Effects of Grazing Management on Forage Sward Height, Mass, and Nutrient Concentrations and the Proportions of Fecal Cover and Bare Soil in Pastures

A.S. Leaflet R2206

Mat M. Haan, assistant scientist;
James R. Russell, professor of animal science;
Dan Morrical, professor of animal science;
Daryl Strohbehn, professor of animal science

Summary and Implications

Grazing management can alter the characteristics of the pasture sward. Changes in pasture forage characteristics can affect both the nutritional value of the forage and the environmental impacts of the grazing system. Six 30-acre cool-season grass pastures, containing predominantly smooth bromegrass and bisected by a 642-foot stream segment were grouped into two blocks and assigned one of three treatments: continuous stocking - unrestricted stream access (CSU), continuous stocking - restricted stream access (CSR), and rotational stocking (RS). Forage sward height and mass along with the proportion of bare ground and fecal cover were determined monthly from open and congregation areas within four zones in the pasture. Zones were defined as on the stream bank (bank), from the stream bank to 110 feet from the stream bank (110), 110 feet to 220 feet from the stream bank (220), and greater than 220 feet from the stream bank (upland). Forage samples were analyzed for *in vitro* dry matter digestibility (IVDMD), crude protein (CP), and phosphorus (P). The occurrence of bare ground and fecal cover was greater in congregation areas than open areas across all pastures. Bare ground was greater along the banks in all grazing management practices but was not different between pastures in the 110, 220, or upland zones. Mean forage CP concentrations were greater and P concentrations tended to be greater in the RS pastures than in CSU or CSR pastures.

Introduction

There are concerns about negative impacts of grazing beef cattle on the quality of surface waters in the Midwest. These concerns are partially related to the potential for poorly managed grazing animals to elevate concentrations of sediment and phosphorus (P) in surface water. Without proper management, grazing animals may remove protective vegetation from the soil surface and concentrate nutrients on the soil surface in their feces, which may increase runoff of sediment and nutrients to pasture streams. Improved grazing management practices should reduce fecal deposition and bare ground near pasture streams, reducing negative impacts of grazing livestock.

Use of rotational grazing systems has been shown to have positive impacts on the nutritional quality and quantity of available forage. It is possible that properly managed grazing systems will not only improve animal performance, but also reduce the potentially negative impacts of grazing on surface water quality.

The objectives of the current study were to determine the effects of grazing management on forage sward height, mass, and nutrient concentration, and the proportion of bare ground and fecal cover in cool-season grass pastures.

Materials and Methods

Six 30-acre cool-season grass pastures, each bisected by a 642-foot stream segment were grouped into two blocks and assigned one of three grazing management treatments. Treatments included: continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access restricted to a 16-foot wide crossing (CSR), and 5-paddock rotational stocking with one paddock in the riparian zone (RS). Riparian paddocks in the RS treatment were stocked for a maximum of four days or until forage sward height decreased to a minimum of four inches. Cattle in the upland paddocks of pastures with RS were moved between paddocks after 50% of the forage was removed. Riparian buffers on either side of the crossing in the CSR treatment were not grazed. Each pasture was stocked with 15 fall-calving Angus cows from mid-May through mid-October in 2005 (mean cattle BW = 1428 lb) and 2006 (mean cattle BW = 1271 lb).

Forage sward height, mass, and composition, along with the proportion of bare ground and fecal cover, were determined monthly from open and congregation areas within four zones in the pasture. Zones were defined as on the stream bank (bank), from the stream bank to 110 feet from the stream bank (110), 110 feet to 220 feet from the stream bank (220), and greater than 220 feet from the stream bank (upland). Congregation areas were defined as areas providing cattle access to the stream, water tanks, or mineral supplementation sites, and under the dripline of trees. Open areas were any areas that were not classified as a congregation area. Area of congregation areas was determined with tape measures in August of each year.

The proportions of bare or fecal-covered ground were determined by the line-transect method over 50 feet. Forage sward height was measured with a rising plate meter (8.8 lb/yd^2). Forage samples were hand-clipped and analyzed for *in vitro* dry matter digestibility (IVDMD), crude protein (CP), and phosphorus (P). Nutrient composition data have been determined only for samples collected in 2005; all other values are for both 2005 and 2006. Bare and manured-covered ground and sward height were measured and forage samples were collected from six sites in open and congregation areas on the banks and in the 110 and 220 foot zones in each pasture unless limited by the number of congregation areas. In the upland zone, bare and fecal-covered ground and sward height were measured in 24 open and 12 congregation areas and forage samples were collected from 12 open and congregation areas. The mean proportions of bare and fecal-covered ground and the forage mass, sward height, and nutrient concentrations within each zone of each pasture were calculated as weighted averages, based on the ratio of open and congregation area.

Results and Discussion

Fecal Cover – Bare Ground

The proportion of bare ground was greater (P<0.05) in congregation (16.1%) than in open (8.7%) areas of pastures. Bare ground was greater (P<0.05) on the banks than other pasture zones across all treatments. Banks in the CSU pastures (49.1%) had greater bare ground than in the RS pastures (31.1%) which was greater than in the CSR pastures (18.2%; Table 1). The proportion of bare ground in the 110, 220, or upland zones did not differ between treatments, averaging 5.6%.

Fecal cover was greater (P<0.05) in congregation (2.0 ± 0.1%) than open (1.0 ± 0.1%) pasture areas. There was no fecal cover on the bank or in the 110 zone in pastures managed by CSR as a result of cattle not having access to these areas (Table 2). As a result, the proportion of fecal-covered ground in the 110 foot zone of pastures with the CSR treatment was greater (P<0.05) than the RS treatment. In contrast, the proportion on fecal-covered ground in the 220 foot zone was greater (P<0.05) in pastures with the CSR than CSU treatments. However, there were no differences between grazing treatments in the proportions of fecal-covered ground on the banks or in the upland zones of the pastures. There were no grazing treatment by month interactions for either the proportion of bare ground or fecal cover.

Forage Mass and Sward Height

Forage sward height and mass were greater (P<0.05) in open areas than in congregation areas in all pasture zones except for the 110 zone (Table 2). There was no grazing treatment by pasture zone by open vs. congregation area interaction for either sward height or forage mass.

Forage sward height was greater (P<0.05) along the bank and the 110 foot zone of the CSR pasture than for the other grazing treatments (Table 3). Forage sward height was also greater (P<0.05) in the 110 foot zone of pastures with the RS than in the CSU treatment.

Similar to sward height, forage masses on the banks and in the 110 foot zone of the CSR pastures were also greater (P<0.05) than for the CSU or RS treatments. Forage masses on the banks tended to be greater and in the 110 zone were greater (P<0.05) in RS pastures than in CSU pastures. Neither forage sward height nor mass differed in either the 220 or upland zones across grazing management treatments. There were no grazing treatment by month interactions for either forage mass or sward height.

Forage Nutrient Concentration (2005)

Mean forage CP concentrations were greater (P<0.05) and P concentrations tended to be greater in the RS pastures than in the other grazing management treatments (Table 4), implying that rotational grazing did reduce forage maturity. Crude protein concentration was lowest in forage along the stream banks compared to other zones, while P concentration was lowest in the upland zone compared to the riparian zones (Table 5). Crude protein concentration of forage was greatest in May (14.0%), decreased in June (10.2%), and then increased and remained stable for the remainder of the summer (11.6, 12.7, 11.6, and 11.9% in July, August, September, and October, respectively, Table 6). Phosphorus concentration of forage was greatest in May (0.299%), decreased in June (0.245%), July (0.249%), and August (0.241%), increased in September (0.283%), and decreased again in October (0.241%). In all pastures, zones within pastures, and during all months CP and P concentrations of forage were adequate to meet the nutritional requirements of a mature beef cow during peak lactation, indicating that no supplementation of these nutrients would be required. There were no treatment by zone, treatment by month, or zone by month interactions for concentration of either CP or P in the forage. The lack of these interactions implies that including the composition of ungrazed forage within the riparian buffers in the analysis did not have a large effect on treatment or zone differences.

Mean IVDDM of forage was greatest in the RS (48.2%) pastures, intermediate in the CSU (47.3%) pastures, and lowest in the CSR (45.5%) pastures. Neither zone nor zone by treatment interactions were significant for the IVDMD of forage. *In Vitro* dry matter digestibility was greatest in May (58.8%) and gradually decreased to a minimum in October (40.9%). There were no interactions of month with either treatment or zone for IVDMD.

The use of rotational stocking decreased the proportion of bare ground along the banks of a pasture stream compared to pastures managed by continuous stocking with cattle having unrestricted access to the stream, however, when cattle were completely restricted from the stream bank the occurrence of bare ground was further decreased. Forage sward height, mass, and nutrient concentration are effected by grazing management, location within a pasture, and month. Rotational grazing did improve the nutritional value of the forage compared to continuous grazing. The lower nutritional value of forage in pastures with continuous grazing likely resulted from the composition of forage in the buffer areas in which grazing was prohibited. Regardless of grazing management, concentrations of CP and P in the predominantly cool-season grass pastures of the current study were sufficient to meet the nutritional requirements of mature beef cows during lactation.

Acknowledgements

The authors would like to thank the undergraduate and gradate students who assisted with data collection and analysis. The publication of this document has been funded in part by the Iowa Department of Natural Resources through a grant from the U.S. Environmental Protection Agency under the Federal Nonpoint Source Management Program (Section 319 of the Clean Water Act) and the Leopold Center for Sustainable Agriculture.

Table 1. Effect of grazing management on the proportion of bare ground (SE = 2.0) and fecal cover (SE = 0.3) in four pasture zones relative to a pasture stream in 2005 and 2006.

	CSU[b]	CSR	RS
		Bare Ground, %	
Bank[a]	49.1[c]	18.2[e]	31.1[d]
110	8.8	0.8	2.4
220	4.6	6.2	5.2
Upland	6.2	7.7	7.5
		Fecal Cover, %	
Bank	1.1	0.0	0.7
110	1.6[cd]	0.0[c]	1.8[d]
220	1.1[d]	3.8[e]	2.6[de]
Upland	2.2	2.4	2.1

[a]Bank = on the streambank, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet from stream.
[b]CSU = Continuous stocking with unrestricted stream access, CSR= Continuous stocking with restricted stream access., RS = Rotational stocking.
[cde]Values with different superscripts within a row differ (P<0.05).

Table 2. Effect of pasture zone on forage sward height (SE = 0.6) and mass (SE = 160) in open and congregation areas of pastures in 2005 and 2006.

	Open[b]	Congregation
	Forage Sward Height, cm	
Bank[a]	15.6[c]	6.8[d]
110	17.1	16.3
220	15.9[c]	8.7[d]
Upland	14.8[c]	8.1[d]
	Forage Mass, kg/ha	
Bank	2115[c]	908[d]
110	2793	2666
220	2586[c]	1396[d]
Upland	2477[c]	1259[d]

[a]Bank = on the streambank, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet from stream.
[b]Congregation areas were defined as areas providing cattle access to the stream, water tanks or mineral supplementation sites, and under the dripline of trees. Open areas were any areas that were not classified as a congregation area.
[cd]Values with different superscripts within a row differ (P<0.05).

Table 3. Effect of grazing management on forage sward height (SE = 1.0) and forage mass (SE = 231) in four pasture zones relative to a pasture stream in 2005 and 2006.

	CSU[b]	CSR	RS
		cm	
Bank[a]	5.5[d]	17.7[c]	10.0[d]
110	9.8[e]	25.4[c]	15.8[d]
220	12.4	11.0	14.3
Upland	11.4	11.1	13.1
		kg/ha	
Bank	697[d]	2356[c]	1568[cd]
110	1444[e]	4131[c]	2638[d]
220	1932	1868	2243
Upland	1693	1624	2000

[a]Bank = on the streambank, 110 = 0 to 110 feet from stream, 220 = 110 to 220 feet from stream, Upland = greater than 220 feet from stream.
[b]CSR = Continuous stocking restricted stream access, CSU = Continuous stocking unrestricted stream access, RS = Rotational stocking.
[cde]Values with different superscripts differ (P<0.05).

Table 4. Effect of grazing management on nutrient composition in four zones of the pastures over the grazing season in 2005.

	CSR[a]	CSU	RS	SE[b]	
		% of DM			
CP	10.9[d]	12.2[cd]	12.9[c]	0.7	<.05
P	0.252	0.253	0.274	0.009	.06
IVDMD	45.5[d]	47.3[cd]	48.2[c]	0.9	<.05

[a]CSR = Continuous stocking restricted stream access, CSU = Continuous stocking unrestricted stream access, RS = rotational stocking.
[b]SE = Standard error of the mean.
[cde]Differences between means within a row with different superscripts are significant (P<0.05).

Table 5. Mean forage nutrient concentrations in four zones within pastures managed by continuous or rotational stocking systems in 2005.

	Bank[a]	110	220	Upland	SE
			% of DM		
CP	10.4[d]	12.7[c]	12.8[c]	12.1[c]	0.8
P	0.257[cd]	0.269[cd]	0.274[c]	0.239[d]	0.010
IVDMD	46.7	47.7	46.8	46.8	0.9

[a]Bank = Stream bank, 110 = 110 feet away from stream bank, 220 = 110 feet to 220 feet from the stream bank, Upland = greater than 220 feet from the stream bank.
[b]SE = Standard error of the mean.
[cd]Differences between means within a row with different superscripts are significant (P<0.05).

Table 6. Mean monthly forage nutrient concentrations across grazing management practices in 2005.

	May	June	July	Aug.	Sept.	Oct.	SE[a]
				% of DM			
CP	14.0[b]	10.2[d]	11.6[c]	12.7[bc]	11.6[cd]	11.9[bc]	0.8
P	0.299[b]	0.245[c]	0.249[c]	0.241[c]	0.283[b]	0.241[c]	0.011
IVDMD	58.8[b]	51.3[c]	45.3[d]	46.2[d]	46.8[d]	40.9[e]	1.1

[a]SE = Standard error of the mean.
[bcde]Differences between means within a row with different superscripts are significant (P<0.05).