The Effect of Clipping Leaves and Stems on Number of Tillers, Herbage Weights, Root Weights, and Food Reserves of Little Bluestem[1]

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Sound range management is based on a knowledge of the responses of the range vegetation to grazing influences. Because grazing influences are complex, range management research often attempts to reproduce portions of the influences by artificial means so that a particular function may be studied in detail. This procedure is especially valuable when the experimental treatment closely reproduces some portion of the grazing influence.

In this study clippings were made in such a manner that the effect of removing leaves could be evaluated independently from the effect of removing stems. The importance of independent evaluation of these treatments is pointed out by the grazing use made of little bluestem *(Andropogon scoparius)*. Observations have shown that cattle graze mostly on the leaves of little bluestem until late August (Figure 1) and after that date the seed stalks receive the major grazing use (Figure 2).

Previous Studies

Aldous (1930b), Bukey and Weaver (1939) and Neiland and Curtis (1956) have shown that more frequent and more severe clippings of little bluestem have reduced carbohydrate reserves more than less frequent and less severe clippings.

Weaver (1950) found that the weights of roots taken from poor condition pastures in Nebraska were only 42 percent of those taken from good condition pastures. Crider (1955), investigating the effect of clipping on 8 species of grasses grown in boxes, found that severe clipping usually stopped root growth within 24 hours, and that no new root growth occurred for 6 to 18 days after clipping. When 40 percent or less of the foliage was removed, cessation of root growth did not occur.

FIGURE 1. Little bluestem plants with basal leaves grazed from July 10 to August 20. Photographed August 22, 1955.

Aldous (1930a) showed that clipping big bluestem *(A. gerardi)* and little bluestem plots to 1½ inches beginning on September 1 reduced production less than clipping beginning earlier in the season. Cassady (1953) reported that plots of bluestem *(A. divergens)* harvested May 1 and September 4 were not reduced in production, but clipping 4, 7, and 15 times reduced production the following year 23, 37, and 49 percent, respectively. Clipping 7 and 15 times reduced production the first year.

Hereford (1951) found that clipping little bluestem only once each year at heights of 2, 4, and 6 inches before seedstalks were formed resulted in decreased production the first year, but that clipping after seedstalk formation resulted in increased production the first year.

Neiland and Curtis (1956) showed that under some conditions clipping little bluestem increased the number of shoots, but decreased the number of shoots under other conditions. New shoots arise from activated axillary buds. Leopold (1949) demonstrated that when the apical meristems are destroyed the major source of auxin is removed and the axillary buds are free to elongate. Removing elongated stems which contain the apical meristems (Branson, 1953) also removes the main source of auxin. Other actively growing tissue, such as young leaves, can also suppress axillary buds as shown by Snow (1929). However, Mitchell (1953) found that young leaves of ryegrass *(Lolium* spp.) were not effective in inhibiting lateral buds.

Methods

This study was conducted in south central Texas during 1955 and 1956. Field experiments were established in an experi-

[1] *Excerpt from a dissertation presented by the senior author to the Graduate Faculty of the A. and M. College of Texas in partial fulfillment of the requirements for the degree of Doctor of Philosophy, 1958.*

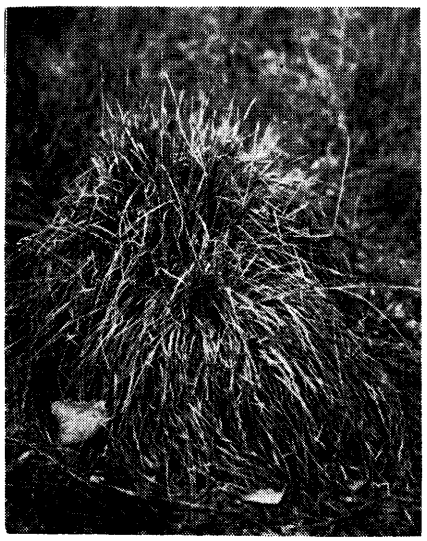

FIGURE 2. Little bluestem plant with seed stalks grazed during late summer. Photographed September 16, 1955.

mental pasture of the Department of Range and Forestry, A & M College of Texas, and plants for pot studies were taken from the same area.

Stimulation of Tillering by Clipping

Twenty plants were clipped during 1955 to determine the degree of tillering caused by clipping elongated and unelongated stems of little bluestem plants. One to two weeks after clipping the number of elongated axillary buds on each culm was counted and the length of leaf regrowth was measured. Separate tabulations were made for elongated and unelongated culms.

Herbage Weights and Root Weights of Plants Grown in Pots

Two series of little bluestem plants were collected and placed in No. 3 crocks. Topsoil was added to the crocks as needed and the plants were settled by thoroughly soaking the soil. The potted plants were left outdoors and were watered 3 times a week.

The first series of plants was collected on June 25, 1955. The 24 plants in the series were transplanted with about 8 inches of roots remaining attached. These plants were divided into 3 plant-size groups of 8 plants each. Four treatments were applied in a factorial manner: (1) check (no treatment), (2) leaves removed (Figure 3), (3) stems removed (Figure 4), and (4) both leaves and stems removed. Leaves and stems were both removed to a height of about 3 inches. Material removed was oven dried for 24 hours at 65 - 70° C., and weighed.

Half of the plants in the first series were harvested 1 week after treatment to determine the initial effect of treatment, and the other half were harvested at 4 weeks to determine recovery from treatment. All plants were harvested immediately after daylight to provide uniform effect of photosynthetic activity. They were removed from the pots, and the roots and crowns were washed free of soil. After washing, the plants were sectioned in roots, crowns to 1 inch above the ground level, and tops.

Roots and crowns were placed in an oven at 120° C. for 15 to 30 minutes to arrest enzyme action since this material was to be used later in chemical analysis. Roots, crowns, and tops were then oven dried at 65-70° C. for 24 hours and weighed. The number of tillers on each plant, exclusive of newly elongated axillary buds, was counted at harvest time as an index of plant size. Average weights were based on the number of major tillers.

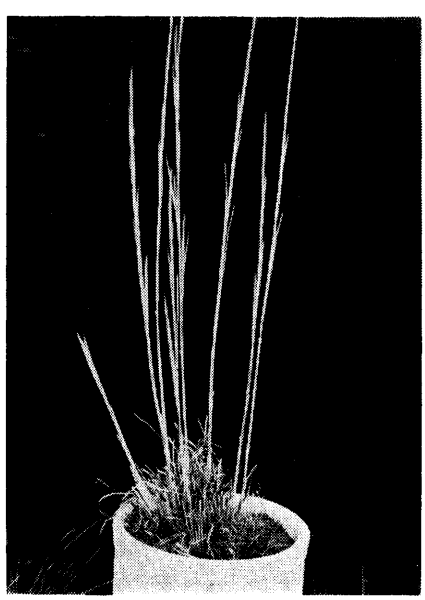

FIGURE 3. Little bluestem plant treated by removing leaves.

On August 16, 32 additional little bluestem plants were selected and transplanted to pots as before, except that the sods were reduced to a thickness of about 2½ inches in order that the new root growth would comprise a larger portion of the total root weight. Reduction of old roots was later shown to be unnecessary as the changes due to treatments were not greatly different than when 8-inch sods were used. The plants were assigned to size classes on the basis of number of elongated culms. It was assumed that the number of elongated culms was a valid basis for this segregation, because it probably expresses the physiological activity of the plants and definitely influences the total weight of herbage.

Treatments were applied by removing leaves and stems on August 23 following the methods outlined above. Harvest was accomplished on September 6 and 7 without consideration as to the time of day. Material was oven dried at 80° C. for 24 hours and weighed.

Food Reserves of Plants Grown in Pots

Plant crowns and roots of the first series of potted plants described in the previous section were analyzed for carbohydrate and nitrogen content. Carbohydrate determinations, including reducing sugars, sucrose, and starch, were by the semi-micro method of Wildman and Hansen using Fehling's solution. This method has been outlined by Eaton and Rigler (1945). A semi-micro Kjeldahl apparatus was used to determine total nitrogen.

FIGURE 4. Little bluestem plant treated by removing stems.

Herbage Weights of Plants Treated in the Field

The design of this part of the experiment was a partially confounded 2 x 2 factorial using the same treatments as described above. Blocks of 2 units were established, and 1 degree of freedom was confounded in each replication. Blocks consisted of pairs of adjacent plants selected on the bases of size, numbers of seed stalks, and stage of plant development. Treatments were applied to 5 sets of replications in July of 1956, and to 5 in August of the same year. Weights of material removed during applications of the treatments were added to the weights of material clipped at the final harvest in early October when all plants were clipped to about 2 inches. All clipped material was oven dried at 80°C. for 24 hours before weighing.

Results

Stimulation of Tillering by Clipping

The counts of tillers from clipped plants are shown in Table 1. Clipping of elongated culms greatly increased the number of tillers as compared with the number of tillers on unclipped plants. Clipping of unelongated culms was much less effective in producing tillers, but some tillering was stimulated by the August 23 clippings. Three unclipped, unelongated culms had had the apical meristems destroyed by disease or insects, and tiller elongation on these culms appeared to be similar to that of clipped elongated culms.

No consistent trends were apparent in the number of tillers on unclipped plants, but tillering of clipped plants increased as the season progressed and the regrowth of leaves decreased. A slight but consistent increase in the number of tillers of plants clipped at 2 inches was evident as compared with those clipped at 5 inches, both for elongated and unelongated culms.

Herbage Weight, Root Weight, and Food Reserves of Plants Grown in Pots

Results from the study of plants grown in pots are shown in Table 2. The differences between the herbage weights resulting from the various treatments was not statistically significant when analyzed by analysis of variance, but the treatment means do give some indication of possible differences. Removal of leaves alone and removal of stems alone reduced the herbage weights somewhat, but removal of leaves and stems together did not reduce herbage weights.

Root weights were reduced by removal of either leaves or stems and the differences were statistically significant (Table 3). The effect of these two treatments were additive and removal of leaves and stems together did not produce an interaction.

Removal of leaves reduced the carbohydrate content of the crowns to less than half of that of the unclipped plants 1 week after treatment, but the effect was somewhat overcome by 4 weeks after treatment. Removal of leaves and stems together did not reduce carbohydrates as much as removal of leaves alone. The same general trends were apparent in the carbohydrates of the roots, but were not statistically significant.

Nitrogen content was not clearly affected by the treatments applied, except that there may have been some increase in the nitrogen of crowns due to removal of stems.

Herbage Weights of Plants Treated in the Field

Herbage weights of field grown plants are also shown in Table 2. The treatment means for this part of the study show

Table 1. Number of elongated culms and height of leaf regrowth produced by little bluestem plants when clipped at different heights and dates as compared to unclipped plants.

Clipping Date	Date Buds Examined	Type of Culm	Ht. of Clipping (Inches)	Regrowth of Clipped Leaves (Inches)	Av. No. of Elongated Buds per Culm
June 4	June 11	Unelongated	None		0.02
			2	5.98	0.08
			5	4.57	0.08
July 30	August 6	Unelongated	None		0.50
			2	1.08	0.18
			5	1.12	0.13
		Elongated	None		0.31
			2	.....	1.92
			5	.....	1.82
August 23	Sept. 6	Unelongated	None		0.09
			2	.25	1.04
			5	.25	0.50
		Elongated	None		0.35
			2	.....	4.18
			5	.....	3.69

Table 2. Herbage weight, root weight, carbohydrate content, and nitrogen content of little bluestem plants treated by removing leaves and stems.

Plant Factor	Check (No Treatment)	Leaves Removed	Stems Removed	Leaves and Stems Removed
Pot grown plants				
Herbage weight[1]	1.22	1.11	0.96	1.24
Root weight[1]	0.63	0.47	0.41	0.34
Crown carbohydrates[2] at 1 week	3.23	1.22	3.51	1.47
Crown carbohydrates[2] at 4 weeks	5.04	3.69	4.52	4.82
Root carbohydrates[2] at 1 week	2.65	2.23	2.62	2.06
Root carbohydrates[2] at 4 weeks	2.75	2.15	2.23	2.44
Crown nitrogen[2] at 1 week	0.53	0.57	0.54	0.63
Crown nitrogen[2] at 4 weeks	0.49	0.40	0.67	0.46
Root nitrogen[2] at 1 week	0.51	0.54	0.51	0.49
Root nitrogen[2] at 4 weeks	0.67	0.65	0.64	0.68
Field grown plants				
Herbage weight[3]	44.6	24.5	33.9	34.3

[1] Figures are grams per culm based on 14 plants.
[2] Figures are percent of oven dry weight based on 3 plants.
[3] Figures are grams per plant based on 30 plants.

that removal of leaves alone reduced production to 55 percent of the check. Removal of stems alone and leaves and stems togeather reduced production to a lesser degree. Analysis of the data showed that leaf removal produced a highly significant negative effect and that stem removal had no effect. Although combined removal of leaves and stems resulted in a decrease of production when compared with no clipping, the reduction was less than the effects of leaf removal alone or stem removal alone, giving a highly significant interaction. July clipping had the same effect as August clipping.

Discussion and Conclusions

The results of the clipping studies agreed in general with the results of Hereford (1951). Clipping before seedstalk production reduced production; clipping the entire plant after seedstalk production increased production. Hereford found that clipping to 2 inches in July increased production, but clipping to 4 and 6 inches on the same date did not increase production, probably because the apical meristems were high enough to be removed by the 2-inch clipping but not by the 4- and 6-inch clippings. On the other hand, Hereford found that clipping to 4 inches on August 15 resulted in an appreciable increase in production, probably because by that date many culms would have elongated enough to be affected by the 4-inch clipping.

The importance of separating leaf removal from stem removal in clipping studies of little bluestem is shown by both the grazing use made of the species and its responses to clipping. Only the leaves are grazed to an appreciable degree for most of the season, then for a period of a few weeks in the early fall when seed are being set, the stems are grazed almost exclusively. This is in direct contrast to mowing, where both leaves and stems are removed simultaneously. If it can be assumed that clipping both leaves and stems would result in considerable tillering, but that clipping of stems alone would not, then responses of the experimental plants can be explained to some degree by the influence of leaves and stems on tillering. Herbage weights would be proportional to the degree of tillering: weights were decreased less by removal of both leaves and stems which allowed the greatest numbers of tillers to form than by removal of leaves alone which allowed fewer tillers to form. Root weights would be inversely proportional to the degree of tillering: weights were decreased more by removal of leaves and stems together than by removal of either leaves or stems alone. However, if the number of tillers would be the same regardless of leaf removal when the apical meristems are destroyed, then these relationships would not hold true.

Carbohydrate percentages of the crowns were decreased by removing leaves, but there was

Table 3. Analysis of variance of herbage weight, root weight, carbohydrate content, and nitrogen content of little bluestem plants treated by removing leaves and stems.

Plant Factor	Mean Square: Treatment (3 d.f.)	Leaves Removed (1 d.f.)[1]	Stems Removed (1 d.f.)[1]	Leaves and Stems Removed (1 d.f.)[2]	Error	Error Degrees of Freedom
Pot grown plants						
Herbage weight	.2309				.1608	39
Root weight	.2139**	.2016*	.3978**	.0424	.0382	38
Crown carbohydrates	4.2724**	11.1521**	.2440	1.4211	.5636	14
Root carbohydrates	.3177				.7565	17
Crown nitrogen	.0162				.0189	17
Root nitrogen	.0005				.0051	11
Field grown plants						
Herbage weight	195690**	301803**	80	285187**	23762	51

[1] Significant effects were negative.
[2] Significant effects were positive.
** Indicates significance at the .01 level.
* Indicates significance at the .05 level.

less decrease when stems were clipped at the same time. Carbohydrate percentages in the roots were not significantly influenced by treatments, but the tendency was in the same direction for carbohydrate of the crowns. Apparently the major influence of clippings on the roots was to stop further root growth rather than to utilize the carbohydrates already in the roots.

This study does not indicate which treatment would have the most severe effects after several seasons of treatment, but it does point out that future clipping studies with little bluestem, and perhaps with other species as well, should be designed to reproduce grazing influences as closely as possible. Studies which involve only height and frequency of cutting without regard to plant parts are valuable only to indicate the effects of mechanical harvesting.

LITERATURE CITED

ALDOUS, A. E. 1930a. Effect of different clipping treatments on the yield and vigor of prairie grass vegetation. Ecology 11: 752-759.

———. 1930b. Relation of organic food reserves to the growth of some Kansas pasture plants. Jour. Am. Soc. Agron. 22: 385-392.

BRANSON, FARREL A. 1953. Two new factors affecting resistance of grasses to grazing. Jour. Range Mangt. 6: 165-171.

BUKEY, F. S. AND J. E. WEAVER. 1939. Effects of frequent clipping on the underground food reserves of certain prairie grasses. Ecology 20: 246-252.

CASSADY, JOHN T. 1953. Herbage production on bluestem range in central Louisiana. Jour. Range Mangt. 6: 38-43.

CRIDER, F. J. 1955. Root growth stoppage resulting from defoliation of grass. U.S.D.A. Tech. Bul. 1102. 23 pp.

EATON, F. M. AND N. E. RIGLER. 1945. Effect of light intensity, nitrogen supply, and fruiting on carbohydrate utilization by the cotton plant. Plant Physiol. 20: 380-411.

HEREFORD, L. R. 1951. The effect of different intensities and frequencies of clipping on forage yield of *Andropogon scoparius* Michx. and *Paspalum plicatulum* Michx. Unpublished M. S. thesis A & M College of Texas.

LEOPOLD, A. C. 1949. The control of tillering in grasses by auxin. Amer. Jour. Bot. 36: 437-440.

MITCHELL, K. J. 1953. Influence of light and temperature on the growth of ryegrass (*Lolium* spp.). II. The control of lateral bud development. Physiol. Plantarum 6: 425-443.

NEILAND, BONITA MILLER AND J. T. CURTIS. 1956. Differential responses to clipping of six prairie grasses in Wisconsin. Ecology 37: 355-365.

SNOW, R. 1929. The young leaf as the inhibiting organ. New Phytol. 28: 345-358.

WEAVER, J. E. 1950. Effects of different intensities of grazing on depth and quantity of roots of grasses. Jour. Range Mangt. 3: 100-113.