Effects of One Year of Intensive Clipping on Big Bluestem

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Highlight: *Effects of 1 year of clipping on tiller density, herbage yield, rhizome weight, rhizome nitrogen content, and rhizome total nonstructural carbohydrate content of big bluestem were investigated. We observed that as clipping frequency increased, tiller density, herbage yield, and total nonstructural carbohydrate content decreased, that recovery of rhizome nitrogen percentages was rapid under rest, and that rhizome weight was not significantly affected.*

Heavy forage use may seem advisable in rangeland management programs in a given year. If temporary heavy use severely limits growth and plant vigor in following years, it may not be advisable. Management must be based on the amount of forage that can be removed without lessening plant vigor. Carbohydrate reserve quantity and quality are integral factors in plant growth and survival (McKendrick, 1971). Reserve levels depend largely on the amount of photosynthetic material present for carbohydrate production, but also are governed by size or quantity of storage organs. Any treatment that affects photosynthesis will be reflected in carbohydrate storage.

Grasses having severe foliage removal reportedly have reduced quantities of storage organs, particularly roots (Crider, 1955; Biswell and Weaver, 1933). Dwyer et al. (1963) suggested that both tops and roots are replaced in number proportional to the severity of top removal. That severe foliage removal reduces quality of storage organs of grasses, is reflected in lower total nonstructural carbohydrate percentages (Bukey and Weaver, 1939; Pierre and Bertram, 1929).

We studied the effects of one year of clipping at different intensities, followed by a year of nonclipping, on rhizome total nonstructural carbohydrate levels, herbage yield, tiller production, rhizome weight, and rhizome nitrogen content of a pure stand of big bluestem (*Andropogon gerardi* Vitman).

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Materials and Methods

During the 1969 growing season a series of clipping treatments were applied to rectangular plots (.91 m x 2.44 m) in an 8-year-old stand of Kaw big bluestem that had not been grazed for 3 years prior to the study, but had been burned in late spring (May 1) each of those 3 years. Plots were organized in a completely random design with 5 replications and 6 clipping treatments. Clipping was done to a 4-cm stubble height:

Treatment level	Clipping date
0	no clip
1	July 17
2	July 17, Aug. 1
3	July 17, Aug. 1, Aug. 15
4	July 17, Aug. 1, Aug. 15, Sept. 1
5	July 17, Aug. 1, Aug. 15, Sept. 1, Sept. 15

Twenty to one-hundred big bluestem rhizomes were collected from 20-cm-wide sod strips removed from across the middle of each plot at the end of the growing season in 1969 and in 1970. After sods were dug, brought to the lab, and cold-water washed, rhizomes only were retained. In 1969 the rhizome samples were analyzed collectively; in 1970 they were divided into current year (1970), past year (1969), and 2-year-plus (1968 and older) age classes, then oven dried at 70°C for 5 days and weighed. All samples were ground in a Wiley mill (40 mesh screen), then stored in sealed glass bottles in the dark. Total nonstructural carbohydrates (TNC) present were determined by acid extraction and copperiodometric titration (Smith, 1969). Kjeldahl nitrogen also was run on each sample.

In mid-July 1970, grams dry matter/1000 cm^2 and tiller number/500 cm^2 were collected. For yield data, shoots were clipped to soil surface in rectangular areas (20 X 50 cm) in each plot.

An analysis of variance (.05 level) was used to test effects of clipping treatments, rhizome-age class, and year on rhizome TNC content, rhizome nitrogen content, rhizome weight, herbage yield, and tiller density. Linear effects among clipping treatments were compared orthogonally (Cochran and Cox, 1968). Means were separated by LSD multiple range tests when significant F-values were found.

Results and Discussion

Tiller Density

Clipping frequency during 1969 significantly affected tiller density in 1970, which did not decrease linearly, however, as clipping increased (Fig. 1). Tiller densities on plots clipped more than once did not differ but were significantly lower than those on unclipped or clipped-once plots. Unclipped plots and once clipped-plots had similar tiller densities.

Alberda (1957) stated that immediately after they clipped grass, tillers did not form for a time and leaf growth was slower. Intensive clipping apparently greatly reduced tiller formation, although White (1973) noted that grazing intensely may be less detrimental than clipping, provided grazing leaves ungrazed tillers while removing others, allowing for transfer of carbohydrates. Crider (1955) showed that tillers of bunchgrass plants function independently, with partial foliage removal stopping growth for only those tillers clipped.

On blue grama-buffalograss range in western Kansas basal cover was reduced only by clipping closely during the growing season (Albertson et al., 1953). Through McKendrick (1971) stimulated secondary shoots on big bluestem by removing growing points on tillers, he never found tertiary shoots on secondary shoots under intensive use; thus, tiller density decreased under intensive use.

Herbage Yield

When clipping frequency of big bluestem increased one season, herbage yields the following growing season declined linearly (Fig. 2). Unclipped plots yielded significantly ($P<.05$) more herbage than did clipped ones. Plots clipped 5 times yielded less herbage than did those clipped 1 or 3 times, and plots clipped 1, 2, 3, or 4 times had similar herbage yields.

Differences in dry matter produced and in amount of soluble carbohydrate in various plant parts are caused mainly by tiller number and carbohydrate differences, not necessarily by differences in tiller weight (Alberda, 1957). Intensive clipping of big bluestem with low tiller density can be expected to decrease herbage yield. Dwyer et al. (1963) reported that herbage yields of tall grasses decreased when defoliation frequency was increased.

Rhizome Weight

Clipping frequency in 1969 did not significantly affect rhizome weight for all age classes combined in 1970, but all age classes differed from each other in rhizome weight; 1969 rhizomes were heaviest (111 mg/rhizome), 1968 intermediate (88mg/rhizome), and 1970 lightest (53 mg/rhizome). Apparently, 1970 rhizomes were still in the developmental stage at season's end with some deterioration taking place in the 1968 and older rhizomes, which may account for the lower rhizome weights.

Evidently, clipping herbage intensively for only one season does not reduce big bluestem rhizome weight. Alberda (1957) and Crider (1955) observed that clipping stops root and rhizome growth temporarily, simultaneously decreasing weight, but that recovery time varies with conditions and plant species. As carbohydrate reserves are depleted over time and not allowed to rebuild, rhizome weights decrease, new rhizomes fail to be produced, and old rhizomes die more rapidly, resulting in decreased plant vigor and eventual plant death (Crider, 1955; Jameson and Huss, 1959).

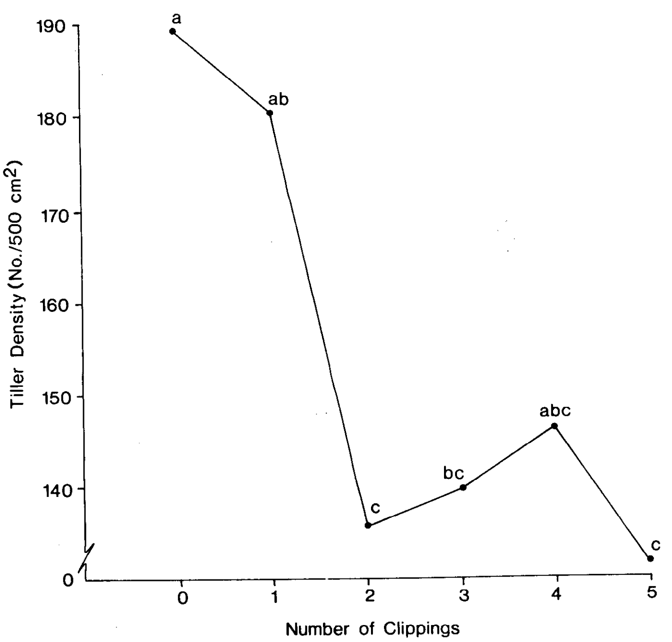

Fig. 1. *Big bluestem tillers per 500 cm² for indicated treatments (July, 1970). Means with a common letter do not differ significantly (P < 0.05).*

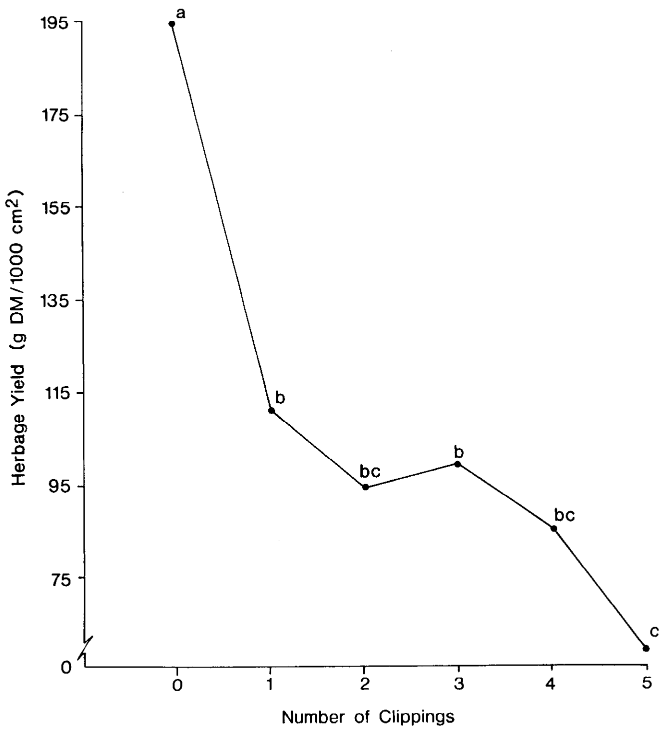

Fig. 2. *Big bluestem herbage yield (grams D.M./1000 cm²) for indicated treatments (mid-July, 1970). Means with a common letter do not differ significantly (P < 0.05).*

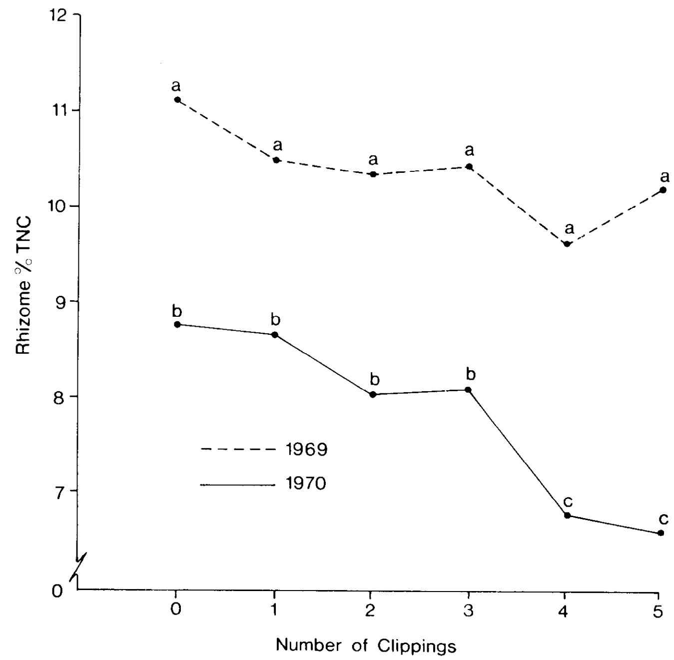

Fig. 3. *Total nonstructural carbohydrates (%) in big bluestem rhizomes (all age classes combined) for indicated treatments on Oct. 8, 1969, and Nov. 6, 1970. Means with a common letter do not differ significantly (P < 0.05).*

Rhizome Nitrogen Content

Clipping frequency did not affect rhizome nitrogen content, but nitrogen content of various age rhizomes differed significantly ($P<.10$), in within-year comparisons. Nitrogen content was highest in 1970 rhizomes (1.04%), intermediate in 1969 rhizomes (0.68%), and lowest in 1968 or older rhizomes (0.48%). Rhizome nitrogen content of combined age classes in 1969 was lower than that of 1970. Regrowth following clipping contains more nitrogen than does forage on unclipped plots (Owensby et al., 1970). Nitrogen would have been drawn from storage organs following clipping in 1969 but would have been stored in 1970, when there was no clipping.

That increased clipping and grazing decrease nitrogen in roots is substantiated by Jameson (1964), Barnes (1961), and Pierre and Bertram (1929). Stoddart and Smith (1955b) concluded that when photosynthetic tissue is reduced so are carbohydrate and nitrogen reserves, accompanied by decreased root and forage production. However, that effect seems to be limited to current year of intensive clipping.

Total Nonstructural Carbohydrates

Clipping intensity in the summer of 1969 did not affect TNC levels of rhizomes collected that fall, but a significant linear trend downward was observed as clipping intensity increased (Fig. 3). Residual effects of summer 1969 clipping were indicated by lower TNC percentage in fall of 1970 for plots clipped 4 and 5 times (Fig. 3). Rhizomes produced in 1968 (6.67%) and 1969 (7.23%) had lower percentage TNC in fall of 1970 than did those produced in 1970 (9.62%).

Percent TNC from combined overall age classes was lower in 1970 than in 1969, with lowest levels under the most intensive clipping (Fig. 3).

Kinsinger and Hopkins (1961) reported that big bluestem carbohydrate-reserve storage was not affected adversely by a single year's intensive clipping, but that two years of intensive clipping reduced reserve storages. Apparently, the effects of intensive clipping on reserve storage carry over into the next growing season before a reduced carbohydrate storage can be seen.

Conclusions

One year's intensive clipping:

1) decreased tiller density the following year;
2) decreased herbage yield the following year;
3) did not significantly affect rhizome weight;
4) decreased rhizome nitrogen percentage during the year of intensive clipping, probably because of increased nitrogen in regrowth;
5) decreased total nonstructural carbohydrate percentages the following year; and
6) indicated that in the tallgrass prairie even one year's intensive use is not advisable as a range management practice.

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