Response of Mixed C_4 Grasses to Various Multiple Paddock Grazing Strategies

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THEME # 08

RESPONSE OF MIXED C_4 GRASSES TO VARIOUS MULTIPLE PADDOCK GRAZING STRATEGIES

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Abstract

The botanical composition of mixed grass pastures may change during grazing due to the various grazing period/recovery period lengths associated with multiple-paddock grazing strategies. This 4-year study compared changes in relative species composition and basal plant cover of a C_4 grass mixture grazed using a nested paddock design to simulate 2, 4, 6 and 12-paddock grazing cells in eastern Nebraska. Total basal plant cover declined from 11.6% prior to grazing to 7.3% after one year of grazing and then remained nearly constant thereafter. Neither relative species composition nor basal density were affected greatly by grazing strategy. Within grazing strategies, however, some changes occurred although high variability made it difficult to detect significant differences among plant species. Across all grazing strategies, switchgrass [*Panicum virgatum* L.] frequency was inversely related to big bluestem [*Andropogon gerardii* Vitman] and indiangrass [*Sorghastrum nutans* (L.) Nash.] while sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.] was inversely related to little bluestem [*Schizachyrium scoparium* (Michx.) Nash.] and indiangrass.

Keywords: Species composition, basal plant cover

Introduction

Composition and productivity of grassland ecosystems become less stable when frequency and intensity of defoliation are high (Gammon, 1978). Animals selectively graze the most palatable plants, causing a shift in species composition towards grazing resistant species. Multiple-paddock systems that permit short grazing periods (1 to 4 days) and proportionately lengthy recovery periods may help maintain grassland stability and productivity. However, response of grassland ecosystems to various grazing period/recovery period lengths has not been described adequately.

This study examined botanical changes caused by four combinations of grazing period/recovery period lengths using small paddocks on nearly level terrain to eliminate spatial variability in grazing distribution.

Material and Methods

This research was conducted at the University of Nebraska Agricultural Research and Development Center near Mead, NE (96^o 33' W longitude, 41^o 11' N latitude) near the western edge of the tallgrass prairie region of the United States. Topography varies from nearly level to slopes of less than 3%. Soils are primarily a Sharpsburg silty clay loam (fine, montmorillonitic, mesic, Typic Argiudol).

Four grazing units averaging 2.24 ha were seeded in 1990 to a mixture of big bluestem [*Andropogon gerardii* Vitman], indiangrass [*Sorghastrum nutans* (L.) Nash.], switchgrass [*Panicum virgatum* L.], little bluestem [*Schizachyrium scoparium* (Michx.) Nash.] and sideoats grama [*Bouteloua curtipendula* (Michx.) Torr.]. In 1991 and 1992 they were harvested once each year for hay; they were grazed at light intensity (<150 steer days ha^{-1}) by cattle as part of a rotational grazing system in 1993 and 1994. Beginning in 1993, pastures were fertilized annually with 90 kg N ha^{-1} in late May.

In 1995, each of the four grazing units was divided into four paddocks representing ½, 1/4, 1/6 and 1/12 of the grazing unit area to simulate a 2, 4, 6 and 12-paddock grazing strategy, respectively, and grazed as a nested paddock design (Anderson et al., 1997). Thus, each grazing unit represented one replication. Each grazing unit was grazed rotationally by 10 crossbred steers averaging 282 kg for 72 d from early June through late August each year from 1995 through 1998. Steers rotationally grazed through the nested paddocks in three grazing cycles of 12, 36 and 24 d in length.

Within each grazing unit, the grazing cycle began in a different sized paddock to balance differences in plant growth stages during grazing across grazing units. The number of days each herd remained on a paddock during a grazing cycle was proportional to the size of the paddock so that each paddock received the same number of animal grazing days ha^{-1} (321 steer days ha^{-1}). The direction of rotation always was from the larger paddock to the next smaller one, except when animals were rotated from the smallest paddock (1/12) to the largest paddock (½). At the start of grazing each subsequent year, the grazing cycle within a grazing unit was advanced one paddock from the position grazing began the previous year. Thus, during the four years of grazing in this study, grazing for the year began once on every paddock.

All grazing units were burned in early May of 1995 and again in 1999. Between 20 and 30 d following burning, percentage basal cover by species and relative species composition were determined in each paddock using a modified single step-point method (Owensby, 1973) with over 400 points per paddock. Percentage basal cover was calculated from the number of times the point actually came in contact with a plant base while relative species composition was determined using the plant closest to the point that also was in front of the point.

Statistical analysis was a modified latin square (Lenter and Bishop, 1993). Major sources of variation were grazing unit (i.e., pasture replication), stage (i.e., order in which paddocks were grazed within a grazing unit) and treatment (i.e., grazing strategy, grazing period/recovery period lengths or paddock size). The linear model thus was as follows:

$$Y_{ijk} = u + g_i + s_j + t_k + e_{ijk}$$

where Y_{ijk} is the observation in the i^{th} grazing unit during the j^{th} stage of the k^{th} treatment and u is the overall mean, g_i is the effect of the i^{th} grazing unit, s_j is the effect of the j^{th} stage, t_k is the effect of the k^{th} treatment and e_{ijk} is the random error.

Results and Discussion

Averaged across all grazing strategies, total percentage basal cover declined from 11.6% prior to grazing in 1995 to 7.3% in 1996 and then remained nearly constant through spring 1999

(7.1%). Total percentage basal cover changed significantly more in the simulated 2-paddock strategy (6.9 percentage unit decline) than in the other three strategies (average 3.7 percentage unit decline). However, when grazing started in 1995 total percentage basal cover of the simulated 2-paddock strategy (13.7%) was 2.8 percentage units higher than the average of the other three strategies (10.9%), so it is unclear whether this difference in amount of change was due to grazing strategy or random chance.

There were few consistent relationships among species in changes in percentage basal cover (Table 1). Indiangrass was inversely related to sideoats grama; changes in percentage basal cover of sideoats grama tended to become increasingly negative as grazing strategy changed from 2-paddock to 12-paddock while percentage basal cover of indiangrass changed in the opposite direction (Table 2). Also, the relative magnitude of percentage basal cover change of big and little bluestem tended to be similar.

Relative species composition changed little overall following four years of grazing. Changes in relative species composition never differed significantly for any individual species across grazing strategies although sideoats grama tended to decrease as grazing strategy changed from 2-paddock to 12-paddock (Table 2). Within grazing strategies, however, some changes occurred although high variability made it difficult to detect significant differences among plant species. Across all grazing strategies, relative species composition of switchgrass was inversely related to big bluestem and indiangrass while that of sideoats grama was inversely related to little bluestem and indiangrass (Table 1).

Neither relative species composition nor percentage basal cover were affected greatly by grazing strategy in this 4-year study. Concurrent studies in the same area using this same mixture of grasses showed that relatively short term grazing studies, such as the 4-year study reported here, may be inadequate to determine long term effects (Anderson, 1999). Herbage biomass production did not differ significantly across grazing strategies the first two years (Burboa-Cabrera, 1997) but visual observations in year four suggested that biomass differences were beginning to develop (data not presented). This study will be conducted through a second 4-year cycle with continued monitoring of botanical composition as well as biomass production.

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Table 1. Partial correlation coefficients relating changes in percentage basal cover or relative species composition of five C_4 grasses following four seasons of grazing in eastern Nebraska.

	Switchgrass	Indiangrass	Little bluestem	Sideoats grama
	percentage basal cover			
Big bluestem	0.28	0.38	0.44^{+}	- 0.23
Switchgrass		0.04	0.30	0.20
Indiangrass			0.14	- 0.53*
Little bluestem				- 0.41
	relative species composition			
Big bluestem	- 0.68**	- 0.15	0.29	- 0.26
Switchgrass		- 0.51*	- 0.05	0.15
Indiangrass			- 0.01	- 0.44^{+}
Little bluestem				- 0.55*

$^{+, *, **}$ Probability of significant correlation between the two specified grass species at 0.10, 0.05, and 0.01 significance level, respectively.

Table 2. Changes in percentage basal cover or relative species composition of five C_4 grasses following four seasons of grazing in eastern Nebraska.

Grazing strategy	Big bluestem	Switchgrass	Indiangrass	Sideoats grama	Little bluestem
	- - - - -- - - - - percentage basal cover, percentage units - - - - - - - - - -				
2-paddock	- 3.7[b]	- 1.5[ab]	- 2.0[ab]	0.4[a]	- 0.1[ab]
4-paddock	- 1.1	- 1.3	- 0.4	0.1	0.0
6-paddock	- 1.5	- 1.1	- 0.8	0.1	- 0.1
12-paddock	- 2.4[b]	- 2.0[b]	0.2[a]	- 0.4[ab]	- 0.1[ab]
P>F	0.23	0.84	0.13	0.29	0.75
	- - - - - - - - relative species composition, percentage units - - - - - - - -				
2-paddock	- 2.6[ab]	1.4[ab]	- 3.9[b]	5.9[a]	- 0.8[ab]
4-paddock	4.3[a]	- 7.8[b]	0.7[ab]	2.1[a]	0.0[ab]
6-paddock	- 2.0	2.4	- 1.5	1.6	- 0.6
12-paddock	- 2.6[b]	- 6.6[b]	11.9[a]	- 2.8[b]	- 0.7[b]
P>F	0.73	0.52	0.28	0.38	0.70

[a,b] Values within a row with different superscripts are different ($P<0.10$).