did not exhibit consistent trends on the pastures.

Composition (based on cover) of blue grama was also consistently higher under short-duration grazing than under continuous grazing (Table 4). Blue grama composition was similar at the beginning of the study (53.1% for short-duration paddocks and 51.5% for the continuous pasture). Composition of other grasses was slightly higher for the continuous pasture. Composition of other grasses and forbs was higher under continuous grazing than under short-duration grazing. Shrubs were minor components on all pastures.

Herbage Biomass

End-of-season total herbage biomass averaged about 1,200 kg • ha^{-1} for 6 years of the study for both sets of pastures (Table 5). For 3 years of the study, differences in herbage biomass were not consistent between the pastures. ANOVA did not show a significant difference ($P<0.05$). Blue grama biomass was higher under continuous grazing, compared to short-duration grazing, from 1980 to 1982 but lower from 1983 to 1985 (Table 5). Average biomass of other grass species on the continuously grazed pasture exceeded that on the short-duration pastures by more than 100 kg • ha^{-1}. This pattern occurred every year except for 1982 when biomass of other grasses was similar (only 20 kg • ha^{-1} difference) between the 2 sets of pastures. Although forb biomass averaged over 6 years was higher on the short-duration pastures than on the continuously grazed pasture, the difference was not consistent over the years.

Table 3. Mean basal plant cover (%) by species and year for the continuous (CG) and short duration (SDG) grazing treatments.

Species	1984 CG	1984 SDG	1985 CG	1985 SDG
Grasses				
Aristida divaricata Humb. & Bonpl.	0.15	0.18	0.23	0.08
Aristida purpurea Nutt. var. *fendleriana* (Steud.) Vasey	0.03		0.03	0.03
Bouteloua curtipendula (Michx.) Torr.	0.63	0.13	0.28	0.13
Bouteloua gracilis (H.B.K.) Lag.	7.08	10.00	7.28	8.78
Elymus elymoides (Raf.) Swezey.	0.03	0.05	0.03	0.05
Elytrigia smithii (Rydb.) D.R. Dewey		0.03		0.05
Hilaria jamesii (Torr.) Benth.	0.10	0.10	0.10	0.03
Lycurus phleoides H.B.K.	2.50	1.20	1.45	1.00
Muhlenbergia repens (Presl.) Hitch.	0.75	0.50	0.48	0.25
Muhlenbergia torreyi (Kunth) Hitchc.	0.33	0.35	0.13	0.20
Muhlenbergia wrightii Vasey	0.03	0.05	1.00	1.10
Panicum obtusum H.B.K.	0.03	0.03		
Total Grasses[1]	4.58	2.71	3.79	3.11
Forbs				
Artemisia carruthii Wood	0.20	0.18	0.08	0.25
Artemisia ludoviciana Nutt. subsp. *albula* (Woot.) Keck.	0.08	0.05	0.05	
Cirsium arizonicum (Gray) Petrak.	0.02	0.02	0.02	
Erigeron divergens Torr. & Gray	0.10	0.04		0.01
Erigeron flagellaris Gray	0.05	0.01		0.02
Eriogonum wrightii Torr.	0.03	0.08	0.03	0.02
Gutierrezia sarothrae (Pursh) Britt. & Rusby	0.35	0.05	0.18	0.03
Leucelene ericoides (Torr.) Greene	0.08	0.08	0.08	0.05
Solanum elaeagnifolium Cav.	0.02	0.02		
Sphaeralcea angustifolia (Cav.) G. Don.	0.01	0.01	0.01	
Sphaeralcea coccinea (Pursh) Rydb.	0.04	0.04	0.04	0.01
Verbena bipinnatifida Nutt.	0.02		0.04	0.02
Verbena perennis Woot.	0.01		0.01	0.01
Total Forbs	1.34	0.65	0.66	0.55

[1]Total grasses is exclusive of blue grama.

Table 4. Mean vegetational composition of cover (%) ± standard error of the mean by component and year for the continuous and short duration grazing pastures.

Component Grazing treatment	Year 1984	1985
Blue Grama		
Continuous	51.1 ± 2.10	58.4 ± 1.51
Short duration	63.2 ± 1.87	69.6 ± 2.20
Other-Grass		
Continuous	35.4 ± 2.13	28.0 ± 1.52
Short duration	25.4 ± 1.75	20.4 ± 2.09
Forbs		
Continuous	13.5 ± 0.99	14.4 ± 1.02
Short duration	11.4 ± 0.88	10.9 ± 1.00
Shrubs		
Continuous	0.1 ± 0.04	0.1 ± 0.05
Short duration	0.1 ± 0.06	0.1 ± 0.06

Table 5. Mean[1] herbaceous vegetation production (kg • ha^{-1}) ± standard error of the mean by component and year for the continuous and short duration grazing treatment.

Component Grazing Treatment	1980	1981	1982	1983	1984	1985	Mean
Total Herbage							
Continuous	1,045 ± 60	1,449 ± 79	1,032 ± 80	1,048 ± 99	1,405 ± 96	1,216 ± 64	1,199 ± 36
Short duration	913 ± 84	1,514 ± 93	1,161 ± 84	962 ± 83	1,539 ± 171	1,196 ± 111	1,214 ± 48
Blue Grama							
Continuous	454 ± 75	656 ± 81	488 ± 61	225 ± 36	533 ± 66	501 ± 67	476 ± 29
Short duration	267 ± 43	511 ± 84	398 ± 43	332 ± 84	563 ± 64	446 ± 64	446 ± 27
Other-grass							
Continuous	424 ± 76	532 ± 87	426 ± 78	398 ± 64	477 ± 79	475 ± 83	455 ± 32
Short duration	223 ± 56	338 ± 84	446 ± 91	295 ± 58	460 ± 86	443 ± 83	368 ± 32
Forbs							
Continuous	167 ± 45	261 ± 69	118 ± 23	425 ± 94	395 ± 98	240 ± 37	268 ± 29
Short duration	423 ± 104	666 ± 134	317 ± 85	335 ± 66	476 ± 129	190 ± 50	401 ± 42

[1]Yearly means calculated using N = 24, mean calculated using N = 144.

Aboveground Net Primary Productivity

Maximum productivity for blue grama was 9.2 kg • ha^{-1} • da^{-1} on the short-duration pastures from 6 July to 15 August (Table 6). Primary productivity for blue grama was consistently higher on the short-duration pastures than the continuously-grazed pasture. However, confidence intervals overlapped for each period, except for the 6 July–15 August period (Table 6). Growth rate of other grass species varied among the 2 sets of pastures, although growth rate was generally higher for the continuously-grazed pasture. Forb productivity also tended to be higher for the continuously-grazed pasture than for the short-duration pastures. Growing-season precipitation was also higher on the continuously-grazed pasture (Tables 1 and 6), and may have contributed to the higher productivity of other grass species and forbs.

Table 6. Mean daily growth rate (kg • ha^{-1} • da^{-1}) standard error of the mean by growing period for the continuous and short duration grazing pastures 1985 growing season.

Component Grazing treatment	Growing Period[1] 1	2	3	4
Blue Grama				
Continuous	1.9 ± 0.67	5.7 ± 1.79	1.8 ± 1.11	3.7 ± 1.18
Short duration	2.3 ± 0.58	9.2 ± 1.10	2.8 ± 0.91	4.4 ± 0.79
Other-Grass				
Continuous	1.6 ± 0.90	1.6 ± 1.80	3.6 ± 1.43	2.5 ± 2.10
Short duration	1.7 ± 0.42	0.8 ± 2.08	3.5 ± 1.53	1.2 ± 1.34
Forbs				
Continuous	3.4 ± 0.65	4.5 ± 1.81	2.7 ± 1.29	2.9 ± 1.35
Short duration	1.5 ± 0.52	1.8 ± 1.30	2.3 ± 1.09	2.3 ± 1.58
Total				
Continuous	6.9 ± 0.95	11.7 ± 1.46	7.5 ± 1.26	9.1 ± 2.04
Short duration	5.5 ± 0.89	11.8 ± 3.31	8.6 ± 1.87	7.9 ± 1.61
Precipitation				
Continuous	164[2]	127[3]	264[4]	264[4]
Short duration	146[2]	116[3]	240[4]	240[4]

[1]Period 1, (10 June to 22 August).
Period 2, (6 July to 15 August).
Period 3, (18 August to 12 October).
Period 4, (25 August to 12 October).
Periods overlap because rest periods overlapped in different pastures in short-duration regime.
[2]Received, 1 May through 21 August 1985.
[3]Received, 1 May through 14 August 1985.
[4]Received, 1 May through 31 September 1985.

Discussion

Differences in vegetational responses to short-duration and continuous grazing on blue grama rangeland were small. Total end-of-season standing crop of all species was similar for all years of the study. These results agree with those of several other studies (Clatworthy 1984, Pitts and Bryant 1983, Reece 1986) that show small differences between short-duration and some other grazing regime or inconsistent differences. In the present study there were some indications that total basal plant cover and blue grama composition and productivity were responding to short-duration grazing, although mechanisms for this response are not clear. In the Edwards Plateau of Texas, mid grasses declined under short-duration grazing while the short grasses increased (Thurow et al. 1988). Apparently any increase in herbaceous vegetation under short duration grazing did not result from increased infiltration (Thurow et al. 1986, Warren et al. 1986, Weltz and Wood 1986, and Pluhar et al. 1987). Several of these studies indicate stocking can be increased moderately (10–20%) under short-duration grazing with no detrimental impact on vegetation. Heavy, continuous stocking resulted in decrease in grass cover and in increase in forb cover (Pieper et al. In press). However, livestock responses to short-duration grazing were not superior to those under continuous grazing (Parker et al. 1987). Consequently, benefits from short-duration grazing are likely to come from ease of livestock handling, slightly higher stocking, and improved management necessary to implement short-duration grazing successfully (Dahl 1986).

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