Some Growth Responses of Crested Wheatgrass Following Herbage Removal

C. WAYNE COOK AND L. A. STODDART

Associate Research Professor and Professor, Department of Range Management, Utah State Agricultural College, Logan

THE growth and tissue regeneration of forage plants following grazing are of primary importance in range management. However, these activities are complex and are not widely understood.

The authors had an opportunity to study regrowth characteristics of a large number of tagged and clipped plants of crested wheatgrass (*Agropyron cristatum*) being used in a study of forage production over a period of four years. General principles of plant responses resulting from various grazing treatments have been considered by range ecologists and physiologists but certain specific responses noted in these grasses do not seem to have been observed or recorded in the literature. Many accepted theories appear to have resulted from continued repetition rather than from scientific study.

Physiological Response to Grazing

The capacity of a plant to withstand grazing depends largely upon its ability to regenerate foliage tissue. Some investigators (Pool, 1948; Sampson, 1952; Stoddart and Smith, 1943) suggest that grasses as a group withstand grazing better than other plants because their growing region is located near the base of the blade and that growth is not arrested even if the greater part of the leaf blade is removed.

This theory, however, does not hold true in all cases since meristematic tissue of crested wheatgrass leaves appears to be inactive after the leaf unfolds. When a portion of the leaf is grazed after unfolding, the leaf does not grow back to its original length as sometimes believed (Pool, 1948).

The leaf of a grass reacts to grazing very similarly to that of a forb or shrub. Also lateral stem growth and branching of the grass plant in many ways is similar to that of a forb or a shrub following grazing. If the developing stem tip of a grass is cut below the uppermost node while still in the leaf sheath, that particular stem undergoes no further elongation or development. Instead, lateral branches or tillers are produced at the basal nodes and the stem and forage are thus replaced.

Origin and Development of the Grass Shoot

The initial spring growth in crested wheatgrass arises from the lowermost nodes of the previous year's stem. The first two internodes of this new culm never elongate more than one-half centimeter in length but internodes above these are progressively longer from the lower to the upper. The uppermost internode may grow to as long as 10 to 15 inches. Most culms possess from six to eight internodes with an equal number of leaves. Tiller buds or axillary buds may develop from any of the first three nodes.

Grass leaves originate at the shoot apex as an outgrowth called a leaf primordium. The rudimentary leaves within the shoot bud grow rapidly and telescope out from within the sheath of the next lower leaf

(Fig. 1-A). This results both from growth of the leaf and from elongation of the internodes within the sheaths. As soon as the leaves are free of the enclosing sheath and the leaf has unrolled, all meristem apparently becomes inactive for that particular leaf and any further growth is impossible. A leaf cut or grazed after it is fully emerged from the sheath of the next-lower leaf actually will not grow or develop in the slightest.

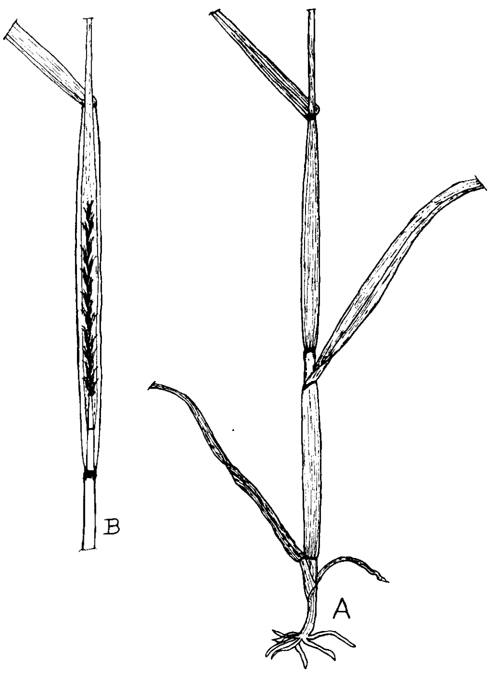

FIGURE 1. A. Crested wheatgrass plant in the fourth leaf stage. B. Longitudinal section of the shoot apex.

RESPONSE OF CRESTED WHEATGRASS TO SIMULATED GRAZING

When a terminal bud of crested wheatgrass still within the leaf sheath is removed by grazing, axillary leaf buds at the base of the plant are stimulated and, if soil moisture permits, new shoots begin growth and replace the original stems. In some grasses, the axillary leaf buds of the second and third leaves sometimes give rise to "blind shoots" possessing leaves and internodes but no inflorescense (Sharman, 1947). Such shoots appeared on crested wheatgrass late in the summer but it was not determined whether absence of a seed head was inherent to the shoot or whether late-season drought and early frost arrested the development of a head.

At the time the grass plant has produced four leaves, all the leaves, nodes, internodes, and heads can be recognized by dissection of the shoot apex without aid of a microscope. At this time the terminal bud is elongating rapidly and usually is composed of two leaves still fully contained within the uppermost leaf sheath and a seed head about one-half inch long. The developing head at this stage of development has risen to from one to three inches above the crown of the plant and becomes vulnerable to damage by a grazing animal. Plants that were cut at a stubble height of one inch above the crown at this time produced culms in the fall that possessed varied leaf and head development (Fig. 2). It can be seen in Figure 2 that the outermost culm on the right side (somewhat decumbent and hence cut above the developing head) possessed two cropped leaves and normal seed head. Stems nearer the center of the crown were clipped closer and hence possessed only cropped sheaths and deformed and cropped seed heads because the cut was made through the developing head. Stems still nearer the center of the plant were cut below the head but above the uppermost node. Here, an elongated but headless culm was produced. Center culms were cut below the uppermost node and did not develop nor elongate in the slightest thereafter.

When a plant was harvested at a height such that the developing terminal bud was removed below the uppermost node, the culm underwent no further elongation

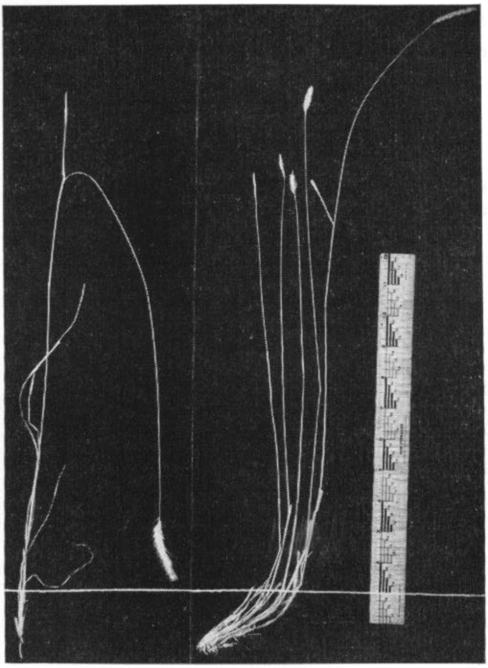

FIGURE 2. The culm on the left came from a plant that had no cropping treatment and the culms on the right came from a plant that was clipped at one-inch stubble height when the third leaf on most culms was completely unfolded. The culms on the right represent regrowth after clipped on May 7 and are not tillers originating from axillary buds of clipped stems.

and an axillary bud at the base of the original stem was stimulated. If sufficient time remained with favorable growing conditions, this branch replaced the parent culm and produced a normal seed head. In some cases when the plant was vigorous, and growing conditions were optimum, two axillary buds were stimulated on the parent culm, thus, increasing the number of culms. However, when plants were harvested in this manner, rate of growth was retarded and plants often did not produce mature seed before frost, especially during dry summer months. There appeared to be a latent period in regrowth when the plant was required to replace forage by axillary bud stimulation. Plants clipped below the uppermost node looked dead for approximately 10 days. No obvious growth or regeneration took place, but dissection revealed basal buds beginning growth within the sheath of lowermost leaves. Within 15 days vigorous leafy shoots appeared which grew rapidly and often extruded a new seed head two weeks later. These shoots, although never as tall nor as vigorous as those on unclipped plants, produced abundant and viable seed unless hampered by further grazing or unfavorable late-season growing conditions.

Since stems of grass are relatively unpalatable and low in nutrients compared to leafy forage, plants grazed closely so as to arrest stem growth and stimulate new leafy tillers give highest quality of forage. However, on arid ranges, such regrowth may not take place and plants may suffer from lack of photosynthetic tissue during summer months and seed production may be prevented.

Summary

The physiological and morphological responses of plants to grazing are not well understood and theories explaining such responses are misleading to practical range managers.

A large number of marked individual crested wheatgrass plants were harvested at various dates and frequencies during 1948–1952 in an effort to determine how grass reacts to grazing.

If harvesting while the terminal bud was still relatively close to the crown removed any part of the developing culm below the uppermost node, then regrowth came only from stimulated axillary buds at the base of the culm. If clipped above the last node, the shoot continued to elongate and develop. If the culm was cut between the seed head and the uppermost node on the stem, then elongation of the culm continued but it remained headless. When the upper part of the head was removed the remaining portion of the head developed. When plants were clipped early in the season while the terminal bud was close to the ground and hence not injured, then a normal culm was produced but leaves were entirely absent if clipped below the collar, or only leaf stubs remained when clipped above the collar. A leaf blade grazed after it fully emerged from the sheath of the next lower leaf did not grow in the slightest thereafter.

Such a stemmy growth is both unpalatable and low in nutritive value. Regrowth from axillary buds of the basal nodes, stimulated by clipping close to the ground and below the uppermost node of the developing culm, is much preferable for grazing. However, such regrowth may not occur under arid or otherwise unfavorable growing conditions.

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