

Tiller Defoliation in a Moderate and Heavy Grazing Regime

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Abstract

An investigation defining the intensity and frequency of tiller defoliation in brownseed paspalum (*Paspalum plicatulum*), a native perennial, bunchgrass, was conducted with yearling steers in a moderate and heavy grazing regime. Tillers were marked with alternately colored loops of plastic-coated wire so that an individual tiller could be located on successive sampling dates. Tiller height was reduced 50% within 7 days in the heavy grazing regime. The percentage of leaves defoliated per tiller was 63, 78 and 82 following 4, 7, and 11 days of grazing, respectively. Tillers in the heavy grazing regime were uniformly regrazed at approximately 3 to 4 day intervals. A significant reduction in tiller height did not occur in the moderate grazing regime until after 18 days of grazing and tiller height was reduced only 46% at the end of the 33-day grazing trial. The percentage of leaves defoliated per tiller was 5, 9 and 26 following 11, 21, and 33 days of grazing, respectively. By the end of the moderate grazing trial 82% of the tillers were grazed at least once, 31% at least twice and 10% at least three times. The nonuniform frequency of tiller defoliation and wide range of tiller heights at the end of the moderate grazing trial resulted in an inefficient harvest of available tillers.

Most rangeland grazing systems have been of an extensive nature, thereby, limiting the need and interest for research on defoliation patterns. However, with the advent of short duration grazing in the United States (Savory and Parsons 1980), it has become apparent that our understanding of grazing dynamics must increase in order to evaluate and utilize this approach to grazing management. This necessitates collection of information on the pattern of defoliation by livestock for evaluating plant responses to defoliation, in both actual and simulated grazing situations.

Several authors have previously noted that while the importance of understanding growth patterns is emphasized, often no mention is made of investigating patterns of defoliation (Barnes 1972, Gammon and Roberts 1978c, Spedding 1965). Thus, there is often no method for making meaningful comparisons of plant responses to defoliation among various grazing systems; nor, are there any criteria for determining realistic defoliation patterns when conducting simulated grazing studies.

Gammon and Roberts (1978b) compared a continuous grazing system and a simulated six-pasture rotation system and found that the pattern of defoliation was similar for most species during most seasons. However, they did observe that differences occurred in height of grazing among veld types, among species, among species within veld types and among seasons. Frequent light defoliation was rare, the more frequently grazed tillers tended to be the more severely defoliated ones. Both frequency and severity of defoliation increased with an increase in stocking rate (Hodgson and Ollerenshaw 1969).

Investigations simulating grazing by clipping at uniform arbitrarily chosen stubble heights are probably not representative of

livestock grazing in most situations. Gammon and Roberts (1978b) observed that height of grazing was characteristic of individual species rather than of veld types. Tillers with the greatest height and green leaf lengths were utilized to the greatest extent (Gammon and Roberts 1978b, Greenwood and Arnold 1968, Hodgson and Ollerenshaw 1969). In addition, expanding and mature leaves were defoliated more frequently than were old leaves (Hodgson 1966, Morris 1969).

Several detailed studies on pattern of defoliation have been conducted with sheep grazing forage grasses (Greenwood and Arnold 1968, Hodgson and Ollerenshaw 1969, Hodgson 1966, Morris 1969) and one with sheep grazing native range (Hodgkinson 1980). However, we are aware of only one study on pattern of defoliation (Gammon and Roberts 1978a, 1978b, 1978c) of native grass species grazed by cattle. Therefore, an investigation utilizing brownseed paspalum (*Paspalum plicatulum*), a native, perennial, bunchgrass, was conducted with yearling steers to determine the intensity and frequency of defoliation in a moderate and heavy grazing regime. Individual tillers were utilized as the major unit of investigation and forage availability to the animal was estimated to evaluate grazing regimes.

Study Area and Methods

The study area was located on the Texas A&M University Range Research Area, 3 km southwest of College Station in the Post Oak (*Quercus stellata*) Savannah region of east-central Texas. Mean annual precipitation for the study site is 98.8 cm with a predominant spring and fall distribution pattern. Both pastures were located on a Tabor sandy loam soil. The site was previously described in detail by Britton et al. (1978).

Two 1.5-ha pastures were selected to monitor the pattern of tiller defoliation. Pasture one (heavily grazed) was essentially a grassland community on which most woody species had been killed with tebuthiuron (*N*-[5-(1,1-dimethylethyl)-1,3,4-thiadiazol-2-yl]-*N,N'*-dimethylurea) 3 years prior to the study. Dominant herbaceous vegetation consisted of little bluestem (*Schizachyrium scoparium*) and brownseed paspalum. Each species comprised 22% of the herbaceous composition of the stand by weight. Pasture two (moderately grazed) was a woodland savannah with an overstory dominated by post oak and yaupon (*Ilex vomitoria*). Little bluestem and brownseed paspalum dominated the herbaceous layer of the community with 34 and 17% of the composition by weight, respectively. The remainder of the herbaceous standing crop consisted of a forb and vine component.

Standing crop before and after grazing was determined by the cage difference method (NAS-NRC 1962). Ten sets of tri-paired 0.25 m² plots were located at random, one caged for herbage accumulation, one immediately clipped to ground level for standing crop with the remaining plot clipped at the end of each grazing trial for residual standing crop. Herbage allowance, weights of herbage per unit weight of live animal, and net herbage accumulation, change in aboveground herbage weight between successive measurements, were calculated according to the procedures described by Hodgson (1979). Herbage allowance was calculated to provide an index of herbage availability to herbage demand by the animal.

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The procedures utilized for marking and relocating individual tillers were similar to that of Gammon and Roberts (1978a). In the heavily stocked pasture, grazed April 5 through 17, 1979, three belt transects (11–15 m $\times$ 0.3 m) of 100 tillers each were uniformly distributed within the pasture. In the moderately stocked pasture, grazed June 1 through July 3, 1979, six belt transects (6–9 m $\times$ 0.3 m) of 50 tillers each were uniformly located within a second pasture. Six transects were utilized in the second pasture because brownseed paspalum occurred in less uniform stands. Tillers were selected on the basis of uniform heights ranging from 15 to 25 cm and 30 to 45 cm at the time of the heavy and moderate grazing trials, respectively. Tillers were marked at 10 to 15 cm intervals along the transects with 3 cm lengths of 14 gauge plastic-coated copper wire formed into a loop at the time it was attached to the base of the tiller. The wire loops were alternately colored so that an individual tiller could be located and data recorded on successive sampling dates. To aid in detection of a regrowth event, previously defoliated leaf blade tips were marked with a narrow band of red fingernail polish. Gammon and Roberts (1978a) indicated that marking in this manner did not influence animal selectivity during grazing.

Following installation of the belt transects, initial marking and data recording on sample tillers, Hereford $\times$ Brahman steers with an average weight of 186 and 231 kg were turned into pastures one and two, respectively. In the heavy grazing trial, stocking the 1.5-ha pasture with eight steers for 11 days resulted in an average herbage allowance of 3.7 kg DM $\cdot$ 100 kg BW $\cdot$ d⁻¹. In the moderate grazing trial, stocking the 1.5-ha pasture with four steers for 33 days resulted in an average herbage allowance of 6.5 kg DM $\cdot$ 100 kg BW⁻¹ $\cdot$ d⁻¹. Allison and Kothmann (1979) indicated that restrictions to animal intake may occur at a herbage allowance of less than 4.4 kg DM $\cdot$ 100 kg BW⁻¹ $\cdot$ d⁻¹. Therefore, the first grazing trial represented the lower limit of herbage allowance for short duration grazing strategies, indeed a heavy grazing regime, while the second grazing trial represented a more moderate grazing regime.

The following data were recorded twice weekly for each sample tiller: whether defoliated or not; tiller height (from soil surface to highest outstretched leaf tip); total number of leaves; and number of defoliated leaves. Increments of tiller removal were calculated by summing reductions in tiller height between sampling dates.

Statistical analysis consisted of analysis of variance and Duncan's mean separation tests. The variance of expected probabilities of the percent frequency of grazed and ungrazed tillers were compared by date. Each belt transect was considered a separate sampling unit.

Results and Discussion

Heavy Grazing Regime

Standing crops before and after the 11-day heavy grazing trial were 393 kg $\cdot$ ha⁻¹ and 400 kg $\cdot$ ha⁻¹, respectively. The similar values for standing crop are indicative of the rapid rates of net herbage accumulation, 57 kg $\cdot$ ha⁻¹ $\cdot$ d⁻¹, that occurred during this period. Approximately 60% of the total herbage was comprised of unpalatable ironweed (*Veronia* spp.) and was omitted from herbage allowance calculations.

Tiller height was rapidly reduced throughout the grazing trial from an initial height of 20 cm to a minimum height of 8 cm at the end of the 11-day trial (Fig. 1a). At this level of herbage allowance, it took only 7 days of grazing to reduce tiller height 50%. At the end of the trial 76% of the tillers ranged between 0 and 10 cm in height indicating uniform grazing (data not shown).

The increment of tiller removed between sampling dates decreased during the grazing trial (Fig. 1a). An average of 7 cm was removed per tiller between the initial two sampling dates while only 2 cm was removed between the two final sampling dates. At the end of the 11-day grazing trial an average of 14 cm had been removed per tiller.

Since brownseed paspalum made up only 22% of the herbaceous

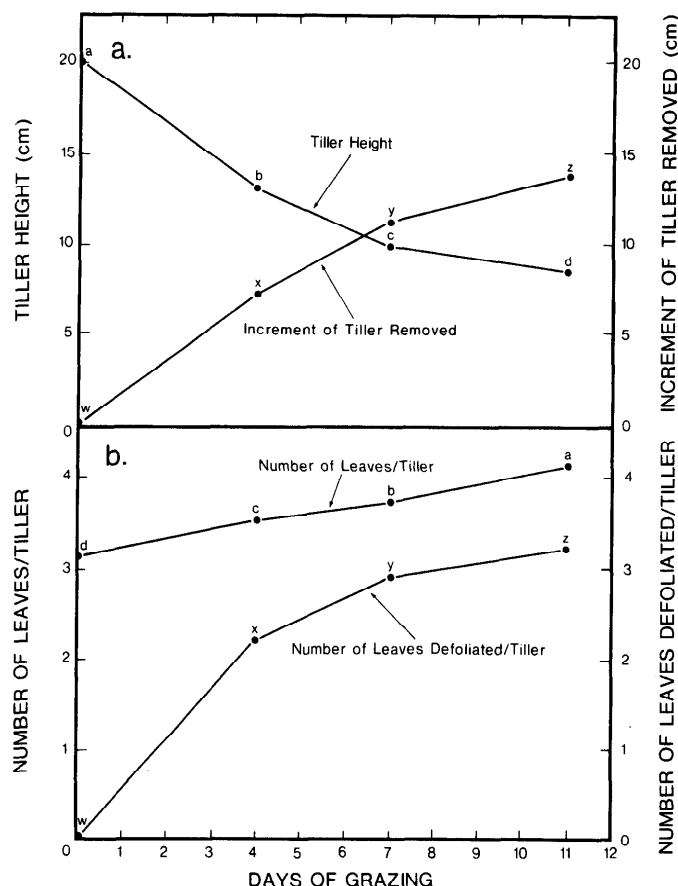


Fig. 1. Heavy grazing regime. (a). Tiller height and increment of tiller removed following 0, 4, 7, and 11 days of grazing. (b). Number of leaves per tiller and number of leaves defoliated per tiller following 0, 4, 7, and 11 days of grazing. Means associated with the same letter are not significant at the 0.05 level.

vegetation, this decrease in increment of tiller removed may have resulted because animals switched to an alternative forage as tiller height and forage availability declined. A decrease in the increment of tiller height removed first became apparent between sampling dates 2 and 3, which correspond to tiller heights of 13 and 10 cm, respectively. Tayler (1966) observed that performance of 2-year-old steers declined when the height of herbage residue reached 13.5 cm overall, or 9.8 cm in the grazed areas. There may be a strong relationship between available forage and tiller height within morphologically similar groups of species as suggested by Alden and Whittaker (1970). They found rate of intake more closely related to tiller height than to dry matter yield per unit area.

Both number of leaves and number of leaves defoliated per tiller increased significantly throughout the grazing trial (Fig. 1b). While the average number of leaves per tiller increased from 3 to 4, approximately 63, 78, and 82% of the total number of leaves per tiller were defoliated following 4, 7, and 11 days of grazing, respectively.

Frequency of defoliation was high and occurred uniformly among tillers (Fig. 2). After only 4 days of grazing 89% of the tillers were defoliated at least once. After 7 days of grazing, 89% of the tillers were grazed at least twice and 8% at least once. Following 11 days of grazing, 89% of the tillers were grazed at least three times, 9% grazed at least twice, and 2% at least once. Thus, at this level of herbage allowance, tillers were regrazed at approximately 3 to 4-day intervals.

The high frequency of defoliation illustrates the need for very short grazing periods when high stocking densities are combined with low herbage allowances in short duration grazing strategies. The high intensity of defoliation combined with the high frequency

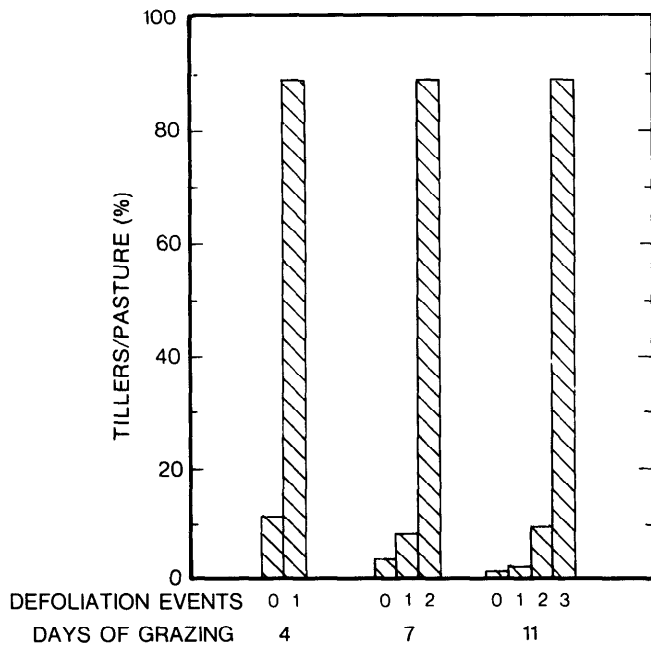


Fig. 2. Percentage of tillers defoliated 0 to 3 times following 4, 7, and 11 days of grazing in a heavy grazing regime. Significant differences occurred between grazed and ungrazed tillers at all sampling dates ($P < 0.05$).

of defoliation resulted in efficient utilization of available tillers but would probably be detrimental to key forage grasses after several grazing periods because of rapid utilization of regrowth. In fact, rates of regrowth may be a major consideration for determining length of grazing periods in short duration grazing strategies.

Moderate Grazing Regime

Standing crops before and after the 33-day moderate grazing trial were $923 \text{ kg} \cdot \text{ha}^{-1}$ and $485 \text{ kg} \cdot \text{ha}^{-1}$, respectively. Net herbage accumulation was approximately $12 \text{ kg} \cdot \text{ha}^{-1} \cdot \text{d}^{-1}$ during this period.

Initial tiller height was 42 cm and a significant reduction in average height did not occur until after 18 days of grazing (Fig. 3a). Growth rate exceeded defoliation resulting in an increase in average tiller height during the first 11 days of the grazing trial. However, after 11 days of grazing, tiller height decreased in a linear

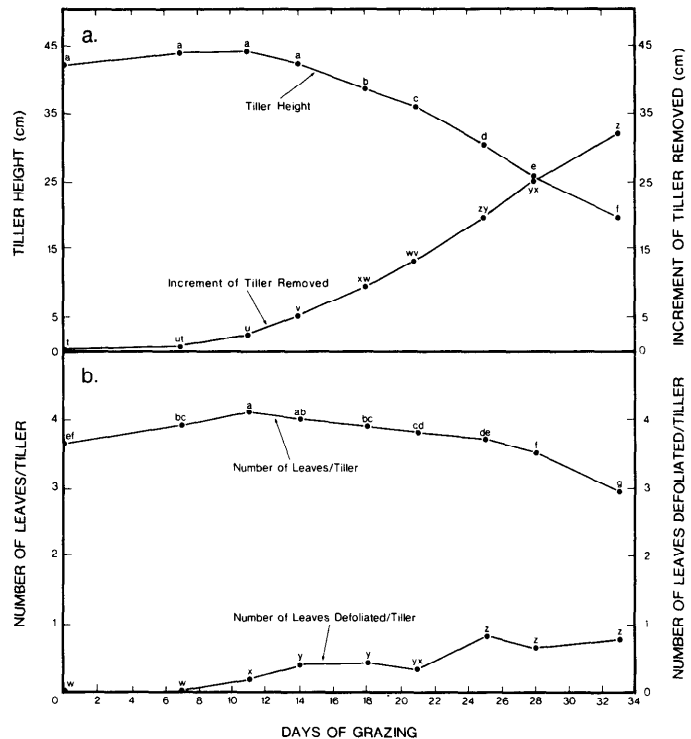


Fig. 3. Moderate grazing regime. (a). Tiller height and increment of tiller removed following 0, 7, 11, 14, 18, 21, 25, 28 and 33 days of grazing. (b). Number of leaves per tiller and number of leaves defoliated per tiller following 0, 7, 11, 14, 18, 21, 25, 28 and 33 days of grazing. Means associated with the same letter are not significant at the 0.05 level.

fashion for the remaining 22 days. Tiller height was only reduced 46%, to 19 cm, at the end of the 33-day grazing trial. At the end of the trial 26, 39, and 16% of the tillers ranged between 0 to 10, 10 to 20, and 20 to 30 cm in height, respectively, indicating nonuniform grazing (data not shown).

The increment of tiller removed between sampling dates increased during the grazing trial (Fig. 3a). Approximately 2, 4 and 7 cm was removed per tiller between sampling dates 2 and 3, 5, and 6, and 8 and 9, respectively. The increment removed per tiller

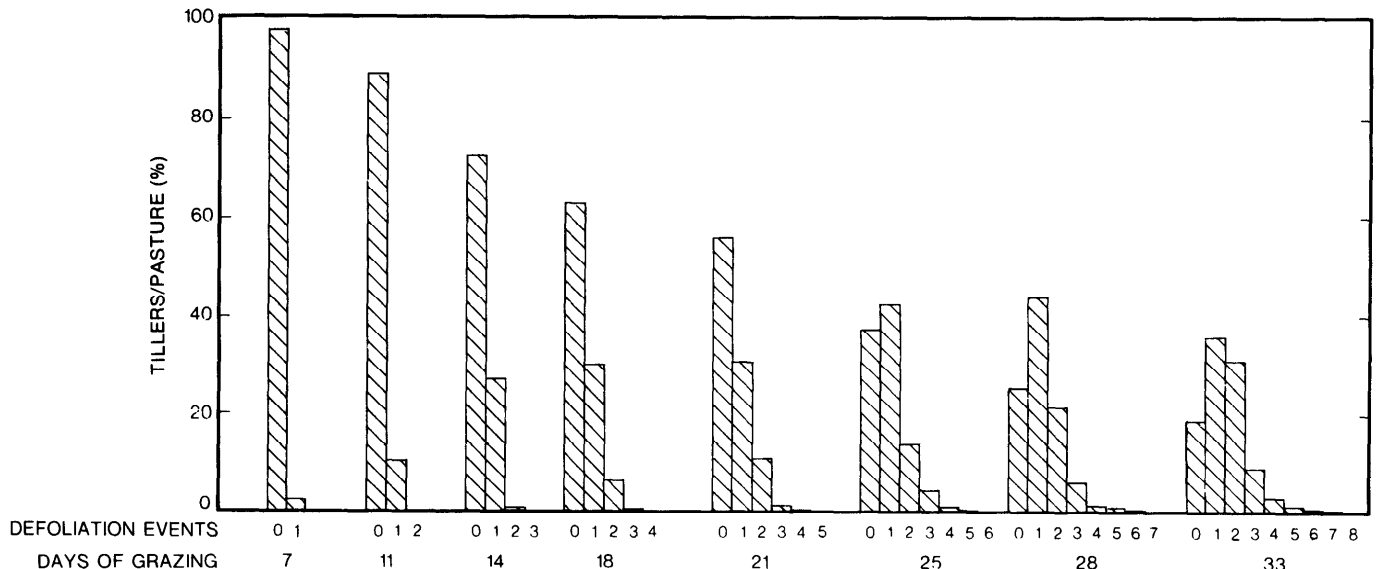


Fig. 4. Percentage of tillers defoliated 0 to 8 times following 0, 7, 11, 14, 18, 21, 25, 28 and 33 days of grazing in a moderate grazing regime. Signifi-

cant differences occurred between grazed and ungrazed tillers at all sampling dates ($P < 0.05$).

midway through the trial was 13 cm with 32 cm having been removed by the end of the grazing trial.

Maximum leaf number per tiller was 4 and gradually decreased to 3 by the end of the trial (Fig. 3b). Maximum leaf number defoliated per tiller was only 0.8, which occurred after 25 days of grazing. The percentage of leaves defoliated per tiller was 5, 9 and 26 following 11, 21 and 33 days of grazing, respectively.

Frequency of defoliation was also indicative of a moderate grazing regime (Fig. 4). The percentage of ungrazed tillers decreased only slowly from 98 after 7 days of grazing to 19 at termination of the 33-day trial. There was a concurrent increase in the number of tillers grazed once, twice and three times. The percentage of tillers grazed at least once was 2 after 7 days and increased to a maximum of 44 following 25 days of grazing. Tillers grazed at least twice were first observed after 14 days and increased to a maximum of 31% following 33 days. Tillers grazed at least three times were first observed after 18 days and attained a maximum of 10% following 33 days. Tillers grazed in excess of three times occurred after 21 days but were so few that no distinct pattern could be formulated. The nonuniform frequency of tiller defoliation and the wide range of tiller heights at the end of the trial are evidence that this type of defoliation may lead to "spot grazing" resulting in an inefficient harvest of available tillers.

Conclusion

A large percentage of the leaves and tillers within a pasture remained ungrazed or were only lightly grazed even at relatively high stock densities. These leaves and tillers were less likely to be subsequently grazed as leaf senescence, culm elongation and inflorescence emergence progressed to a greater extent than in previously grazed plants. Consequently, a portion of the tillers within a pasture remained ungrazed and a portion were grazed frequently and intensively resulting in an inefficient harvest of available tillers and a potential delay or reduction in the productivity of those tillers severely grazed.

High stock densities increased the percentage of leaves and tillers grazed but simultaneously created the potential for excessive frequency and intensity of tiller defoliation throughout the pasture. Additional research is required to further quantify the relationship between frequency and intensity of tiller defoliation, in relation to the percentage of tillers grazed, to optimize tiller utilization on a sustained yield basis. Moreover, this type of information is a prerequisite to more realistic simulated defoliation investigations and will facilitate the comparison of plant responses to defoliation among various grazing systems.

Literature Cited

- Alden, W.G., and L.A. Whittaker. 1970.** The determinants of herbage intake by grazing sheep: The interrelationship of factors influencing herbage intake and availability. *Aust. J. Agr. Res.* 21:755-766.
- Allison, C.D., and M.M. Kothmann. 1979.** Effect of level of stocking pressure on forage intake and diet quality of range cattle. *Proc. West. Sec. Amer. Soc. Animal Sci.* 30:174-178.
- Barnes, D.L. 1972.** Defoliation effects on perennial grasses-continuing confusion. *Proc. Grassld. Soc. South Afr.* 7:138-145.
- Britton, C.M., J.D. Dodd, and A.T. Weichert. 1978.** Net aerial primary production of an *Andropogon-Paspalum* grassland ecosystem. *J. Range Manage.* 31:381-386.
- Gammon, D.M., and B.R. Roberts. 1978a.** Patterns of defoliation during continuous and rotational grazing of the Matopos Sandveld of Rhodesia. 1. Selectivity of grazing. *Rhod. J. Agr. Res.* 16:117-131.
- Gammon, D.M., and B.R. Roberts. 1978b.** Patterns of defoliation during continuous and rotational grazing of the Matopos Sandveld of Rhodesia. 2. Severity of defoliation. *Rhod. J. Agr. Res.* 16:133-145.
- Gammon, D.M., and B.R. Roberts. 1978c.** Patterns of defoliation during continuous and rotational grazing of the Matopos Sandveld of Rhodesia. 3. Frequency of defoliation. *Rhod. J. Agr. Res.* 16:147-164.
- Greenwood, E.A.N., and G.W. Arnold. 1968.** The quantity and frequency of removal of herbage from an emerging annual grass sward by sheep in set-stocked system of grazing. *J. Br. Grassld. Soc.* 23:144-148.
- Hodgkinson, K.C. 1980.** Frequency and extent of defoliation of herbaceous plants by sheep in a foothill range community in northern Utah. *J. Range Manage.* 33:164-169.
- Hodgson, J., and J.H. Ollerenshaw. 1969.** The frequency and severity of defoliation of individual tillers in set-stocked swards. *J. Br. Grassld. Soc.* 24:226-234.
- Hodgson, J. 1966.** The frequency of defoliation of individual tillers in a set-stocked sward. *J. Br. Grassld. Soc.* 21:258-263.
- Hodgson, J. 1979.** Nomenclature and definitions in grazing studies. *Grass and Forage Sci.* 34:11-18.
- Morris, R.M. 1969.** The pattern of grazing in continuously grazed swards. *J. Br. Grassld. Soc.* 24:65-70.
- NAS-NRC. 1962.** Basic problems and techniques in range research. Publication No. 890. Washington, D.C. 342 p.
- Savory, A., and S. Parsons. 1980.** The Savory grazing method. p. 215-221. *In: Beef Cattle Science Handbook*, M.E. Ensminger (ed.), Vol. 17.
- Spedding, C.R.W. 1965.** The physiological basis of grazing management. *J. Br. Grassld. Soc.* 20:7-14.
- Taylor, J.C. 1966.** Relationships between the herbage consumption or carcass energy increment of grazing beef cattle and the quantity of herbage on offer. *Proc. 10th Internat. Grassld. Congr., Helsinki*, p. 463-470.