Defoliation of Intermediate Wheatgrass under Seasonal and Short-duration Grazing

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Abstract

Defoliation of intermediate wheatgrass (*Agropyron intermedium*) by cattle was examined under seasonal and short-duration grazing. Tiller height, number of green leaves per tiller, phenological status, and defoliation frequency were measured on individually marked tillers during 2 grazing seasons.

Defoliations at high and low stocking densities (5.2 and 2.6 animal-units/ha) were examined during the 1983 growing season. At equal stocking rates, standing crop decreased more rapidly under low stocking density. Mean tiller height and mean number of leaves per tiller decreased linearly over time in both treatments.

In 1984, 14 heifers were moved through 3 rotations of an 8 subunit short-duration grazing system in 72 days. A larger fraction of tiller height and a higher number of green leaves per tiller were defoliated during rotation one than during rotation three. Animals grazed the greatest number of tillers during rotation one. Biting rate varied logarithmically with the mean number of green leaves per tiller. Time spent grazing was significantly and inversely related to the mean number of green leaves per tiller. This result suggests that animals were selectively grazing green leaves over coarse stem, and spent more time searching for them as their numbers decreased.

Key Words: grazing management, grazing plan, grazing systems

Rotational grazing systems have been developed to meet the needs of the vegetation, soil, and livestock, while allowing flexibility in management. Part of the research in selecting a suitable grazing system involves detailed field studies of grazing systems under different conditions. Essential field information on plant and animal performance under different grazing systems can then be considered within a general management model, and one or more suitable management plans can be developed. For results of field studies on grazing systems to be widely useful, research should focus on dynamics of herbage growth, disappearance, and defoliation as well as animal performance or plant species composition. Research should be designed to provide researchers and managers with predictive equations describing defoliation effects of livestock over time, rather than comparisons of mean defoliation effects between specific grazing systems.

Presently, however, little information exists describing defoliation of tillers and plant parts under different grazing systems. Gammon and Roberts (1978a, 1978b, 1978c) studied the selectivity of grazing and the severity and frequency of defoliation by cattle under continuous and rotation grazing within the Matapos sandveld of Rhodesia. Degree of selection and changes in animal selectivity were attributed to the morphological features of the different plant species, changes in moisture content, and changes in relative tiller height. By the end of grazing, tiller heights did not differ between treatments by more than 1 cm. The more frequently grazed tillers tended to be the more severely defoliated. While rotational grazing caused a slight reduction in multiple defoliations of any one tiller, there was little difference in mean frequency of defoliations between treatments.

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Hart and Balla (1982) measured forage production and removal from tillers of western wheatgrass (*Agropyron smithii*) and crested wheatgrass (*Agropyron desertorum*) under 2 stocking rates. Tillers of both species were grazed more frequently under the higher stocking rate. Difference in stocking rate had little influence on the proportion of available forage removed at each grazing event. Only at the higher stocking rate on crested wheatgrass were all tillers grazed at least once. A small percentage of tillers remained ungrazed under all other grazing treatments.

In Texas, Briske and Stuth (1982) investigated tiller defoliation patterns by yearling steers under moderate and heavy grazing. Tiller height of brownseed paspalum (*Paspalum plicatulum*), a warm-season bunchgrass, was reduced 50% within 7 days in the heavy grazing treatment. A significant reduction in tiller height within the moderate grazing treatment did not occur until after 18 days of grazing and tiller height was reduced only 46% at the termination of grazing. Tillers in the heavily grazed treatment were uniformly regrazed at 3–4 day intervals. Tillers in the moderate grazing treatment were nonuniformly grazed and had a wide range of tiller heights at the termination of grazing. By the end of the moderate grazing trial 82% of the tillers had been grazed at least once, 31% at least twice, and 10% at least 3 times.

Our study was designed to determine and compare the frequency, timing, and degree of defoliation of individual tillers of intermediate wheatgrass (*Agropyron intermedium*), a cool-season, rhizomatous grass, under (1) continuous grazing at 2 different stocking densities (animal-units (AU)/ha) and (2) within 3 rotations of a short-duration grazing system. We also determined relationships between tiller defoliation measurements and grazing behavior (especially diurnal grazing time and biting rate) under short-duration grazing.

Study Area and Methods

Study Area

The study was conducted on a 48-ha intermediate wheatgrass pasture in central Washington. The semiarid region has a mean annual precipitation of 32 cm. Precipitation between August 1982 and August 1983 was approximately 44 cm, and between August 1983 and August 1984, 41 cm. Most precipitation falls as snow between November and March; summer showers contribute trace amounts. Mean monthly temperatures range from -4°C in January to 24°C in July.

In 1969, approximately 65% of the area was seeded, with the remainder being rock outcrops or steep stony areas with shallow soils. Fifteen years after seeding, the area supports a dense stand of intermediate wheatgrass. Peak standing crops vary from approximately 1,500 to 2,250 kg/ha with peak herbage growth rate (kg/ha-day) occurring in early to mid-June. Small invading populations of Russian and diffuse knapweeds (*Centaurea repens* and *Centaurea diffusa*) are present. The native vegetation on the unseeded area consists of *Agropyron spicatum*, *Festuca idahoensis*, *Elymus cinereus*, *Balsamorhiza* spp., *Eriogonum* spp., and introduced species including *Bromus tectorum*. Forage production on these native sites is low and is a negligible fraction of the total standing crop.

Methods

In 1983, the 48-ha area was divided into 2 pastures based on

ocular and stratigraphic estimation of equal standing crops. One pasture was stocked with 62 cow-calf pairs for 26 days (24 June to 20 July) for a stocking density of 2.6 AU/ha to achieve a low stocking density (low SD) treatment. The other pasture was stocked with 124 cow-calf pairs for 12 days (24 June to 6 July) for a stocking density of 5.2 AU/ha to achieve a high stocking density (high SD) treatment.

Twenty transects were randomly distributed within strata in each pasture. Each transect contained 20 tillers spaced approximately 10 cm apart. Each tiller was marked with colored, 14-gauge solid-core copper wire loosely wrapped around its base. Alternate colors were used so that individual tillers could be identified and repeatedly measured, as described by Briske and Stuth (1982). Five ungrazed transects protected by wire exclosure cages were randomly placed in each pasture.

Tiller measurements were recorded every 2 days. Variables measured were phenological status (vegetative, culmed, or flowering), tiller height (measured from soil surface to tip of highest outstretched leaf), number of green leaves per tiller, and number of partially grazed leaves per tiller. Each tiller was recorded as grazed or ungrazed since the previous measurements. Fingernail polish was used to mark edges of grazed parts of tillers so that repeated measurements of all variables were possible. Gammon and Roberts (1978a) found that this method of marking did not influence plant selectivity by cattle.

Fifty 0.5-m² plots, randomly distributed with strata, were clipped to a 2.5-cm stubble height both before and after grazing in each pasture. Clippings were oven dried and used to estimate changes in standing crop within each pasture. Linear regression analysis (Steel and Torrie 1980) was used to analyze each variable over time for each pasture.

In 1984, a radial set of 8 subunits was constructed on a 6-ha portion of the 48-ha area used in the first year of the study. The area was selected on the basis of uniform standing crop, elimination of unseeded area, and proximity to water. The area was divided into smaller subunits on the basis of ocularly and stratigraphically estimated equivalent standing crops. Subunits averaged 0.75 ha in size and contained an average of 2,100 kg/ha initial standing crop. The 8 subunits radiated from the water source located in a small portable corral. A 3-wire (center wire grounded) fence attached to permanently placed fiberglass posts on 35-foot centers delineated subunit boundaries. After each grazing period, wires were reeled onto large spools, and unreel along the boundary of the next subunit to be grazed.

Twenty-five transects, each containing 10 tillers, were randomly located between marked fence posts in subunits 2, 4, 6, and 8. Methods of tiller identification were the same as used in 1983. Variables measured were the same as in 1983 with the addition of the number of senescent leaves per tiller (estimated to the nearest half leaf). Fingernail polish was again used to mark grazed portions of tillers for repeated measurement of variables.

Twenty-five 0.5-m² plots, randomly distributed within strata, were clipped before and after grazing in each subunit throughout 3 rotations. Standing crop measurements were used to estimate forage availability and regrowth for each subunit within each rotation. A more detailed description of sampling methods can be found in Pierson (1985).

Fourteen bred heifers of similar age and size were moved through successive subunits every 3 days. Three rotations of the 8 subunits were completed in 72 days (3 June to 14 August). Stocking densities for each subunit ranged from 9.1 to 16.1 AU/ha, with a total stocking rate over the 72 days of 100 animal-unit-days (AUD)/ha. Animals were moved between 9:00 and 10:00 AM PDT after their morning grazing period.

Analysis of variance procedures using a split-plot repeated measures design (Steel and Torrie 1980) were used to determine differences between pastures and between rotations for appropriate variables. A Least-Significant Difference test (Steel and Torrie

1980) was used to test for differences between stocking densities. Regression analysis (Steel and Torrie 1980) was used to determine relationships between tiller measurements and time, standing crop, and utilization. Regression analysis was also used to determine relationships between tiller measurements and behavioral measurements (grazing times and biting rates) of 4 heifers on each subunit during each rotation of the study, reported by Abu-Zanat (1985). Unless otherwise noted, statistics were tested for significance at $\alpha=0.05$.

Results and Discussion

1983

Initial standing crops within the low SD and high SD pastures were 2,700 kg/ha and 1,910 kg/ha, respectively. Stocking rates for both SD's at the termination of grazing were approximately equal to 62.4 (AUD)/ha. Standing crop ((initial-final) $\times$ 100%) was reduced 64% on the low SD pasture and 58% on the high SD pasture. Assuming similar forage disappearance rates not due to grazing, animals in low SD pasture averaged a higher daily intake. The percentage of tillers defoliated within corresponding sampling periods was variable for both SD's and showed no trend of one SD being higher than the other. The percentage of plants defoliated per sampling period did not decrease over time as Greenwood and Arnold (1968) found for sheep grazing a set-stocked pasture.

Mean tiller height in both treatments decreased linearly over time. The change in tiller height over time showed the high SD treatment had a slope of more than twice that of the low SD treatment (Fig. 1). The more than doubling of slope was likely due

Fig. 1. Mean tiller height over time for intermediate wheatgrass in central Washington (1983). Results shown are for tillers grazed by cattle at 2 stocking densities (SD), (n=400 tillers).

to unequal grazing pressures (AU/kg) between treatments. The high SD pasture had twice the stocking density and less total forage. The average number of leaves per tiller over time for each treatment showed more closely a doubling of slopes between treatments (Fig. 2).

The percentage of plants defoliated at least once over time for each treatment produced asymptotic regression lines as the percentage of plants defoliated approached 100% (Fig. 3). Perhaps as the percentage of ungrazed tillers decreased, the chance of animals locating ungrazed tillers also decreased and they began to choose previously defoliated tillers. Briske and Stuth (1982) found that ungrazed tillers were less likely to be grazed than previously grazed tillers due to increased leaf senescence, culm elongation and inflorescence emergence. Under 2 stocking rates Hart and Balla (1982) observed some tillers were frequently and severely defoliated while others remained ungrazed. Regression of both the percentage of tillers defoliated twice and three times over time increased linearly

Fig. 2. Mean number of leaves per tiller over time for intermediate wheatgrass in central Washington (1983). Results shown are for tillers grazed by cattle at 2 stocking densities (SD), (n=400 tillers).

Fig. 3. Percentage of intermediate wheatgrass tillers grazed at least once over time for cattle grazing at 2 stocking densities (SD), (n=400 tillers) (1983).

Fig. 4. Percentage of intermediate wheatgrass tillers grazed at least twice over time for cattle grazing at 2 stocking densities (SD), (n=400 tillers) (1983).

Fig. 5. Percentage of intermediate wheatgrass tillers grazed at least three times over time for cattle grazing at 2 stocking densities (SD), (n=400 tillers) (1983).

over the percentage in both SD treatments (Fig. 4 and 5). The percentage of tillers grazed 4 or more times in both treatments was low and no trends were evident.

1984

There was a significant interaction between subunits and rotations for the number of tillers grazed in each subunit during each rotation. Examination of the number of tillers grazed in each subunit between rotations showed the general trend that the greatest number of tillers were grazed during rotation one and the fewest during rotation three. Seventy-seven percent of the tillers were grazed during rotation one, 57% during rotation two, and 42% during rotation three.

There were significant differences in the mean increment of tiller height removed during grazing between rotation three (6.8 cm) and rotations one (12.2 cm) and two (11.1 cm). No significant differences were found in height removed between rotations one and two. There were similar trends in the mean number of green leaves per tiller defoliated during grazing of each rotation. These relationships combined with the significant relationship between standing crop before grazing and mean tiller height before grazing (Fig. 6),

Fig. 6. The relationship between standing crop before grazing and mean tiller height before grazing for intermediate wheatgrass in central Washington (1984).

suggest that the smaller increment of height removed during rotation three would have produced a smaller change in standing crop. As stated, by the third rotation the animals defoliated fewer tillers and the severity of grazing were apparently reduced. However, changes in standing crop for each subunit was generally higher during rotation three (27–35%) than during rotations one (14–24%) and two (19–30%). Increasingly higher forage disappearance rates over time from rotation one to three may have contributed to this inconsistent increase in changes in standing crop. Change in standing crop was inversely related to the mean number of green leaves per tiller before grazing (Fig. 7). At times during rotation three, animals appeared to graze the thick mulch layer in preference to coarse stems.

Fig. 7. The relationship between reduction in standing crop (%) for each subunit and mean number of green leaves per tiller before grazing. Results shown are for heifers grazing intermediate wheatgrass in central Washington (1984).

There were significant interactions between subunits and rotations for the mean change in tiller height and for the mean change in number of green leaves per tiller due to regrowth between rotations. Examination of variables between rotations showed increases in tiller height and number of green leaves per tiller were significantly greater during the rest period between rotations one and two than the rest period between rotations two and three. The number of green leaves per tiller decreased between rotations two and three because senescence exceeded regrowth. Regrowth of tiller height within subunits between rotations one and two decreased in the same order in which the subunits were initially grazed. The subunit grazed first (subunit two) had the greatest regrowth, while the subunit grazed last (subunit eight) had the least. The rest period between rotations for subunit two was earlier in the growing season and thus had more favorable regrowth conditions. There were no differences in regrowth of tiller height between subunits within the rest period between rotations two and three. Little regrowth occurred later in the season due to reduced soil moisture and plant maturity.

Tiller measurements were analyzed relative to measurements of grazing behavior collected concurrently and reported by Abu-Zanat (1985). As the number of green leaves per tiller declined, biting rate (bites/minute) declined (Fig. 8). Perhaps as the number of green leaves decreased, the animals slowed their biting rate to selectively graze them in preference to coarse stem. Also, animals often grazed the mulch layer during rotation three. As biting rate decreased and grazing selectivity increased, fewer plants were defoliated (Fig. 9). Grazing time increased with a decrease in green leaves (Fig. 10). Animals appeared to be selectively grazing green leaves and apparently spent more time searching for them as their numbers decreased.

Fig. 8. The relationship between biting rate on day one of grazing in each subunit and mean number of green leaves per tiller before grazing. Results shown are for heifers grazing intermediate wheatgrass in central Washington (1984).

Fig. 9. The relationship between the number of tillers grazed (%) and mean biting rate over 3 days of grazing in each subunit. Results shown are for heifers grazing intermediate wheatgrass in central Washington (1984).

Fig. 10. The relationship between grazing time on day one of grazing in each subunit and mean number of green leaves per tiller before grazing. Results shown are for heifers grazing intermediate wheatgrass in central Washington (1984).

Many variables must be examined to fully understand progressive defoliation under livestock grazing. Individual variables, their interrelationships, and their effect on system behavior must all be considered before scientific management can be applied. Study of the dynamics of defoliation is essential in analyzing the response of the vegetation and livestock under different grazing systems and should be a fundamental part of future field studies of livestock grazing.

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