

Response of cattle to cured reproductive stems in a caespitose grass

DAVID GANSKOPP, RAY ANGELL, AND JEFF ROSE

Authors are range scientists, USDA-ARS, Eastern Oregon Agricultural Research Center, Squaw Butte Station, HC71 4.51 Hwy. 205, Burns, Oregon 97720; and research assistant, Oregon State University, Eastern Oregon Agricultural Research Center, Squaw Butte Station, HC 71 4.51 Hwy. 205, Burns 97720.

Abstract

Accumulation of wolf plants in rangeland pastures frequently results in waste or incomplete utilization of high quality forage by cattle. The objective of this research was to establish the degree of sensitivity of cattle to cured stems in crested wheatgrass (*Agropyron desertorum* (Fischer ex Link) Schultes) at 3 stages of phenology (late-boot, anthesis, and quiescence). This was accomplished by providing individual plants having densities of 0, 3, 6, 9, or 12 cured stems per dm² basal area and measuring frequency and degree of utilization after exposure to cattle grazing. Project design was a split-plot in a randomized complete block with 3 replications, 3 stages of phenology as whole plots, and 5 densities of stems as treatments. A significant ($P < 0.01$) phenology $\times$ treatment interaction occurred with cattle being equally sensitive to all treatments containing stems at late-boot and anthesis and oblivious to their presence at quiescence. At late-boot and anthesis stages of phenology 75% of plants with no stems were grazed while only 45% of plants with stems were grazed. Respective levels of utilization from the same treatments were 25 and 8%. A negative response was exhibited by cattle during anthesis when as little as 4% of biomass was contributed by cured stems. These results suggest that old growth stems should be removed or their presence noted as a covariate when conducting palatability studies or when observing plant-specific responses to defoliation by cattle. Cattle were not sensitive to treatments at quiescence when roughly 75% of plants in all treatments were defoliated with 25% herbage removal. This suggests that heavy grazing of a pasture with an objective of obtaining utilization of wolf plants would be most successful after all forage has cured, and cattle are less selective.

Key Words: *Agropyron desertorum* (Fischer ex Link) Schultes, grazing behavior, old growth, wolf-plants, forage preference, palatability, optimum foraging

A generally accepted axiom is that morphologic characteristics of grasses contribute to their relative palatability or acceptance by livestock, and that typically leaves are preferred over stems (Cook and Stoddart 1953, Cook 1959, Heady and Torell 1959, Reppert 1960, Heady 1964, Arnold 1964, Gangstad 1964, Gillet and Jadas-Hecart 1965, Galt et al. 1969, Murray 1984, Truscott and Currie 1989, O'Reagain and Mentis 1989). When bunchgrasses remain ungrazed in a given year, standing dead stems often persist, and livestock are less likely to graze those plants in subsequent seasons (Norton and Johnson 1986). These ungrazed "wolf plants" (Stoddart et al. 1975) may result in substantial loss of forage if they are present in high densities.

This aspect of grazing behavior has been observed in both wild

and domestic herbivores but has not been researched in a controlled manner. Recent detailed evaluations of cattle grazing behavior in crested wheatgrass (*Agropyron cristatum* (L.) Gaertner) detected an aversion to larger plants which was partially attributed to old growth material in larger bunches (Norton et al. 1983, Norton and Johnson 1986). Ruyle and Rice (1991) noted cattle preferred tufts of Lehmann lovegrass (*Eragrostis lehmanniana* Nees.) lacking residual stems, and they became less discriminating as plants matured. Murray (1984), in a palatability evaluation of 14 grass accessions, was able to account for 94% of the variation in forage utilization by sheep with models related to indices of seed-stalk density. Other scientists, focusing on patterns of forage use by wild herbivores, have noted greater utilization of forages where old growth material was removed by domestic animals or fire (Peck et al. 1979, Gordon 1988, Willms et al. 1980).

The primary objective of this research was to establish the degree of sensitivity of cattle to cured reproductive stems in crested wheatgrass (*Agropyron desertorum* (Fischer ex Link) Shultes)) at 3 different stages of phenology (late-boot, anthesis, and quiescence). This was accomplished by augmenting individual plants with various densities of cured stems and measuring frequency and degree of utilization after cattle grazing.

Materials and Methods

The study was conducted on the Squaw Butte Experimental Range (119° 43' W, 43° 29' N) 72-km west-southwest of Burns, Ore. Mean annual precipitation is 28.4 cm with peak monthly accumulations in November, December, January, and May (ranging from 2.9 to 3.6 cm); and a mean minimum accumulation (0.8 cm) in July (NOAA 1988). Mean annual temperature is 7.6° C with extremes of -29° and 42° C (NOAA 1952-1986). Nine 0.6-ha pastures were established by subdividing an 18-year-old crested wheatgrass seeding with electric fence. The seeding was heavily grazed the previous fall to remove standing old-growth material. Soil in the pastures is a Milcan fine sandy loam, (coarse-loamy, mixed, frigid Orthodic Durixerolls) (Lentz and Simonson 1986). Within each pasture 400-m of line transect was established in randomly placed 100-m increments. One-hundred points along each 400-m transect were selected randomly by computer drawing and the plant closest to each point randomly assigned to 1 of 5 treatments, for a total of 20 plants per treatment per pasture. Treatments consisted of plants artificially supplied with densities of either 0, 3, 6, 9, or 12 old-growth seed stalks/dm² of basal area. Treatment densities bracketed naturally occurring conditions as a sampling of ungrazed crested wheatgrass the previous fall detected a mean density of 4.3 (± 2.1 95% CI) reproductive culms/dm² basal area. Seed stalks used in the study were collected at quiescence the previous growing season and were stored indoors until needed the subsequent year.

Basal areas of plants were determined by measuring each crown's greatest diameter, second greatest diameter perpendicular

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to the first, and solving for the area of an ellipse. Holes were punched in the soil within each crown with a chaining pin, and the number of seed stalks necessary to obtain the designated treatment density inserted. Where calculations demanded a fraction of a seed stalk, the count was rounded up to the next whole number. Actual densities, therefore, were slightly higher than planned with respective mean values for the 3, 6, 9, and 12 stem treatments of 3.5, 6.6, 9.5, and 12.4.

The study was repeated at 3 stages of phenology. These were: late-boot, anthesis, and quiescence, with 3 pastures sampled at each stage. We attempted to duplicate the appearance of naturally occurring wolf plants at each stage of phenology. At late-boot stage, the inserted stems projected 5 to 25 cm above the leafy tillers. At anthesis, current year's growth was still green, and inserted old growth stems were roughly the same height as the current year's flowering stems. During the quiescent stage, all leaves and stems were brown, and current year's reproductive stems were either removed or supplemented to obtain desired treatment densities. Again, added stems approximated the height of the general canopy.

In 1 of the pastures at each sampling period, 5 additional plants per treatment were furnished with stems and harvested to a 2.5-cm stubble to provide measures of treatment effects on forage quality. Quality was indexed by crude protein content (AOAC 1980; kjeldahl nitrogen % $\times$ 6.25 on a dry matter basis). Measures of forage availability and utilization in each pasture were obtained by clipping ten 1-m² plots to ground level immediately before and after cattle grazing. Plots were systematically placed along pace transects diagonally traversing the pasture. At each stage of phenology, 2 yearling steers were placed in each of the 3 pastures (total of 6 animals), where they were allowed to forage until approximately 75% of all plants in the pasture had received some degree of defoliation. A daily step-point sampling of 25 points in each pasture was used to monitor proportions of grazed and ungrazed plants. The same 3 pairs of steers were used throughout the project.

After cattle were removed, treatment plants were evaluated for presence or absence of defoliation, and if defoliated, the percent of utilization by weight was estimated using height-weight relationships (Heady 1950) developed at each stage of phenology. Total values for each treatment within a pasture were viewed as single observations in final analyses, with the data converted to mean values for presentation. Null hypotheses (H_0) of interest were: cattle grazed treatments with equal frequency and degree of utilization, and that treatment effects were independent of stage of phenology. Analyses included: Bartlett's test of homogeneity of variance among treatments (Snedecor and Cochran 1967), a separate evaluation of each stage of phenology with a randomized complete block design (5 treatments and 3 replications), and a final split-plot analysis of compiled data in a randomized complete block design with 3 replications, 3 stages of phenology as whole plots, and 5 treatments. Mean separations ($P \leq 0.05$) were accomplished with orthogonal contrasts.

Results

September (1988) through June (1989) precipitation, which is most strongly correlated with annual forage yield in the region, was 27.7 cm. This is also the long-term mean for that same period at the experiment station. Respective mean levels ($\pm$ SE) of available forage during the study were 500 (106), 802 (90), and 451 (62) kg/ha at late-boot, anthesis, and quiescent stages of phenology. The reduction in available herbage between anthesis and quiescence was most likely a product of leaf senescence and seed shatter. Cattle grazed pastures for 4, 5, and 5 days, respectively, during the 3 stages of phenology, and accompanying levels of utilization ($\pm$ SE) derived from clipped samples after cattle exited were 20 (11.5), 20 (9.6), and 27% (3.1).

Table 1. Split-plot ANOVA of frequency of use (%) and utilization by weight (%) of crested wheatgrass plants augmented with 0, 3, 6, 9, or 12 cured seed stalks per dm² basal area at 3 stages of phenology. **indicates significance ($P \leq 0.01$).

Source	DF	Frequency	Utilization
		MS	MS
Blocks	2	1837	178
Phenology	2	3434**	705**
Block $\times$ Phen.	4	85	24
Treatments	4	826**	250**
Phen. $\times$ Treat.	8	313**	59**
Residual	24	73	18

Split-plot analyses of variance revealed a significant ($P \leq 0.01$) treatment $\times$ phenology interaction with identical interpretations derived from both the frequency of defoliation and utilization data (Table 1 and Figures 1 and 2). The greatest contribution to total

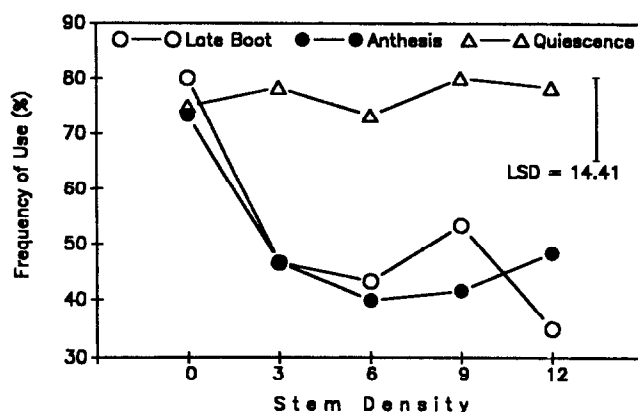


Fig. 1. Frequency (expressed as percent of plants defoliated) of use by cattle of crested wheatgrass tufts augmented with densities of 0, 3, 6, 9, or 12 cured reproductive stems per dm² basal area at 3 stages of phenology. LSD ($P < 0.05$) allows comparison among treatment means at a given stage of phenology.

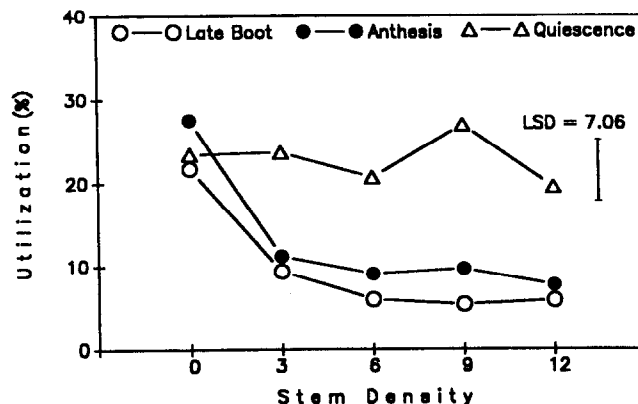


Fig. 2. Utilization (expressed as percent of herbage weight removed) by cattle grazing crested wheatgrass tufts augmented with densities of 0, 3, 6, 9, or 12 cured reproductive stems per dm² basal area at 3 stages of phenology. LSD ($P < 0.05$) allows comparison among treatment means at a given stage of phenology.

variation was derived from the phenology component. Our conjecture that the significant treatment $\times$ phenology interaction effect was predominantly due to responses from the quiescent stage of phenology was verified by conducting a second split-plot analysis including only data of the late-boot and anthesis periods. This

yielded significance ($P \leq 0.01$) for treatment effects but not for phenology or the treatment $\times$ phenology interaction. Consequently, discussions will focus on the late-boot and anthesis periods followed by results from the quiescent stage of phenology.

Contrasts revealed the significant treatment difference ($P \leq 0.01$) at the late-boot and anthesis stages of phenology were attributable only to the presence or absence of cured reproductive stems with no difference among the different densities of stems. These findings were common to both the frequency of use (Fig. 1) and percent utilization (Fig. 2) response variables. No significant treatment effect occurred ($P > 0.05$) during quiescence in analyses of either response variable. Across all treatments, mean frequency of use was 77%, and estimated utilization was 22.8% (Figs. 1 and 2).

Mean crude protein content of stems used to augment plants was 3.5% ($\pm$ SE 0.09), and treatments had a significant ($P < 0.01$) effect on crude protein content of tufts. Generally, plants exhibited a progressive decline in quality at late-boot and anthesis stages of phenology as stem densities increased (Fig. 3). Augmented plants

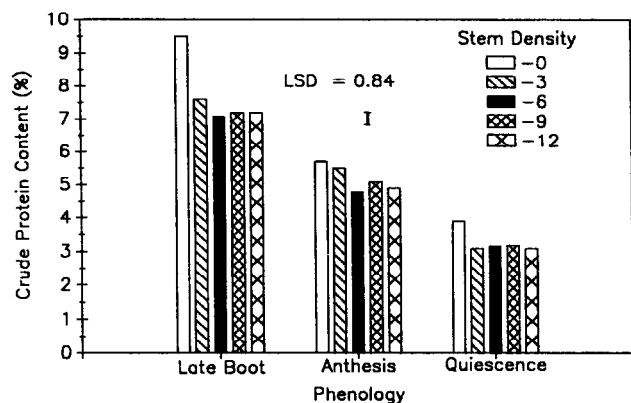


Fig. 3. Crude protein content (%) of entire crested wheatgrass tufts augmenting with densities of 0, 3, 6, 9, or 12 cured reproductive stems per dm² basal area at 3 stages of phenology. LSD ($P < 0.05$) allows comparison among treatment means at a given stage of phenology.

showed little variation in quality at quiescence. Dilution of forage quality among treatments was greatest in the late-boot stage of phenology with the range among treatments spanning 2.4% and least during quiescence with a range spanning only 0.8%. Across the 4 treatments containing stems, the mean percent of biomass contributed by cured stems ranged between 10–19, 4–10, and 10–20% at late-boot, anthesis, and quiescence, respectively.

Discussion and Conclusions

In general steers did not discriminate among treatments containing cured stems at late-boot and anthesis phenologies. The probability these plants would be grazed was 30–35 percentage points less than plants without cured stems. The probability a plant with zero stems would be grazed was about 75%, and the probability for the augmented treatments was approximately 45%. The chances, therefore, that a plant with stems would be grazed about about 60% of that expected for plants without stems. Treatments in this effort lacked sufficient resolution to definitively determine whether steers exhibit a zero tolerance for cured stems in green herbage. In retrospect, 1 and 2 stem treatments should have been included to address this question.

We speculate cattle used visual cues as they selected or bypassed individual plants in the late-boot and anthesis portions of the study. Lack of treatment response during quiescence, when all forage components were of similar color, lends some credence to this, but we have no firm evidence to support this observation. Dwyer et al. (1964) observed cattle made less use of chlorotic than

green forages. They noted, however, that chlorotic plants were specific to nutrient poor sites and aspects other than color may have contributed to forage selection. Krueger et al. (1974) found in domestic sheep that taste was the dominant sense contributing to selective grazing with sight and touch serving supplemental roles.

Ruyle et al. (1987) detected greater handling time per bite when cattle grazed stemmy versus non-stemmy tufts. O'Reagain and Mentis (1989) detected a negative relationship between stemminess and acceptability of different forages to cattle; and in citing the above work and Stobbs (1974), they speculated stemminess may increase the energy expenditure associated with harvesting a given amount of leaf from plants. Work by Black and Kenny (1984) has also suggested animals prefer to graze in areas where forage can be harvested most rapidly. Disparities in forage quality exhibited among our treatments also imply optimum foraging benefits were derived when cattle bypassed stemmy plants.

Due to our lack of treatment response during quiescence, we propose cleanup of pastures with high concentrations of wolf plants would be best accomplished if cattle were introduced after all forage had cured. In pastures of mixed compositions, disparities in acceptability of various species to cattle would most likely still exist, but within each species there is probably still a greater likelihood cattle would defoliate stemmy plants. Forages would be of low quality at this time, and with an extended grazing period, protein supplementation would be required to maintain adequate livestock performance.

Crested wheatgrass is noted for its propensity to accumulate high densities of reproductive stems, and grazing strategies have been proposed to overcome this problem (Hyder and Sneva 1963). This is not unique to crested wheatgrass, however, and we suggest to plant breeders and range reclamation specialists that leafy selections receive greater scrutiny. While a high density of reproductive stems offers germplasm proliferation benefits, it may confer less resistance to defoliation (Branson 1956) and a greater likelihood of developing a "wolfy" stature. Species or selections having less persistent reproductive culms might provide another alternative.

In conclusion, we found cattle were more sensitive than expected to small numbers of cured reproductive stems in standing green herbage. This occurred when as few as 3 cured stems (contributing as little as 4% of plant biomass) were placed in dm² sized tufts. In light of these findings, old growth stems should be removed or their presence noted as a covariate when conducting palatability studies or plant specific responses to defoliation by cattle. Additionally, we emphasize the need to obtain uniform utilization of forages in pastures to avoid development of wolf plants. Cattle were insensitive to cured culms after quiescence, and we suggest that utilization of wolf plants or pasture cleanup would be best accomplished if grazing occurs after standing forage has cured.

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