Effect of Herbage Depletion on the Grazing Dynamics and Short-Term Intake Rate of Steers Grazing Wheat Pastures

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Story in brief

Reduction of herbage mass may not accurately predict herbage intake rate, as it does not incorporate aspects of availability and accessibility of preferred plant parts. There is little research attempting to understand cattle foraging strategies during pasture depletion. This study aimed to assess grazing dynamics and herbage intake rate under pasture depletion grades, analyzing other components than herbage mass. Three steers were assigned to grazing scenarios that simulated 3 levels of pasture depletion (Treatments: Undisturbed sward, CNTL; high level of depletion, HD, and medium level of depletion, MD). Grazing scenarios were characterized by the amount of green leaf and stem, and their ratio. Intake rate was determined by a rumen evacuation technique. Grazing dynamic was determined through bite and eating step rate, bite depth, eating distance and grazed area, and bites and intake per feeding station. From the CNTL to the HD; green leaf mass, stem mass, and accessibility decreased, but green leaf availability increased. Steers showed a decrease of fresh herbage intake rate (P = 0.04), and dry (P = 0.06) and fresh (P = 0.04) herbage intake per feeding station, as well as a tendency (P = 0.1) to increase bite rate with increasing level of depletion. Depletion led steers to increase foraging velocity (eating steps per min) and grazed area. It seems that concepts other than herbage mass need to be taken into account when changes in herbage intake, grazing dynamics and grazing management are analyzed.

Introduction

Under winter-annuals grazing environments, a linear relation between herbage mass and intake is blindly accepted. However, several works clearly show that the reduction of herbage mass itself may not accurately predict herbage intake rate (Iason et al., 2002), as it does not comprise differences in plant parts, nor incorporate aspects of the accessibility of leaves, the preferred plant parts (Drescher, 2003). Consequently, linearity between herbage depletion and intake reductions remains doubtful.

It is recognized that green leaf is the "pasture component" that promotes intake and is better correlated with bite mass than herbage mass (Wade and Carvalho, 2001). At the pasture/animal interface, availability and accessibility of leaves constrain the herbage consumed in each bite (Drescher, 2003). While practically the accessibility of leaves is measured and expressed as sward surface height, what might be determinants for intake rate are the mass and accessibility of green leaves at the bite horizon. Despite these considerations, there are few and sporadic research reports attempting to understand and use cattle foraging strategies during a progressive downward defoliation. The objective of this study was to assess grazing dynamics and herbage intake rate under 3 levels of pasture depletion, analyzing other components than herbage mass.

Experimental Procedures

This study took place at the University of Arkansas Agricultural Research and Extension Center, Fayetteville, in April 2005. Six wheat (*Triticum aestivum* L.) pastures established using 3 tillage methods were used; tillage method was used as a block. Treatments were a high level of depletion (HD; sward surface height 2.75 inches), low level of depletion (LD; sward surface height 5.5 inches) and undisturbed sward (CNTL, sward surface height 8.25 inches). Treatments were generated through different residence times by dairy heifers on each pasture. Three grazing scenarios (0.4 acre, polywire fenced) were set up in each pasture the day before measurements. Grazing scenarios were grazed (grazing session) by 2 of 3 Angus steers (BW = 1,296 ± 62.3 lb), randomly chosen and allocated to treatments and replicates. The night before measurements, steers were shrunk. Three hours before every grazing session, they were fed 4.4 lb of ground corn to reduce differences in appetite. Two hours before grazing sessions, ruminal contents of steers were removed. A grazing session consisted in taking the steers to the allocated grazing scenario, and letting them freely graze for 15 min. During this period, 2 trained observers counted the bites and eating steps during a continuous minute every 5 minutes while steers had their head down and were completely engaged in their eating activity (biting, chewing). After the grazing sessions, ruminal contents were removed, and sampled for DM.

Based on the herbage eaten during grazing sessions, fresh and dry intake rates were calculated. To calculate eating distance, the mean eating step measured by Gregorini et al. (2006) was multiplied by the eating step rate. Each eating step was considered as a feeding station. The area of feeding station was calculated according to Rook et al. (2004) and number of feeding stations multiplied by the area of a feeding to calculate area grazed. Fifty undisturbed sward surface height measurements were taken within each grazing scenario in bitten areas, and an additional 50 were taken immediately adjacent to the bitten area to determine apparent bite depth. Grazing scenarios were sampled for undisturbed sward surface height (pre-grazing) using a sward height ruler. This was measured at 30 random points in each grazing scenario. Herbage mass was collected at ground level by hand clipping nine, 76 x 76 inch quadrants in each grazing scenario. This mass was separated into green leaf and stem mass and oven dried for DM calculation. All dependent variables were analyzed under a completely randomized block design by ANOVA utilizing the GLM procedure of SAS (SAS Inst., Inc., Cary, N.C.). Least-squares means were separated using linear and quadratic contrasts.

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Results and Discussion

The sward surface heights obtained by the differential grazing time applied to each grazing scenario match the sward surface height target (Table 1). In both sward features and grazing behavior variables, the block effect was not significant ($P > 0.05$). Herbage depletion reduced green leaf and stem mass, but increased the green leaf/stem ratio as depletion level increased. In other words, when generating the treatments, steers on the depleting pastures might be induced to eat more stems as well, since most of the upper strata leaves were being eaten, and the remaining leaves were mainly located among stems (less accessible). This might have generated a higher availability at the high depletion rate. The availability of determined herbage mass is the proportion of preferred parts of herbage (leaves) in this total mass of herbage. Accessibility is defined as the ease of ingestion of preferred parts of herbage (Drescher, 2003). As a result, steers on the 3 treatments had to cope with a reduction of green leaf mass, an increased availability but reduced accessibility.

The reduction of green leaf mass (and accessibility, theoretical) with higher depletion level may explain the marked ($P < 0.04$) reduction of fresh herbage (19% DM) intake rate. These results are in accordance with the works of Chacon and Stobbs (1973) and Forbes and Coleman (1993). The latter suggested that green leaf appears to be the single most important component of herbage whether measured as mass, proportion, density or ratio. Dry herbage intake rate tended to differ ($P = 0.14$) among treatments. The changes in grazing dynamics shown by the steers when green leaf density and accessibility decreased through herbage depletion (Table 1) may indicate a positive selection for green leaf. Redmon et al. (1995) argued that reductions in herbage intake are related to decreases in digestibility rather than ingestive issues. If animals positively seek green leaf, and green leaf is the more digestible component of herbage, it is evident that a reduction of herbage mass leads to reductions in herbage digestibility. However, from a behavioral viewpoint, an explanation of a dynamic decrease of herbage intake would be the following: intake rate would decrease during pasture depletion, since preferred profitable bites (leafy bites) are diluted (less clustered). At this point, selectivity would increase. While the selection process occurs, animals look for more profitable bites, trying to maintain a constant energy intake rate. Such a process is time consuming and would be what makes intake rate decrease. In addition, a decrease in accessibility generates bites with less mass and more jaw movements. At the same herbage mass, but different availability and accessibility, Gregorini et al. (2006) showed how steers changed their grazing dynamic. Basically, reductions in accessibility increase the eating step rate and residence time per feeding station.

Cattle graze down vegetative temperate pastures in layers when a plot area and time in it are restricted (Wade and Carvalho, 2001). This phenomenon might ensure a high proportion of leaf in the diet (Wade and Carvalho, 2001). Availability under the high depletion treatment was higher, but accessibility was markedly reduced. A reduced accessibility and green leaf density may have led steers to find feeding stations less profitable as depletion increased. This is supported by the increments of the eating step rate and the reduction of bites per feeding station. The marked difference on fresh and dry intake per feeding station reinforces this concept. Because of a reduction (dilution) of profitable feeding stations, depletion made steers walk and cover more area (Table 1). Clearly, they were seeking leaves. The cost of walking is negligible in relation to the energy requirement of the entire grazing process (Di Marco and Aello, 1998). The present results indicate that, from an energetic point of view, it makes sense for cattle depleting a pasture to keep walking, taking fewer and less deep bites (Table 1) per eating step. Cropping and processing are the most expensive components of the grazing process (Wright and Illius, 1995). Bite rate, used as a mechanism of compensation to maintain intake rate, increased with pasture depletion, which is energetically expensive. However, bite depth decreased ($P < 0.01$). This means that bites had less mass; therefore, bites may have taken less processing effort. It seems that cattle do not graze blindly. Certainly, they may energetically adjust their foraging strategy while depleting pastures to maintain a constant energy intake rate. At this point, to think about a simple amount of herbage as a threshold determining intake rate, a result of a complex process like grazing, seems incomplete.

Implications

At small scales, like paddocks, changes in herbage availability and accessibility determine changes in grazing behavior, intake rate, and consequently, performance. The understanding of grazing dynamics may help us to design grazing management, leading cattle to harvest as much green leaf as possible with the least effort. Therefore, grazing cattle in short grazing sessions, with small leafy areas (pastures) may be an alternative to be considered.

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Table 1. Effect of herbage depletion on pasture features and grazing behavior of steers grazing wheat pastures.

	Level of depletion				P- value	
Trait	**High**	**Low**	**Control**	**SE**	**Linear**	**Quadratic**
Sward features						
Green leaf mass (lb/ft^2)	0.009	0.017	0.035	0.006	0.33	0.01
Stem mass (lb/ft^2)	0.003	0.015	0.027	0.003	0.02	< 0.001
Green leaf/Stem ratio	3.09	1.32	0.89	0.25	< 0.001	< 0.001
Sward surface height (inches)	3.43	5.74	9.23	0.91	0.006	< 0.001
Grazing behavior						
Bite rate (bites/ min)	42.8	32.54	26.55	5.20	0.18	0.10
Bites per feeding station	3.21	5.69	6.33	1.09	0.22	0.13
Eating step rate (steps/ min)	15.16	10.91	6.08	1.54	0.07	0.02
Fresh herbage intake rate (lb/ min)	0.617	0.793	1.058	0.11	0.34	0.04
Dry herbage intake rate (lb/ min)	0.074	0.103	0.125	0.176	0.29	0.14
Fresh intake per feeding station (lb)	0.04	0.130	0.178	0.026	0.04	0.01
Dry intake per feeding station (lb)	0.004	0.017	0.022	0.002	0.06	0.061
Eating distance (ft)	290.91	207.9	116.60	29.42	0.06	0.002
Area grazed (ft^2)	125.93	88.87	50.48	12.70	0.067	0.002
Bite depth (% of SSH)[a]	6.5	39	51	0.03	< 0.001	< 0.001

[a] SSH = Sward Surface Height.