Effects of Herbage Removal on Seedling Development in Cane Bluestem

ABEL E. BERNARDON[1], DONALD L. HUSS, AND WAYNE G. McCULLY

Graduate Student, Assistant Professor, and Associate Professor respectively, Range Science Department, Texas A&M University, College Station.

Highlight

A single harvesting of as much as 60% of current herbage at any stage of seedling development did not significantly depress root and herbage production of cane bluestem plants grown in a greenhouse. Ninety percent removal was detrimental to subsequent root and herbage growth.

The major objective of range management is to obtain maximum sustained animal production consistent with perpetuation of the natural resources. It is important, then, to know the degree to which plants can be grazed without permanent injury. Little is known in this regard concerning seedling grasses. Criteria are needed for judging the grazing readiness of grass seedlings, especially those which can be related to stages of plant development that can be identified in the field. The research reported here sought to identify and relate such stages to the effects of herbage removal on subsequent root and shoot development.

Review of Literature

A number of related studies have been conducted to determine the effects of removing shoots from grass plants on the subsequent growth of roots. Most of these studies showed that cropping (clipping or grazing) will reduce subsequent plant growth, especially root growth, if the cropping is either frequent or excessive. The initial response to grazing or clipping is the interruption of root elongation (Parker and Sampson, 1931; Crider, 1955). Continued defoliation reduces the number and depth of penetration of grass roots (Jacques, 1937; Albertson et al., 1953; Ruby and Young, 1953; Cook et al., 1958). The amount of reduction is directly related to the intensity and frequency of defoliation (Graber, 1931; Thaine and Heinrichs, 1951; Albertson et al., 1953; Thaine, 1954).

According to Crider (1955), a single clipping that removed most of the foliage caused roots

[1] *Present address: I. N. T. A., Villa Mercedes (San Luis), Argentina.*

to stop growing for periods ranging from 6 to 18 days. When these clippings were repeated periodically, as in a system of rotation grazing, root growth of all grasses stopped for periods that ranged from 25 to 45 days during the growing season. The percentage of roots with interrupted growth was proportional to the amount of the foliage which was removed. Schuster (1964) found that, in general, the reduction in root systems of individual forage species on ponderosa-pine-bunch-grass ranges was proportional to the amount of use. Heavily grazed plants had roots with progressively fewer, more sparse and shorter branches.

The effects of clipping frequency on development of seedling grasses was reported by Robertson (1933) and by Thaine and Heinrichs (1951). Robertson found that clipping reduced the growth of both roots and shoots in seedlings of *Bouteloua gracilis, Bromus inermis, Sorghum sudanensis* (Robertson's *Holcus sorghum sudanensis), Koeleria cristata, Poa pratensis* and *Stipa spartea.* Of these, *Koeleria cristata* was least affected. He concluded that removal of the aerial parts of grass seedlings has an immediate injurious effect which was manifested both above and below ground; and that the extent of injury depended largely upon the nature of the species and frequency of the treatment. Thaine and Heinrichs showed that the total yield of roots on Russian wildrye (*Elymus junceus* Fisch.) declined progressively as the number of clippings increased.

Procedure

The study was divided into two parts. First, the ontogenetic expressions were determined for plants of cane bluestem, *Andropogon barbinodis* Lag., grown from seed. Second, the clipping studies were correlated with designated stages of plant development as expressed morphologically.

In the second phase, cane bluestem plants were grown in a greenhouse during the spring and early summer of 1965. This phase pertained to various clipping intensities within the pre-, 4-, 8-, and 12-tiller stages which were clipped to remove 30, 60, or 90% of the above-ground herbage. Data were subjected to an analysis of variance for a completely randomized design with 10 replications for each treatment. An additional 10 plants were allowed to reach maturity with no clipping. Anthesis of the inflorescence of the primary culm was used as the criterion for maturity. The control plants were purposely confounded and could not be included in the analysis of variance of the clipped plants. Mean comparisons of the clipped and unclipped plants were subjected to the Student's "t" analysis.

The various intensities of cropping were designed to remove assigned percentages of foliage (leaf and stem) weight, and are referred to as degree of use, percent use, or utilization. The stubble height corresponding to each degree of use was determined from height-weight clipping studies on five additional plants grown to the designated stage of development.

Each plant except the control was clipped to the designated stubble height and was not clipped again. Data collected at the time of clipping included oven-dry weight of clipped leaves and culms, number of tillers, length of plants, and number of nodes and leaves on the principal culm. The roots and all above ground vegetative material were harvested for all plants at maturity of the control plants.

In both phases, the plants were grown in one-gallon cans filled with a potting mixture consisting of equal parts of sand, peat moss, and perlite. Each can was planted with several caryopses. The emergent plants in all pots were selected for uniformity, and each pot was thinned to leave one seedling. The pots were watered equally with a 20% solution of 10-52-17 fertilizer. The harvested plant material was dried for 8 hr in a forced-draft oven at 60 C prior to weighing.

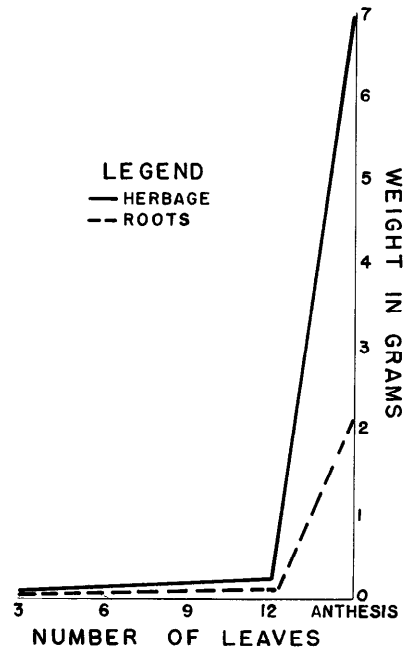

FIG. 1. Root and herbage production of cane bluestem plants from seedling emergence to maturity.

Results and Discussion

The first phase of the study revealed that the seminal root grew rapidly until three leaves were unfolded. Beginning at this time, the increase in root weight was very slow until the plant had 12 leaves, after which the initiation and extension of roots proceeded very rapidly. The first tiller buds at the base of the main stem were not evident externally until nine leaves had unfolded. The number of secondary stems increased rapidly, and their development generally proceeded concurrently with the rapid increase in root production (Fig. 1). It would seem that any reduction in photosynthetic tissue prior to the time second-

Table 1. Characteristics of cane bluestem plants harvested by clipping at different intensities at various stages of seedling development and compared to unclipped plants.

Tiller Stage	Days between Clippings	Percent removal	Number of tillers	Herbage weight grams[1]	Root weight, grams
PRETILLER	0	90	13.6	12.01	2.13
		60	14.8	16.99	2.65
		30	14.3	15.74	2.74
4	11	90	15.4	11.41	2.34
		60	16.8	15.57	2.52
		30	15.7	18.28	3.29
8	11	90	15.4	11.41	2.34
		60	16.8	15.57	2.52
		30	13.6	16.69	3.17
12	13	90	16.4	9.99	2.00
		60	14.8	13.50	2.22
		30	17.7	17.69	2.98
CONTROL	16	0	14.0	15.34	2.93

[1] Sum of weight of above ground vegetative material removed at maturation plus weight of material removed at clipping. Oven-dried at 60 C for 8 hr.

ary culms were produced would be harmful to the plant.

The effect of clipping on subsequent root production varied with the intensity of the clipping and the stage of development at which the clipping was done (Table 1). An analysis of variance of the clipped plants revealed a significant difference at the .05 level in root development due to intensity of use, regardless of the stage of development.

The analysis indicated a decline in root production with successively greater intensities of use. However, when the amount of root production from plants clipped to different intensities of use were compared with the amount of roots produced by the unclipped plants, only the 90% degree of use significantly reduced root growth (Table 2).

Light use appeared to stimulate root production as compared to no use, but this could not be demonstrated statistically. Average root production for the control plants was 0.95 g greater than that of 90% use; 0.38 g greater than 60% use; and 0.12 g less than 30% use.

Herbage production from plants subjected to varying degrees of use followed the same pattern as root production (Table 1). Although the light degree of use appeared to stimulate herbage production, only the plants which were clipped most severely differed significantly from the unclipped plants in yield of herbage (Table 2).

Table 2. Comparison of mean values (g) between control and different clipping intensities as to their effect on root and herbage development (all dates).

Development and Treatment	Clipping intensity, % 30	60	90
Roots			
Control	0.12	− 0.38	− 0.95*
30%	——	——	− 1.07*
60%	——	——	− 0.57*
Herbage			
Control	1.79	0.23	− 5.18*
30%	——	− 1.56	− 6.97*
60%	——	——	− 5.41*

* Significant difference at 95% probability level.

Even though an interaction between intensity and tiller stage could not be statistically demonstrated, it appeared that 90% use at the 8-tiller stage depressed the yields of both root and herbage more severely than clipping at any other stage of development (Table 1). This may be related to the ontogenetic development of seedlings. Root and shoot development were slow until 3 or 4 tillers were initiated (Fig. 1). Development of both was concurrent and rapid after this stage. Therefore, excessive removal of photosynthetic material during this period could have a very adverse affect on subsequent development. The effects of herbage removal prior to this stage could be offset with sufficient time to recover and removal after this stage could be partially offset with greater root and herbage development prior to clipping.

This study has shown that if further development of grass roots is interrupted for 6 to 18 days, as recorded by Crider (1955), this interruption is not reflected in total production after post-harvest intervals ranging up to 51 days except with removal of 90% of the herbage. Both Robertson (1933) and Thaine and Heinrichs (1951) demonstrated that repeated harvesting of seedlings was detrimental. The results from this study indicate that seedlings can be harvested judiciously the first year without damage, provided the harvesting is neither excessive nor prolonged.

This study has shown that as much as 60% of the herbage can be removed from new plants at any stage of development without depressing the production of either roots or herbage. Although it was not demonstrated conclusively, there was some indication that a single harvesting of 30% of the herbage might stimulate subsequent growth.

Summary and Conclusions

The effects of removing 30, 60, and 90% of the herbage at several stages of development (pretiller, 4-tiller, 8-tiller, and 12-tiller stage) was studied using first-year plants of cane bluestem. Subsequent growth of both

roots and shoots were compared with production from undisturbed plants under greenhouse conditions.

It was concluded that:

1. Removal of 90% of the current herbage at any stage of plant development was detrimental to further root and herbage growth.
2. Removal of as much as 30 and 60% of the current herbage at any stage of plant development was not detrimental to subsequent root and herbage production when compared with yields from unclipped plants.

From this study, the effects of herbage removal on first-year plants of cane bluestem are related to the degree of utilization, but show no definite correlation with the stage of development.

This study was conducted in a greenhouse under more or less optimum growing conditions. Further testing under field conditions may introduce considerations not evident here. Nevertheless, it demonstrated that, under the conditions specified, first-year plants of cane bluestem could withstand herbage removal of as much as 60% at very early stages of seedling development as well as later without undue harm to the plant and subsequent growth.

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