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Effect of low densities of senescent stems in crested wheatgrass on plant selection and utilization by beef cattle

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Abstract

Residual stems or cured straw in caespitose grasses are frequently a detriment to utilization of herbage by both wild and domestic herbivores. Cattle alter their grazing methods and remove less forage from plants contaminated with old-growth material. The objective of this research was to establish the degree and persistence of cattle responses to low densities of cured seed stalks in tussocks of crested wheatgrass (*Agropyron desertorum* (Fisher ex Link) Schultes), as pasture resources were progressively depleted. This was researched by augmenting individual plants with densities of 0, 1, 2 or 3 cured seed stalks dm^{-2} basal area, and measuring the frequency and degree of utilization by cattle throughout a 6-day grazing trial. Cattle were less likely to graze and removed less material from plants as the density of cured stems increased. Frequency means indicated cattle responded to treatments differing by two or more stems. Utilization data suggested cattle were aware of just one cured stem in a tussock. Plants augmented with one, two and three cured stems were, respectively, 8%, 20% and 32% less likely to be grazed than control tussocks with no stems, and these same treatments had, respectively, 35%, 39% and 60% less material removed by cattle than controls. Livestock owners or land managers are encouraged to keep pastures free of cured straw or litter to facilitate more uniform and efficient use of forage by livestock or wildlife.

Key words: Cattle; Feeding; Nutrition; Grazing; Bite rate

Introduction

When caespitose grasses remain ungrazed throughout a growing season, residual straw and stems begin to accumulate. The result is that both wild and domestic herbivores are less likely to forage upon these wolf plants (Stoddart et al., 1975), preferring instead to graze where sorting of old and new growth is unnecessary (Willms et al., 1980; Norton et al., 1983; Gordon, 1988; Ganskopp et al., 1992). Selective grazing of this nature wastes forage actually

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available to the animals and may focus undue grazing pressure on the remaining uncontaminated plants in a pasture.

Recent literature indicates that biting rates are reduced when cattle forage upon plants contaminated with the previous year's stems and that their method in defoliating such plants is somewhat altered (Ruyle et al., 1987). Cattle either graze the base from the side or burrow down past residual straw to reach new growth. In uncontaminated plants a top–down approach is more typical. As the growing season progresses, and grasses begin to cure, cattle become less discriminating in their selection of plants (Ganskopp et al., 1992), but disparities in biting rates are still exhibited by cattle grazing clean versus stemmy plants (Ruyle and Rice, 1991).

Ganskopp et al. (1992) attempted to quantify the level of senescent contamination required to affect forage selection by cattle by augmenting actively growing bunches of crested wheatgrass (*Agropyron desertorum* (Fisher ex Link) Schultes) with either zero, three, six, nine or 12 cured seed stalks. That goal was not accomplished, however, because the cattle rejected all treatments containing stems at equivalent rates. The chance that a plant augmented with cured seed stalks might be grazed was about 60% of that expected of plants without stems.

The purpose of this research was twofold. First, to establish whether cattle would exhibit selective responses to low densities cured stems in green and growing bunches of grass. Second, to determine whether cattle would become less selective in their use of clean and stemmy plants as the forage resource was depleted. Null hypotheses tested were: (1) there were no differences in probability or degree of defoliation by cattle of plants containing 0, 1, 2 or 3 cured seed stalks dm^{-2} basal area; (2) that if treatment effects were present, they would remain constant as the sward was progressively depleted.

Animals, materials and methods

The study was conducted on the Northern Great Basin Experimental Range, 72 km west–southwest of Burns, OR, USA. Mean annual precipitation is 284 mm with peak monthly accumulations occurring during winter (29–36 mm) and a mean minimum accumulation (8 mm) in July. Mean annual temperature is 7.6°C, with extremes of −29 and 42°C. Soil is a Milican fine sandy loam (coarse-loamy, mixed, frigid Orthidic Durixerolls) (Lentz and Simonson, 1986). Data were collected from four 0.7-ha pastures supporting 19-year-old crested wheatgrass seedings and sparse overstories of Wyoming big sagebrush (*Artemisia tridentata* subsp. *wyomingensis* Beetle). Pastures were heavily grazed by cattle the previous fall when all plants were dormant to assure removal of senescent material.

In each pasture 400 m of line transect was established in four randomly located 100-m units. Eighty points along each 400-m transect were chosen at random by computer and the crested wheatgrass plant closest to each point randomly assigned to one of four treatments, yielding 20 plants per treatment per pasture. Treatments included controls, containing no cured reproductive stems or straw, and plants augmented with either 1, 2 or 3 cured reproductive stems dm^{-2} basal area. The seed stalks had been collected from ungrazed plants after senescence the previous growing season and stored indoors over winter. Because tussocks were not of uniform size, plant basal areas were determined by measuring each crown's greatest diameter, second greatest diameter perpendicular to the first and solving for the area of an ellipse. To obtain the number of stems to be added to each tussock, basal area was multiplied by the desired density of seed stalks. When calculations yielded a fraction of a seed stalk, the number was rounded up to the next whole number. After plants were cleared of residual straw or stems, the appropriate number of holes were punched in the soil within each crown and the number of seed stalks required to obtain the desired density inserted. Inserted seed stalks projected 5–25 cm above the current year's growth. This duplicated the natural appearance of wolf plants in an adjacent pasture which had not been grazed the previous year. The study was conducted at the late-boot stage of phenology (13–19 May 1990) and tips of newly emerging seed stalks were just beginning to project from enclosing sheaths.

In one of the pastures, eight additional plants per treatment were measured, furnished with stems and harvested to a 2.5-cm stubble to provide indices of treatment effect on percentage of total plant weight contributed by the inserted stems. Measures of forage availability and utilization in each pasture were obtained by clipping ten 1-m^2 plots to a 2.5-cm stubble immediately prior to and after the last day of grazing. Plots were placed systematically along pace transects diagonally traversing each pasture.

Two mature (Hereford×Angus) cross-bred cows were placed in each of the four pastures (a total of eight animals), where they foraged for 6 days. During each day of the trial, all the designated plants along each transect were evaluated for two response variables. These were: (1) the number of plants defoliated, respectively scored as either 1 or 0 for grazed and ungrazed plants; (2) when a plant was grazed, an estimate of the percentage utilization by weight using a height–weight relationship (Heady, 1950) developed at the beginning of the trial. Values ($n=20$) for each treatment within a pasture were totaled each day ($n=6$), with totals viewed as single observations in final analyses. After analyses, data were converted to percentages for presentation.

Project design was a randomized complete block with four replications (pastures) and four treatments. Analyses for the two response variables included a randomized complete block procedure for each day of the trial, and a final analysis of the compiled data with a repeated measures analysis of variance having four blocks, four treatments as main plots and 6 days as subplots (Steel and Torrie, 1980, pp. 390–393). Statistical significance was assumed at $P<0.05$ and mean separations were accomplished with Fisher's Protected Least Square Difference procedures.

Results

Grazing behavior of cattle was significantly affected by the addition of cured stems. Main effects of treatment and day were significant ($P<0.05$), while treatment×day interactions were not ($P>0.05$) for both the frequency of defoliation and percentage utilization response variables (Table 1). Days constituted the largest source of variation, with treatments ranking second. Lack of significant treatment×day interactions implies treatment effects were consistent for the duration of the project and that one may focus discussions on main effect means. However, because trends over time were of primary concern in this effort, we present two-way depictions of data to better illustrate the degree of variation which occurred over time.

As cured stems were progressively added, cattle grazed fewer of the augmented plants (Fig. 1) and removed less material from augmented plants that were defoliated (Fig. 2). After the first day, 25% of the plants with no stems were grazed and only 5% of those with stems were grazed. After the sixth day respective values for these treatments were 95% and 76%. Disparities among overall treatment means of our frequency data indicated cattle could not discriminate between treatments differing by only one stem (Fig. 1). Comparisons involving treatments differing by two stems, however, were significantly different ($P<0.05$).

Trends were similar across utilization data. Utilization for the zero and three stem treatments were, respectively, 14% and 2.5% after the first day,

Table 1

Repeated measures analyses of variance of frequency of use and percentage utilization by cattle of crested wheatgrass plants supplemented with 0, 1, 2 or 3 cured seed stalks dm^{-2} basal area. Treatment error term is blocks×treatments and the days and interactions error term is blocks×treatments×days

Source	Degrees of freedom	Frequency mean squares	Utilization mean squares
Blocks	3	37	369699
Treatments	3	77**	482055*
Blocks×treatments	9	12	81845
Days	5	514**	637822**
Blocks×days	15	1.4	11899
Treatments×days	15	0.7	8188
Blocks×treatments×day	45	2.6	4993

*$P<0.05$; **$P<0.01$.

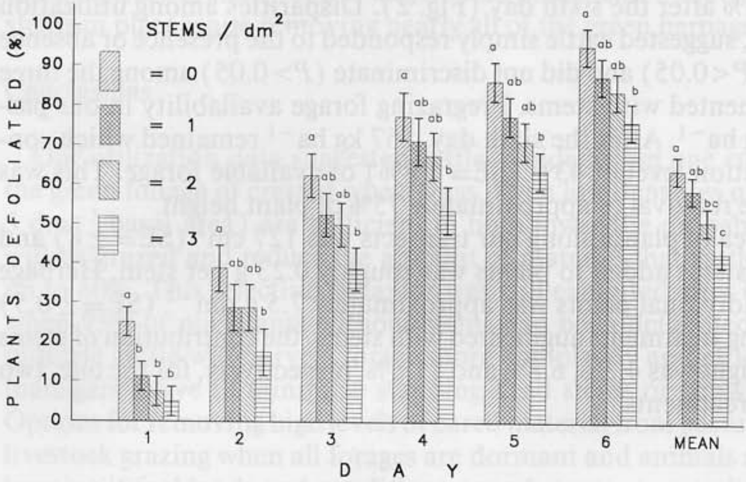

Fig. 1. Frequency (expressed as a percentage of plants defoliated) of grazing by cattle over a 6-day period of green crested wheatgrass tussocks augmented with densities of 0, 1, 2 or 3 cured seed stalks dm^{-2} basal area. Error bars denote ±1 standard error of the treatment mean. Daily error bars are derived from randomized complete block analyses for each day (four replications) and mean error bars from repeated measures analyses with four replications, four stem treatments and six repeated measures (days). Means within a cluster sharing a common letter are not significantly different ($P>0.05$).

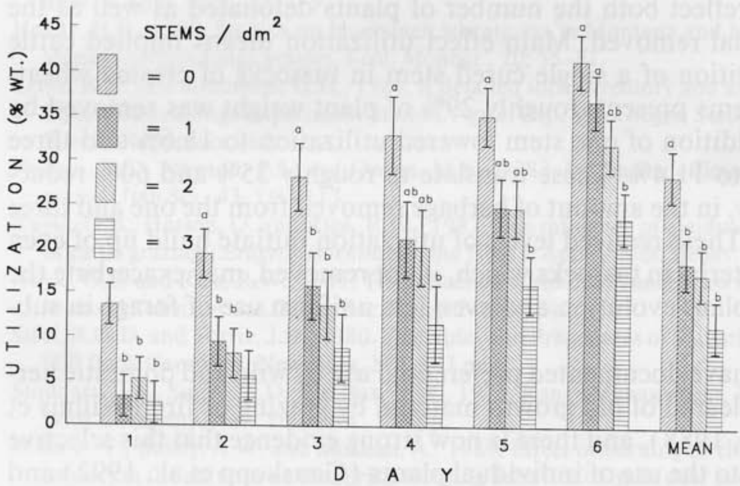

Fig. 2. Utilization (defined as a percentage of plant weight removed) by cattle over a 6-day period of green crested wheatgrass tussocks augmented with densities of 0, 1, 2 or 3 cured seed stalks dm^{-2} basal area. Error bars denote ±1 standard error of the mean. Error bar derivation presented in Fig. 1 header. Means within a cluster sharing a common letter are not significantly different ($P>0.05$).

and 41% and 24% after the sixth day (Fig. 2). Disparities among utilization means, however, suggested cattle simply responded to the presence or absence of cured stems ($P<0.05$) and did not discriminate ($P>0.05$) among the three treatments augmented with stems. Pregrazing forage availability in our pastures was 294 kg ha^{-1}. After the sixth day, 167 kg ha^{-1} remained which constituted a utilization level of 43% (SE= ±8%) of available forage. This was equivalent to the removal of approximately 75% of plant height.

Mean basal area of plants along our transects was 127 cm^2 (SE= ±8) and weight of cured stems added to plants was roughly 0.23 g per stem. Herbage production of individual plants was approximately 7.5 g dm^{-2} (SE= ±0.5) basal area. Among treatments augmented with stems, the contribution of stems to total plant weight was 4.3%, 6.8% and 11.6%, respectively, for the one, two and three stem treatments.

Discussion

Main effect means indexing frequency of plant defoliation, suggested cattle responded negatively to as few as two cured stems within the green herbage of crested wheatgrass. With a mean of 64% of the plants with no stems defoliated and 51% of the plants with two stems grazed, we obtained a 20% reduction in the probability that a plant containing two cured stems would be grazed. The addition of three stems reduced the probability of defoliation by 32%. Utilization data reflect both the number of plants defoliated as well as the amount of material removed. Main effect utilization means implied cattle responded to addition of a single cured stem in tussocks of crested wheatgrass. With no stems present, roughly 29% of plant weight was removed by the cattle. The addition of one stem lowered utilization to 18.6% and three stems reduced it to 11.4%. These translate to roughly 35% and 60% reductions, respectively, in the amount of herbage removed from the one and three stem treatments. These reduced levels of utilization initiate build up of even more residual material in tussocks which, if not removed, may exacerbate the problem of wolf-plant evolution and even less uniform use of forage in subsequent years.

Other workers have documented preferential use by wild and domestic herbivores of areas cleared of old growth material by grazing or fire (Willms et al., 1980; Gordon, 1988), and there is now strong evidence that this selective behavior extends to the use of individual plants (Ganskopp et al., 1992) and even parts of plants (Ruyle and Rice, 1991). Although not quantified in this project, we observed numerous instances where cattle employed the side grazing approach described by Ruyle et al. (1987) while foraging on plants augmented with cured stems. Plants without stems exhibited evidence of the more typical top–down approach of cattle. Bite patterns were clearly evident around the periphery of many of our augmented plants and frequently cattle left our stems in place while removing nearly all of the green herbage from a crown.

Conclusions

Our utilization data suggested cattle avoided even one cured stem among the green foliage of crested wheatgrass. Even low densities of dead stems (1–3 dm^{-2} basal area) are sufficient to both lower the probability that a plant will be grazed and reduce the amount of material that cattle will remove by up to 60%. This selective behavior was still exhibited after 6 days of grazing when 95% of our plants without stems had been defoliated. These findings indicate cattle will harvest forage more completely and efficiently if pasture managers strive to minimize standing dead stems or straw in green forage. Options for removing high levels of cured material from pastures include heavy livestock grazing when all forages are dormant and animals are less selective, burning if fuel loads and conditions are adequate, or mowing if pasture conditions and scale allow the use of equipment.

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