Effects of Clipping on Yield and Tillering of Little Bluestem, Big Bluestem, and Indiangrass

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Highlight

Clipping little bluestem, big bluestem, and indiangrass for 3 successive years at the seed-ripened stage or later increased yields and spring-initiated tillering of plants in a prairie-like glade grassland in the Missouri Ozarks. Clipping at any time during the summer reduced yields, but clipping between floral initiation and anthesis was the most damaging to plants.

Grassland vegetation is sometimes clipped to simulate grazing so that the plant responses to foliage removal at different stages of development may be studied. Results of clipping studies can be useful in planning grazing systems that benefit the major forage species; they can also provide leads for additional research in grassland management.

This paper discusses the responses of three grasses, little bluestem (*Andropogon scoparius* Michx.), big bluestem (*A. gerardi* Vitman), and indiangrass (*Sorghastrum nutans* (L.) Nash), to clipping at various stages of morphological development. These warm-season perennial grasses are major forage species of glade ranges in the Ozarks. The responses to clipping were evaluated on the basis of changes in plant yield and in number and height of tillers and culms.

Experimental Area and Methods

This study was made in a prairie-like grassland in the Ozarks of southwest Missouri. This unique grassland, locally called the glades, is in the transition zone between the eastern oak–hickory forest and the southeastern fringe of the Tall Grass Prairie. Scattered throughout this natural grassed area are eastern redcedar (*Juniperus virginiana* L.) and various other woody plants. Species of oak (*Quercus*) and hickory (*Carya*) predominate on the deeper forested soils throughout the region. Some of the herbaceous species associated with the three study grasses are: prairie dropseed (*Sporobolus heterolepis* Gray), baldgrass (*S. neglectus* Nash), switchgrass (*Panicum virgatum* L.) sedges (*Carex* L. spp.), browneyedsusan (*Rudbeckia missouriensis* Engelm.), and compassplant (*Silphium laciniatum* L.).

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Many of the herbaceous species found in the glades are also common in the Tall Grass Prairie; but the glades differ from the prairie primarily in parent material, soil development, and soil depth. The glade soils are shallow, silty clay loams which overlie bedded dolomitic limestone. The limestone outcrops at irregular intervals and forms contour terraces on the slopes. Depth of soil varies from about 45 cm (18 inches) just below an outcrop to nearly nothing above an outcrop and averages 12.5 ± 10 cm (5 ± 4 inches). Mean annual precipitation is about 111 cm (44.4 inches) with the greatest concentrations in April, May, and June. Soils saturated in the springtime can become air dry during the drought periods that usually occur from mid-July through August (Kucera and Martin, 1957).

Seven clipping treatments were randomly assigned in a randomized block design to selected plants of little bluestem, big bluestem, and indiangrass growing in their natural habitat and previously protected from grazing for 5 years. In each treatment 12 plants of a species were clipped once a year at a prescribed stage of plant development. The treatment was imposed upon the same 12 plants for 3 consecutive years starting in 1961 and ending 1963. The following stages of plant development prescribed for clipping were determined by measuring heights of tillers and growing points throughout the growing season as reported by Vogel (1965).

Stage of plant development	Approximate clipping date
1. Vegetative growth stage—prior to elevation of apical meristems.	May 20–30
2. Growth of spring-initiated vegetative tillers completed—a few apices of big bluestem and indiangrass elevated above clipping level.	June 25–30
3. Early reproductive stage—reproductive apices elevated above clipping level; inflorescences of big bluestem forming in the boot.	July 20–25
4. Flowering stage—big bluestem in anthesis; little bluestem starting anthesis; indiangrass inflorescences starting to emerge from boot.	August 25–September 5
5. Seed-ripened stage—stem elongation ceased; plants drying; seed of bluestems starting to shatter but indiangrass seed still ripening.	October 1–10
6. Plants dormant.	November 15
7. Plants not clipped—yields estimated at time of October clipping.	

In the winter, before beginning the study, standing dead foliage was clipped from each study plant and from all the competitive vegetation within an area of about 0.4 m^2 (4 ft^2). Later, at the appropriate time, the study plants were clipped and the foliage oven-dried and weighed. The vegetation in the 0.4 m^2 area around each plant was also clipped but discarded. All plants were clipped to 4 cm (1.5 inches) above ground level. Yields of non-clipped plants and regrowth of clipped plants were estimated at the end of the growing season. Yields reported for treatments having regrowth are clipped weights plus estimated weights of regrowth at the end of the season.

Tillers were counted on all plants just before the first clipping in May. Reproductive and vegetative culms were counted and their extended length (height) measured either

Table 1. Yields of little bluestem, big bluestem, and indiangrass plants in 1962 and 1963 (in percent of yields in 1961).[1]

Time of clipping	Little Bluestem		Big Bluestem		Indian-grass	
	1962	1963	1962	1963	1962	1963
May	84 a	70 b	85 bc	72 c	65 b	65 bc
June	54 b	53 bc	62 d	63 c	57 b	56 bc
July	43 b	34 c	58 d	52 c	41 b	34 c
August	52 b	76 b	34 e	59 c	41 b	56 bc
October	83 a	125 a	100 b	159 b	66 b	72 b
November	89 a	152 a	122 a	207 a	110 a	132 a
No Clip	84 a	77 b	87 bc	97 c	67 b	81 b

[1] Within each data column, yield percentages having a letter in common are not significantly different at the 5-percent level of probability by the Duncan Multiple Range Test.

when they were clipped or at the end of the growing season.

The changes in yield between 1961 and 1962 and between 1961 and 1963 were tested for treatment differences by analysis of variance for a randomized-block design. Differences between pairs of treatment means were tested for significance by Duncan's Multiple Range Test. Tiller data were not subjected to statistical treatment.

Results

Changes in yields between the first and third years of clipping were significantly different among treatments. Yields of all three grasses increased when clipped for 3 consecutive years in the dormant stage (November). Clipping after seed formation (October) also caused yields of little bluestem and big bluestem to increase but not of indiangrass. Clipping at earlier stages of plant development (May through August) and no clipping reduced yields of all species (Table 1).

Complete foliage removal when flowering stalks were starting to form (late July) was the most damaging treatment to all three grasses (Fig. 1). Furthermore, yields of plants clipped in July continued to decline from the second to third year, whereas yields of plants clipped during anthesis (August) made some recovery the third year. Yields of little bluestem and big bluestem clipped during the vegetative growth stage (May) were reduced the second year and continued to decrease the third year. Yields of indiangrass plants clipped in May and of all three species clipped near the end of their vegetative-growth period (June) were about equal the second and third years. No plants were completely killed by any of the clipping treatments, although some were severely weakened.

Initial tillering and reproductive culm production were also affected by clipping. Two years of clipping in the dormant season increased the total number of tillers initiated the following spring and only slightly decreased the number of reproductive culms. But the effect of earlier clippings and no clipping on tiller initiation and reproductive culm production was inconsistent among treatments and species (Table 2). For example, clipping in October did not affect initial tillering of little bluestem and indiangrass but caused increased tillering of big bluestem; on the other hand, it reduced reproductive culms of indiangrass but not of the bluestems. By the third year, the numbers of tillers on plants clipped in May were nearly the same as the first year. But 2 successive years of clipping in July greatly reduced spring tillering of little bluestem and indiangrass although not of big bluestem (Fig. 2). Clipping in June, July, or August severely reduced the next year's reproductive culm production on all grasses, but clipping in July was especially damaging.

Table 2. Number of tillers and reproductive culms of little bluestem, big bluestem, and indiangrass plants in 1962 and 1963 (in percent of number in 1961).

Time of clipping	Little Bluestem		Big Bluestem		Indian-grass	
	1962	1963	1962	1963	1962	1963
Total tillers[1]						
May	112	94	126	111	121	95
June	71	55	114	96	63	63
July	64	36	100	81	60	36
August	77	80	68	75	73	73
October	100	94	106	133	94	97
November	120	112	145	154	128	142
No Clip	98	68	108	102	95	84
Reproductive culms[2]						
May	30	40	60	60	43	43
June	33	0	50	50	100	20
July	10	5	6	9	([3])	([3])
August	33	33	27	27	23	15
October	83	100	80	120	36	27
November	80	80	43	64	73	91
No Clip	45	45	71	71	50	43

[1] Spring-initiated tillers counted at May clipping date.
[2] End-of-growing-season count for May, June, and no clip treatments. May and June counts represent regrowth after clipping. Other treatments counted at time of clipping.
[3] Reproductive culms not identified in 1961.

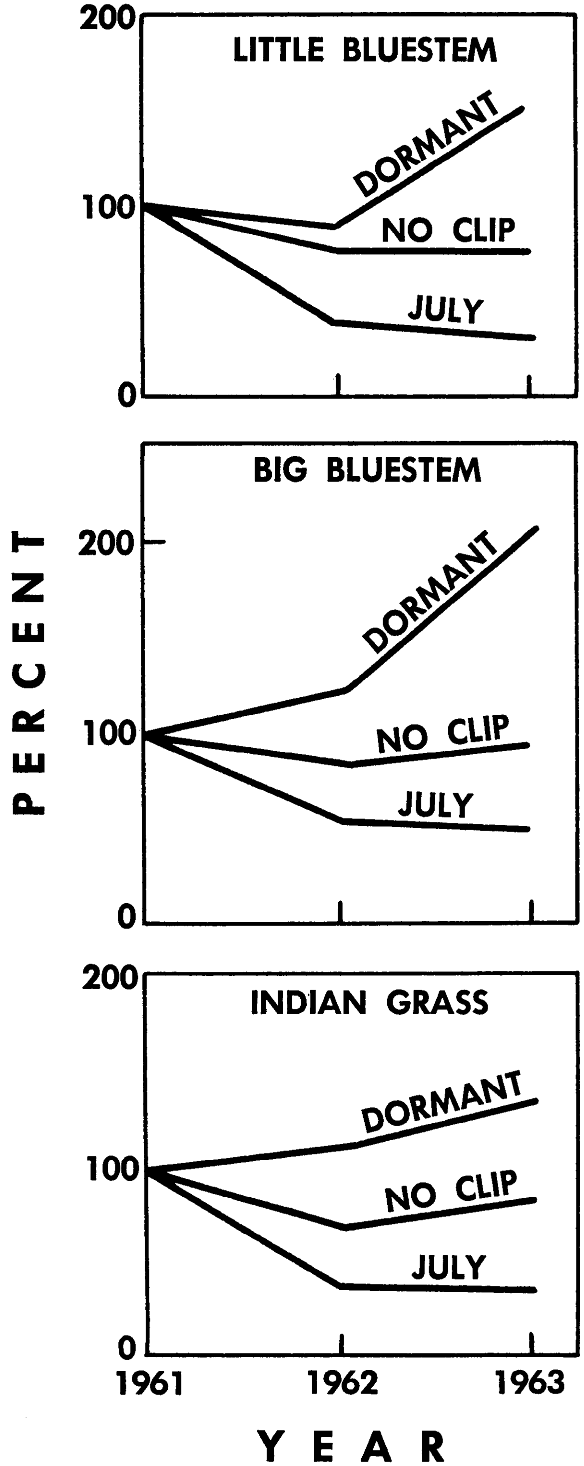

FIG. 1. Average yields in 1962 and 1963 (as percent of 1961) of plants clipped in dormancy, in July, and not clipped.

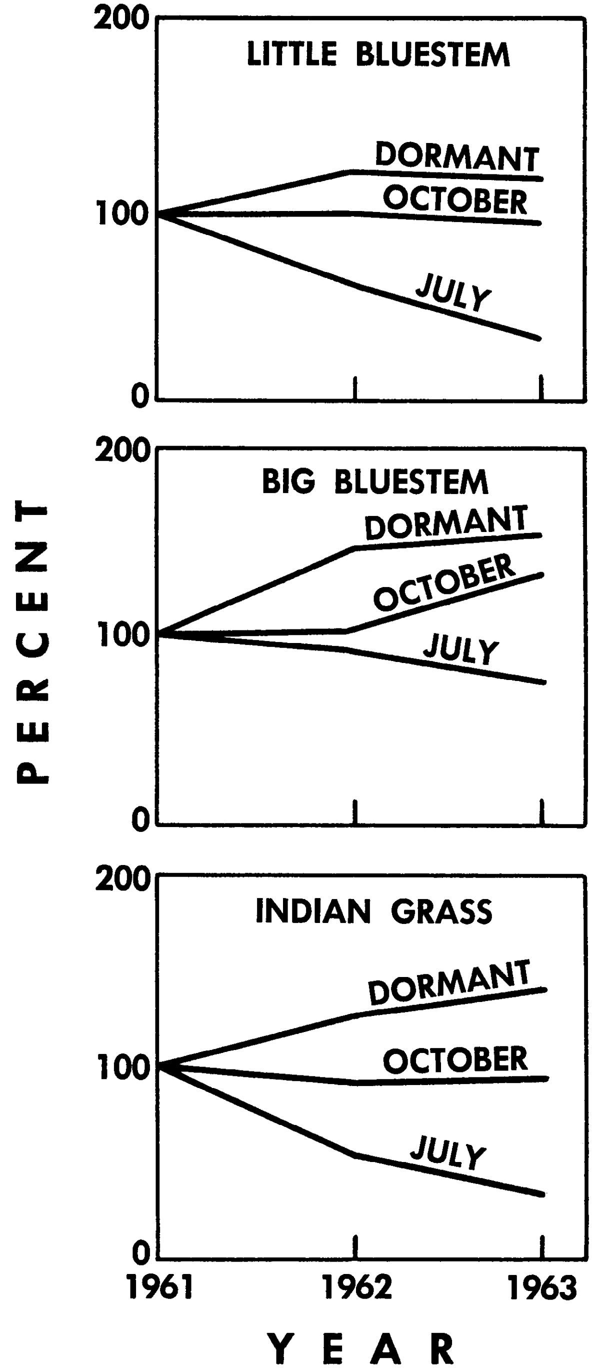

FIG. 2. Number of spring-initiated tillers in 1962 and 1963 (as percent of 1961) on plants clipped in dormancy, October, and July.

Yearly fluctuations in heights of reproductive culms were influenced more by summer precipitation (especially in July and August) than by clipping. Precipitation was highest the first summer, lowest the second, and intermediate the third. Reproductive culms averaged 28, 31, and 24 cm (11.0, 12.2, and 9.5 inches) taller the first year than the second for little bluestem, big bluestem, and indiangrass, respectively, but they were about as tall the third year as the first.

Vegetative tillers of plants clipped in May, June, and July were shorter each year; but on plants clipped later and on plants not clipped, vegetative tiller heights were similar in all years.

Discussion

The response of some perennial grasses to foliage removal has been related to the seasonal development of their apical meristems (Booysen et al., 1963). Grasses in which apical meristems (growing points) reached a height permitting their removal by grazing were generally less resistant to intensive grazing than those grasses with growing points remaining at ground level (Branson, 1953). In our study, removal of growing points was not a major factor influencing the response of the three grasses to clipping. Big bluestem was the only grass in which growing points of vegetative tillers elevated high enough to be removed by clipping, but they did not elevate until after the formation and growth of leaves on vegetative tillers was completed (Vogel, 1965). This suggests that further growth of those tillers will not occur whether growing points are or are not removed. Leaf development stopped on reproductive tillers when the apices entered the reproductive phase, so their removal also would not affect further leaf growth. It appears then that injury from foliage removal during any stage of plant growth was not due primarily to loss of apical meristems but to loss of photosynthetic tissue and potential seed production. The disruption of normal photosynthetic and carbohydrate storage processes would usually be more critical than loss of seed.

Booysen et al. (1963) indicated that the capacity of plants to produce lateral or secondary tillers also contributed to the grazing resistance of grasses. Jameson and Huss (1959) reported that clipping little bluestem after apical meristems were elevated enough to be removed stimulated tillering and increased yields the first year. Our July and August clipping treatments removed reproductive apices of all three grasses and vegetative apices of big bluestem but tillering and yields were greatly reduced. By the second year these July-clipped plants formed so few reproductive tillers that the amount of lateral tillering, if stimulated by apex removal, was small.

Soil moisture on the glades is very limited most years in late July and in August (Kucera and Martin, 1957) so that, after clipping in July, growth of any secondary tillers that do form is greatly handicapped. By measuring root caloric values of grasses in Illinois prairie, Hadley and Kieckhefer (1963) found that food reserves of big bluestem and indiangrass were lowest just before flowering. This would coincide with the period between our July and August clipping dates. Thus, in the shallow soils of the glades, limited or unavailable soil moisture at the same time that food reserves are lowest could greatly restrict growth of new photosynthetic tissue necessary for replenishing food reserves in the roots. Furthermore, Jäntii and Kramer (1956) found that, in soils drier than field capacity, defoliated plants could not absorb moisture nearly as well as intact plants. Therefore, in dry glade soils, defoliated plants may be unable to absorb sufficient moisture for regrowth and for growth of new tillers from lateral buds.

Obtaining reduced yields from clipping these three grasses in midsummer is apparently unique to the grassland under study because of the shallow droughty soils. On prairie grassland with deep loam soils in nearby Oklahoma, greatest sustained yields of pure stands of these grasses were obtained by mowing every year in July—even greater yields than obtained by mowing in the dormant season (Dwyer et al., 1963). In another Oklahoma study, mowing every year about July 1 gave higher sustained yields of big and little bluestem than did mowing about September 1, although indiangrass was favored more by the September 1 mowing date (Hazell, 1965).

Plants of big bluestem and indiangrass clipped in dormancy, in our study, increased in yield the second year even though mid-summer precipitation was below that in the first and third years of the study. The number of spring-initiated tillers also increased the second year and apparently contributed to the increased yields. Clipping of these grasses during the dormant season in an Iowa prairie caused earlier and more rapid growth of tillers the following spring (Ehrenreich and Aikman, 1963). Spring growth of tillers on our plants clipped in dormancy was also more rapid and vigorous than growth of tillers on other treatments. Root caloric values of these grasses were found to be highest after flowering in an Illinois prairie (Hadley and Kieckhefer, 1963). Therefore, plants clipped in the seed-ripening stage and in dormancy had greater food reserves available for tiller growth the following spring than did plants in the other clipping treatments.

The response of big and little bluestem plants to clipping in October was similar to the response of plants clipped in dormancy. Indiangrass plants, however, responded to clipping in October more like the plants clipped in August, suggesting a difference in rate of reproductive development among the grasses. Vogel (1965) showed that flowering stalks of indiangrass developed and matured more slowly than those of big and little bluestem. Flowering stalks of the bluestems had reached 80 to 90% of their final height by late August, but on indiangrass they had reached only 50 to 60% of their final height.

Yields of nonclipped (check) plants might be expected to respond mostly to the amount of summer precipitation, but lower yields in the future would not be unusual. Other studies have shown that litter buildup in undisturbed prairie-grass vegetation caused lower soil temperatures and delayed growth in the spring, fewer flower stalks, and reduced yields (Ehrenreich and Aikman, 1963; Weaver and Rowland, 1952).

Conclusions

The reduced forage yields caused by summer clipping and the increased yields caused by clipping in the seed-ripening and dormant stages suggest that fall and winter grazing is best for glade ranges. But grazing these grasses in fall and winter precludes their use when they are most palatable and nutritious. Therefore, a grazing management system of rotating summer rest periods with summer, fall, and winter use is suggested for maintaining sustained yields in this Ozark grassland. Further research is needed for developing a practicable and economically sound rest-rotation system of grazing for Ozark forest and glade ranges.

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