

# Two New Factors Affecting Resistance of Grasses to Grazing

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THE question, "Why do ranges deteriorate?" may seem to have an obvious answer or answers. Certainly, answers to the question are essential if degeneration of ranges is to be prevented. The causes of degeneration usually listed are too heavy stocking and preference of livestock for individual species. These two factors undoubtedly are basic, but the process deserves further consideration.

During an investigation of the degeneration of range lands in the loess hills of central Nebraska, attention was given to the causes for the decrease of certain grasses and the corresponding increase in others. In addition to the causes usually listed, two new factors have been carefully studied. These are the height to which growing points (apical meristems) (Fig. 1) were elevated and the ratio of fertile to vegetative stems or culms. When the growing points are elevated to more than an inch above the soil they may be removed by grazing and no new leaves may be produced by those stems. A high ratio of fertile to vegetative stems has an effect similar to the elevation of growing points. When a grass stem enters the reproductive phase no new leaves are produced (Purvis and Gregory, 1937; Evans and Grover, 1940) and such flower stalks generally grow above the minimum grazing height (Fig. 2). Thus if either a growing point or a stem bearing a seed stalk is grazed, photosynthetic material may not be replaced.

It is now well established that in the degeneration of native grasslands there is a decrease in desirable forage species

and an increase in undesirable species. Recognition of range degeneration as the replacement of one plant population by another was pointed out in the early work of Sampson (1917). In 1941 Weaver and

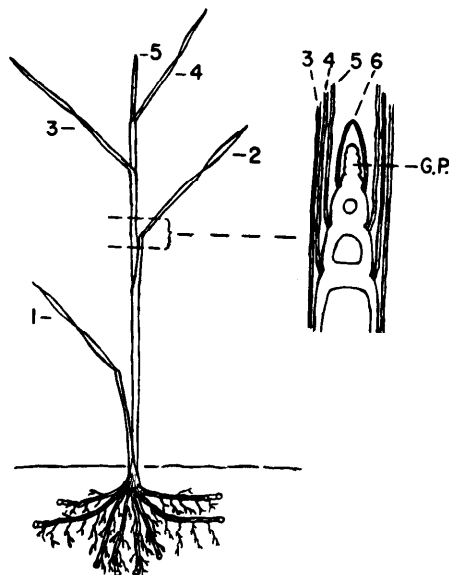


FIGURE 1. Diagram of a young western wheatgrass stem and an enlarged, cross-section insert showing the general appearance of the growing point (apical meristem) and enclosing portions of leaves. The leaves and corresponding portions of leaves are numbered; the growing point is labeled G.P. Growing points of grasses can be observed by splitting the stems with a razor blade.

Hansen showed that with deterioration of ranges certain species of grasses and forbs decrease, others become more abundant, and a third group, invaders, come in to the pastures as the cover is opened. Later work (Dyksterhuis, 1949;

Voigt and Weaver, 1951) has confirmed the validity of this grouping of plants. By this classification, the degree of departure from the original (climax) vegetation is the yardstick by which the condition classes of ranges are established. An explanation of why these changes occur can be had only by a careful study of the individual grass species.

#### DEVELOPMENT OF GRASSES

Measurements were taken of heights of leaves, inflorescences, and growing

In addition five counts of fertile and vegetative stems were made for each species and the ratio of fertile (flower-producing) to vegetative stems computed (Table 1). Since the stands where counts were made occurred in areas not subject to unusual disturbance it is believed that the differences found are due to species rather than different levels of mineral nutrition.

The results are more easily presented and perhaps best understood when each grass is considered separately.

TABLE 1

*Number of vegetative stems, stems producing inflorescences, and the ratio of fertile to vegetative stems*

GRASS	NO. FERTILE STEMS PER SAMPLE AREA*	NO. VEGETATIVE STEMS PER SAMPLE AREA*	TOTAL NO. STEMS PER SAMPLE AREA*	RATIO FERTILE TO VEGETATIVE STEMS
Little bluestem.....	75.4	23.6	99.0	3.20
Switchgrass.....	42.2	19.6	61.8	2.15
June grass.....	51.6	58.0	109.6	0.89
Side-oats grama.....	52.2	109.0	161.2	0.48
Big bluestem.....	26.4	74.0	100.4	0.36
Buffalo grass.....	58.2	398.0	456.2	0.15
Blue grama.....	46.8	304.0	350.8	0.15
Kentucky bluegrass.....	26.2	306.4	332.6	0.09
Western wheatgrass.....	5.0	81.6	86.6	0.06

\* Data are averages of five measurements for each species. Samples of the sod-formers were 1 square-foot in area; bunches of little bluestem and June grass had an average diameter of 6.8 and 3.2 inches, respectively.

points of eight species of grass commonly found in the central Great Plains. Five measurements were made of each of these heights on ungrazed plants of each species at approximately one-week intervals. Grasses studied were switchgrass (*Panicum virgatum*),<sup>1</sup> western wheatgrass (*Agropyron smithii*), little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardi*), Kentucky bluegrass (*Poa pratensis*), buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), and side-oats grama (*B. curtipendula*).

<sup>1</sup> Nomenclature of grasses follows Hitchcock's "Manual of the Grasses of the United States" second edition, 1950.

In *switchgrass* the growing points were elevated above the soil early in the growing season (Fig. 2). By the end of June they were well above the minimum height to which cattle can graze. Switchgrass decreased rather rapidly under intense grazing and was not found in ranges in poor condition. It is quite palatable when young but later becomes coarse and lignified. Its rapid decrease as range condition declined was apparently due to early vulnerability of the growing points and the high ratio of fertile to vegetative culms rather than high palatability (Table 1).

*Western wheatgrass*, although it pro-

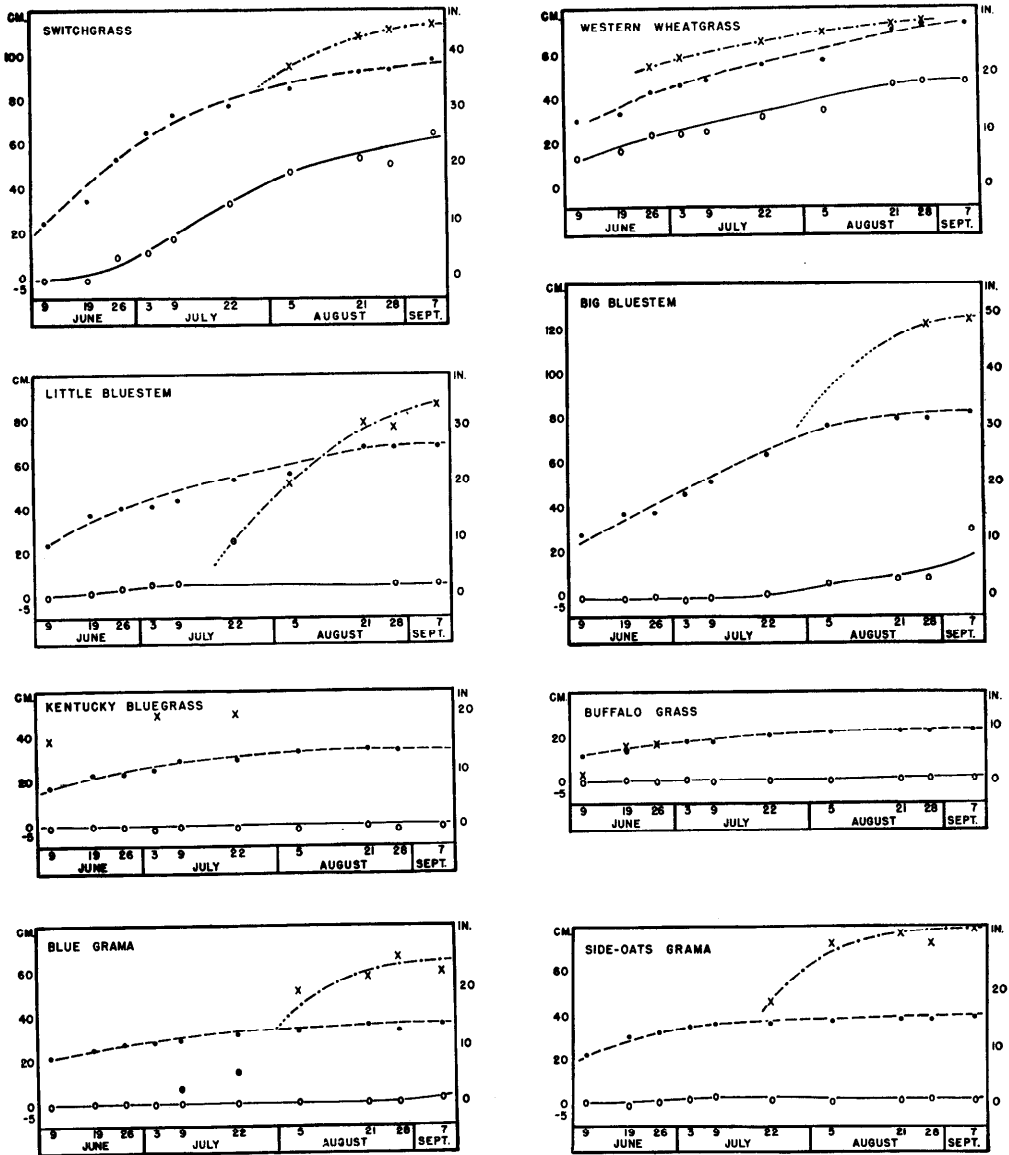


FIGURE 2. Graphs for eight grasses showing average heights of growing points (lower lines), heights of leaves (lines through dots), and heights of flower stalks (lines through Xs) on the dates indicated.

duced very few flower stalks, had an average height of growing points of more than 5 inches as early as June 9. It was either absent from heavily grazed ranges or found in small scattered colonies. The effects of intensive grazing on this grass

could readily be seen along fences of heavily grazed ranges (Fig. 3).

The growing points of *big bluestem* were below the ground level until late in July during the summer of 1950. Observations indicated that although big

bluestem was the most palatable grass of the area it was somewhat more resistant to grazing than switchgrass or Canada wild-rye. The delayed elevation of growing points may explain its greater resistance to grazing.

Slightly more than one-third of the stems of big bluestem produced inflorescences (Table 1). This ratio was high when compared with a species that was highly resistant to grazing, such as Kentucky bluegrass, in which less than one-tenth of the stems produced inflorescences.

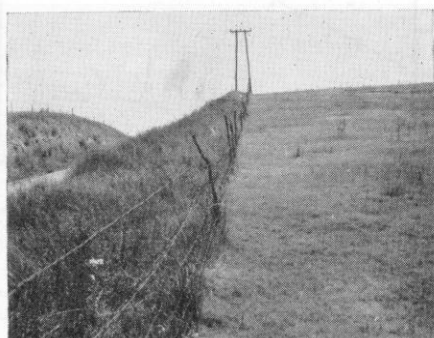


FIGURE 3. A good stand of western wheatgrass beyond a fence enclosing a range in fair condition. The grasses inside the fence are buffalo grass and blue grama.

In *little bluestem* the growing points were slightly more than an inch above the soil (Fig. 2). It is probable, therefore, that the number of stems producing flower stalks was a more important factor in determining the lack of resistance to grazing than the height of growing points of vegetative culms (Table 1). The ratio of fertile to vegetative culms was higher than in any of the other grasses studied. If this factor alone determined resistance to grazing, *little bluestem* might have been expected to decrease more rapidly under heavy grazing than other grasses. However, the abundance of old stems in the bunches seemed to discourage grazing

and caused *little bluestem* to persist somewhat longer than some of the other mid and tall grasses.

Grasses, like those discussed above, with growing points above the soil decreased in pastures (Table 2). Found to increase, however, were most of the grasses in which the growing points of vegetative stems occurred at or below the ground level.

TABLE 2

*A tentative classification of grasses based on the position of the growing points in relation to the ground during the growing season and on the ratio of fertile to vegetative stems*

CLASS I Vegetative growing points above the soil	CLASS II Vegetative growing points at the soil surface	CLASS III Few or no vegetative growing points
Switchgrass Western wheatgrass Big bluestem	Kentucky bluegrass Buffalo grass Blue grama Side-oats grama June grass	Little blue- stem Canada wild- rye Plains muhly Marsh muhly Scribner panic grass Wilcox panic grass Annual grasses

The growing points of vegetative stems of *Kentucky bluegrass* were found below the soil surface throughout the growing season. These results are in agreement with the work of Evans (1949), who found that growing points of vegetative culms of *Kentucky bluegrass* did not exceed 1 to 5 millimeters above the rhizomes from which they originated. *Kentucky bluegrass* often replaced tall grasses in heavily grazed lowlands.

The growing points of *buffalo grass* were just above the ground level except for those that terminated a stolon. The vegetative stems arising from the ends of stolons sometimes elongated to have

externally visible nodes. Terminal stems were relatively few in number; thus most of the growing points were found near the ground. In lowlands of heavily grazed pastures buffalo grass often replaced most or all of the mid and tall grasses.

The ratio of the fertile to vegetative stems in buffalo grass was very low (0.15). The decumbent habit of growth, low leaf and even low flower stalk heights, growing points near the soil, and low ratio of fertile to vegetative stems contributed to the extremely high resistance of buffalo grass to grazing. It was apparently more resistant than any of the other perennial grasses in the region.

*Blue grama* resembled buffalo grass in having growing points of vegetative stems that were at or near the soil surface throughout the growing season and in having comparatively low heights of leaves (Fig. 2). It differed from buffalo grass in having erect flower stalks that extended well above the foliage, but the ratio of fertile to vegetative stems was quite low (0.15). Blue grama was slightly less resistant to grazing pressure than buffalo grass, and under continued high intensities of grazing it was replaced by buffalo grass, if soil conditions were favorable for the growth of the latter.

*Side-oats grama* was somewhat similar to blue grama in growth habits. The growing points of vegetative stems remained near the surface of the soil throughout the growing season (Fig. 2). The point of origin of stems (the root-stem transition) was usually a few millimeters above or below the soil surface. However nearly half the stems produced inflorescences.

The erect growth of side-oats grama, the relatively high ratio of fertile to vegetative stems, and its relatively high palatability help to explain the decrease of this species in fair and poor pastures.

Side-oats grama sometimes increased to replace tall grasses, such as big bluestem and switchgrass, but under intense grazing it was eventually replaced by blue grama and buffalo grass.

#### A CLASSIFICATION OF GRASSES

Grasses of the region studied may be grouped into three general classes on the basis of their habits of growth (Table 2). Classes I and II are based on the positions of the growing points of vegetative stems in relation to the soil surface. In Class III most or all stems produced inflorescences leaving few or none vegetative, and inflorescences usually occurred above the general leaf height.

The group with growing points above the soil, Class I, included grasses that decreased under heavy use. Two grasses that should receive special mention are western wheatgrass and June grass (*Koeleria cristata*). Western wheatgrass, although considered an increaser in higher rainfall areas to the east, decreased in the region studied, especially on ranges heavily stocked during the entire year. June grass, although a decreaser, did not fall into this group. It apparently decreased in the loess plains area because it became green and attractive to livestock before the abundant warm season grasses began to grow. Another factor contributing to its decrease was its relatively high ratio of fertile to vegetative stems.

Grasses in Class II, with growing points near the soil surface, were mostly those that increased on ranges grazed intensively for many years. Two that did not fit well in the category of "increasers" were June grass (discussed above) and side-oats grama. Side-oats grama often replaced tall grasses on favorable sites, such as lowlands, but with continued, heavy grazing Kentucky bluegrass, buffalo grass, or blue grama became dominant.

From observations during this study it appears that all grasses of Class III would decrease if grazed intensively before seed maturity. In species of this group all or nearly all of the stems produced inflorescences. Little bluestem was included in this group since more than three-fourths of its stems produced inflorescences. Canada wild-rye (*Elymus canadensis*) was found only in moist lowlands of ranges in good or excellent condition. Plains muhly (*Muhlenbergia cuspidata*) was found only in moderately grazed ranges. Marsh muhly (*M. racemosa*) occurred only in favorable sites, such as lowlands, and then only in the shade of taller plants, such as shrubs or tall grasses. Scribner and Wilcox panic grasses (*Panicum scribnerianum* and *P. wilcoxianum*) were interstitial species of little importance but were usually most abundant in good or excellent ranges. The most important annual grasses were hairy chess (*Bromus commutatus*), little barley (*Hordeum pusillum*), and six weeks fescue (*Festuca octoflora*). Many of the annual plants escape grazing by early or diminutive growth.

#### DISCUSSION

A view held by some is that when a grass leaf is grazed it is regenerated by growth areas at the base of the blade and base of the sheath (intercalary meristems). There is little experimental evidence to support this view; work by Houghney (1936) showed that cell division occurred only in the immature grass leaf (no cell division was observed after the leaves reached 5 mm. in length) and that the growth rate of clipped immature leaves was the same as that of uninjured leaves. The growth of new leaves to replace those that have been grazed is apparently more worthy of emphasis than regeneration of grazed tissue. Grass leaves

that are removed by grazing are replaced by new leaves from the growing point within the stem. If the growing point is removed that stem cannot produce new leaves. (In rare instances axillary buds may produce leaves.)

In certain grasses, such as Kentucky bluegrass, blue grama, and others (Fig. 2) it was found that no elongation of vegetative stems and no elongation of flower-producing stems occurred until about the time the growing point entered the reproductive phase. In contrast with the above were such grasses as switchgrass and western wheatgrass (Fig. 2), in which even the earliest internodes elongated so that the growing points were elevated above the minimum height of grazing. These different habits of growth were related to the tendency of the grasses to decrease or increase under grazing. Those with protected growing points usually increased under high grazing intensities while those with elongated internodes usually decreased.

Several studies indicate that growth areas (leaf primordia) produced late in the growing season are indeterminate and may produce either flower parts or leaves (Purvis and Gregory, 1937; Evans, 1940). In some species leaf primordia may cease development when the culm enters the reproductive phase. From a forage production standpoint it would seem desirable for as many as possible of the primordia to develop into leaves. Perhaps too much emphasis has been placed on seed-producing ability of grasses for range reseeding and not enough emphasis on resistance to grazing and on forage production. Under controlled conditions it was found that stems that produced reproductive parts produced fewer leaves than those that remained vegetative (Evans and Grover, 1940; Purvis and Gregory, 1937). From the standpoint of

resistance to grazing it appears that grasses producing a predominance of vegetative culms are more resistant to grazing than those producing a high proportion of inflorescences (Table 1).

### SUMMARY

Two factors affecting resistance of grasses to grazing were studied for eight species of grass in the dissected loess plains of central Nebraska. Heights of growing points and the ratio of fertile to vegetative stems were studied in switchgrass, western wheatgrass, little bluestem, big bluestem, Kentucky bluegrass, buffalo grass, blue grama, and side-oats grama. In general, the grasses in which the growing points reached a height that permitted their removal by grazing, decreased as intensity of utilization increased but grasses with growing points at the ground level usually increased. Also species with a high ratio of flower stalks to vegetative stems usually decreased in heavily grazed ranges.

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### WHAT MAKES GOOD SEED?

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2. High yield records
3. High quality of crop
4. High seed purity
5. Small total weed seeds
6. Freedom from noxious weeds
7. High germination
8. Freedom from disease

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