Differential Effect of Herbage Removal on Range Species

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An extensive survey of California livestock operations conducted over nearly a decade by Jones and Love (1945), revealed that the various ranges exemplified every degree of transition from better species toward poorer and *vice versa.*

In every case the trend upward or downward in grazing values was a direct result of practices applied. Where livestock were grazed on a given range only while the plants were green and growing, and were removed before soil moisture became inadequate for maturing the better annuals and perennials, the transition toward better feed proceeded rapidly, provided the livestock load was neither excessive nor too light. On the other hand, where livestock use was deferred until the more rapidly developing annuals had reached the flowering stage or later, the transition toward poorer quality feed was rapid. When a range was used on a year-long basis, the transition to poorer feed was somewhat slower, but range deterioration was in progress as evidenced by an increasing population of weedy plants. Even low rates of stocking did not answer this last problem, because this allowed more opportunity for selective grazing. Such was evidenced by the development of larger and larger colonies of undesirable species that early became unpalatable, *e.g.* red brome (*Bromus rubens*), annual fescues (*Festuca* spp.), annual foxtail barleys (*Hordeum* spp.), and ripgut (*Bromus rigidus*). This was accompanied by a decrease in the population of desirable annuals such as bur clover (*Medicago hispida*) and soft chess (*Bromus mollis*).

Grazing Treatment

These observations indicated strongly that range species react differentially to grazing treatment. Love (1944, 1952) reported the results of experiments showing highly significant response of perennial grasses to early and deferred grazing, especially with respect to stand establishment of the perennials. For instance, line transect counts of seeded *Stipa pulchra* showed 111 plants following early grazing, while only 23 plants were counted under deferred grazing. With *S. cernua* the plant counts following the two grazing treatments were 228 and 24, respectively. Depending on the grazing treatment, Love and Williams (1956) reported significant differences in bur production of *Medicago hispida.* Continuous grazing throughout the season was compared with a grazed-ungrazed-grazed treatment. The latter resulted in 2,264 pounds of burs per acre left on the ground at the end of the season compared with only 664 pounds in the continuously grazed field. These investigators suggested that alternating the two treatments annually would probably result in a high level of annual bur production as well as lamb gains.

Growth Characteristics

Manipulation of species on the range can be guided by critical study of the growth characteristics of the individual plants. Branson (1953) reported differences in growth habit in perennial grasses in regard to elevation of the growing points and the ratio of flower stalks to vegetative stems, and related these characteristics to the tendency of the grasses to decrease or increase under grazing.

Differential responses to herbage removal among species should be recognized so they may be utilized to advantage through proper grazing management. In annual grasses especially, the production of tillers, heads, and seed relate to persistence under grazing. The investigation of such features, particularly as affected by the timing of herbage removal, was the objective of the following studies.

November plantings of soft chess (*Bromus mollis*), foxtail fescue (*Festuca megalura*), slender wild oats (*Avena barbata*), and Mediterranean barley (*Hordeum hystrix*) were made in replicated 4-foot rows in the field at Davis for two years to compare the effect on growth termination of clipping the spring following planting. Clipping was at 3 to 4-inch height, commencing when the "early boot" stage was reached. Such clipping removed the immature inflorescence of the elongating culm, thereby stimulating the development of tillers. By repeating the clipping at approximately two-week intervals, the growing points of successive sets of tillers were removed, and vegetative growth through the production of new tillers was stimulated. The tillers became progressively shorter and fewer, however, as the season advanced.

A comparison of clipped and unclipped rows during the spring of 1954 revealed that green growth in the repeatedly-clipped rows was terminated about two weeks later than in the unclipped. This occurred regardless of the date of "maturity" of the species, which for unclipped plants in this instance was May 21, June 7, June 14, and July 6 for the foxtail fescue, mediterranean barley, soft chess, and wild oats, respectively.

It should be observed that these responses were obtained on deep and fertile soil, with reduced competition from other species, and in a season of favorable rainfall distribution through February, March, and April. The last effective rain fell April 27-28 and totaled 1.3 inches.

Greenhouse Study

To study individual plant behavior more thoroughly, greenhouse plantings of soft chess and of foxtail fescue were made periodically in 6-inch pots. Plants were thinned to three per pot, and 27 plants comprised a treatment. Growth conditions were maintained to permit development to maturity regardless of the date of planting, this being accomplished in winter by providing long photoperiods.

Clippings were made at 1½ inch height, when the first heads were emerged. Measurements included dry weights of clipped tissue, head height, and tillering behavior. Two clipping procedures were employed in each planting. One treatment was clipped twice, giving opportunity to compare the first regrowth with the original production. The other was clipped repeatedly as each successive rank of tillers headed, and indicated the potential growth duration.

Under the conditions of this experiment soft chess continued growth by repeated tillering and heading over a prolonged period. A mid-March planting was still tillering and heading in April of the following year. By then it had been clipped eight times, and two-thirds of the plants had died. However, there had been 83 percent survival through the fifth clipping.

Certain comparisons between the original growth and subsequent regrowth of soft chess were noted under these greenhouse conditions. The dry weight per plant of both the first and subsequent regrowth was approximately one-fifth that of the first production. The average head height of the first regrowth was 40 percent that of the original heads, and each successive rank of heads tended to be slightly shorter than the preceding ones.

Foxtail fescue differed from soft chess in that, following the second clipping, growth was reduced markedly and essentially was terminated after the third herbage removal. Such behavior agrees with the very early maturity exhibited by this species in the field.

Field Clipping

Unlike plants in the greenhouse, those in the field are subjected to variation in environment and respond with seasonal growth. Here the effects of herbage removal have importance in regard to the regulation of growth from the standpoint of grazing management.

Though it is well-known that the time of herbage removal has a pronounced effect on the behavior of a species, very little quantitative data are available on these responses. A field seeding was intensively studied to determine the effects of timing of herbage removal on regrowth and culm development, seed characteristics, and growth cessation in two species of annual grass; namely, soft chess and red brome.

The two species were seeded on November 19, 1954, at a depth of 1½ inches in 5-foot rows spaced 12 inches apart. Treatments were randomized with four replications. Eleven inches of rain fell between planting and May 8, this latter date marking the last effective rain of the season. With the exception of a dry March, the distribution pattern of the precipitation was relatively normal. Growing conditions were favorable, though cool-

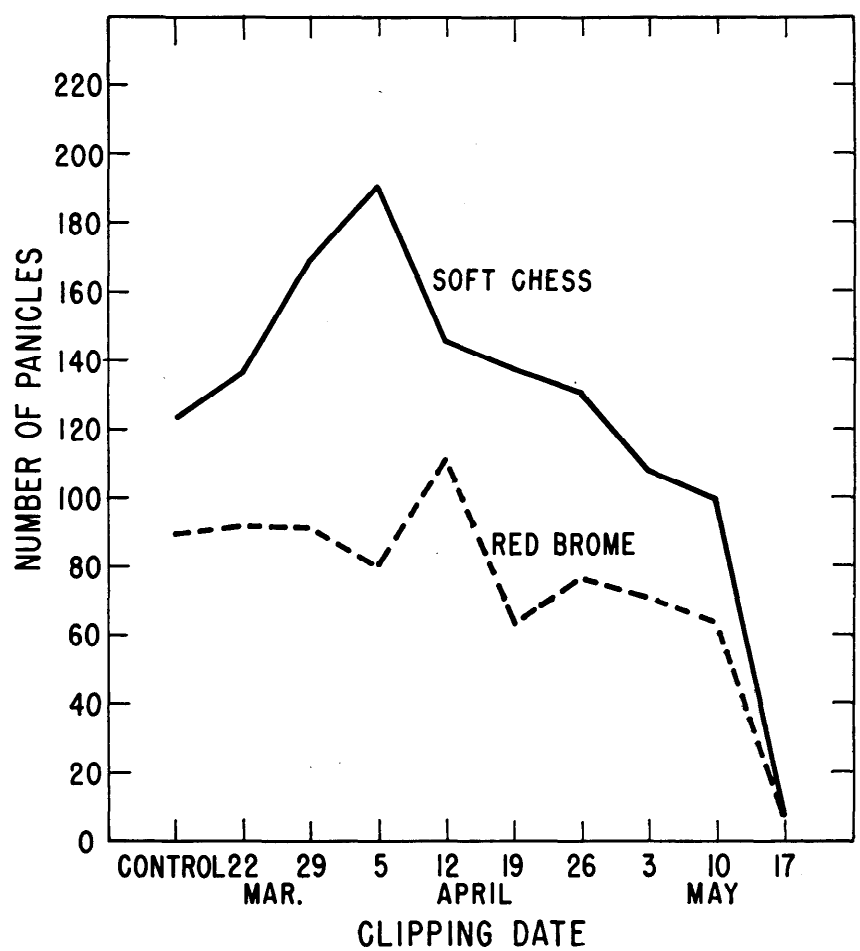

FIGURE 1. Average total number of panicles per foot of row.

ness delayed early growth. First heading was observed in controls of both species on April 4.

The ten treatments consisted of a control and nine treatments clipped once at 1½ inch height. Dates for clipping commenced March 22, by which time culm elongation had started, and continued at weekly intervals until May 17. This permitted a comparison of regrowth following herbage removal on successive dates with the production of unclipped plants.

The panicles were cut from one linear foot of row when mature but before shattering. In the case of the earlier clipping dates, the first inflorescences were followed by a second rank of shorter headed culms which matured later. Two dates of sampling were necessary to get the complete production of these plants. Results were obtained directly, or by computation from counts of culms, weights of spikelets, and determinations of the number of filled caryopses in a given weight of spikelets.

The average total number of panicles produced following the several dates of clipping is presented in Figure 1. Though both species were subjected to the same environment, the response was somewhat different. Soft chess responded to the clippings of March 22, 29, and April 5 with increased numbers of heads in the regrowth, while red brome exhibited relatively little change from the control during the same period. The greatest difference followed the April 5 clipping, when total inflorescence production of soft chess averaged 112 greater per foot of row than did that of the red brome. After mid-April there was a rapid reduction in panicle production in the regrowth of both species and this trend continued throughout the remainder of the growing season.

Change was visible in the size of inflorescences produced as the season advanced. In general, the weight of spikelets per panicle progressively decreased with later

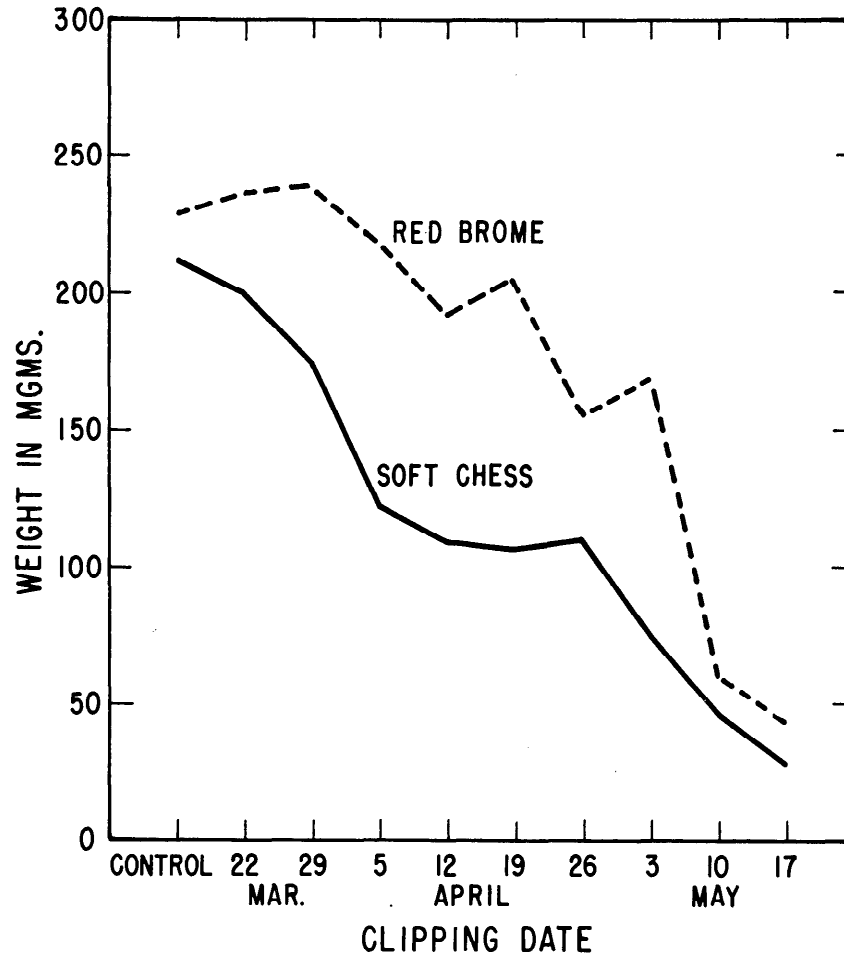

FIGURE 2. Average air-dry weight of spikelets per panicle.

dates of clipping. This is illustrated by the air-dry weight of the spikelets per panicle, determined after removal of the culm and rachis from the inflorescence. Figure 2 depicts this change, and, although the red brome tended to be heavier, both species followed the same pattern.

In the control of an annual species through management the reseeding potential is of primary importance. An evaluation of seed production was made by determining the actual number of filled florets in a given weight of spikelets and then computing the total number of seeds produced per foot of row. The "seed" in this determination included the caryopsis with attached lemma and palea. Empty florets were not included in the count. Increased accuracy was gained by counting three samples within each lot of spikelets. Figure 3 shows the trend in seed production. As might be expected, similarity exists between the number of panicles and the amount of seed produced.

The declining weight of the spikelets following the later clippings suggested lighter seed. Since it is recognized that a relationship may exist between seed size and seedling vigor (Kneebone and Cremer, 1955), this was checked. Plantings of both species were made in soil in the greenhouse using seed from the control and from the regrowth of the clipping treatments of March 29, April 26, and May 3, 10 and 17.

The relationship between seed weight, seedling emergence, and seedling vigor is presented in Figure 4. Seedling emergence 7 days after planting had reached 75 per-

cent or more in all cases, and with additional time the minimum emergence was 80 percent. The dry weight of top growth of 50-plant samples 35 days after planting reflects no reduction in vigor of seedlings from late maturing seed. Rather, increased vigor in soft chess is indicated from mid-season seed. The late matured seed, under the conditions of this experiment, is not associated with marked reduction in emergence or seedling vigor.

The clipping treatments provided opportunity in the spring of 1955 to study the effect of herbage removal on prolongation of green tissue production. The transition from completely green to mature and brown plants was arbitrarily divided into nine classes. On May 30, just before the controls were devoid of green tissue, and again on June 7 and June 14, the treatments were rated visually according to this scale. Both species behaved in like manner. On May 30, depending upon the date of clipping, the range from green to nearly brown was represented. By June 7 green tissue was apparent only in those treatments clipped after mid-April, while by June 14 all treatments except the last two were completely brown. Late developing tillers were the source of the green tissue after clipping at the 1½ inch height.

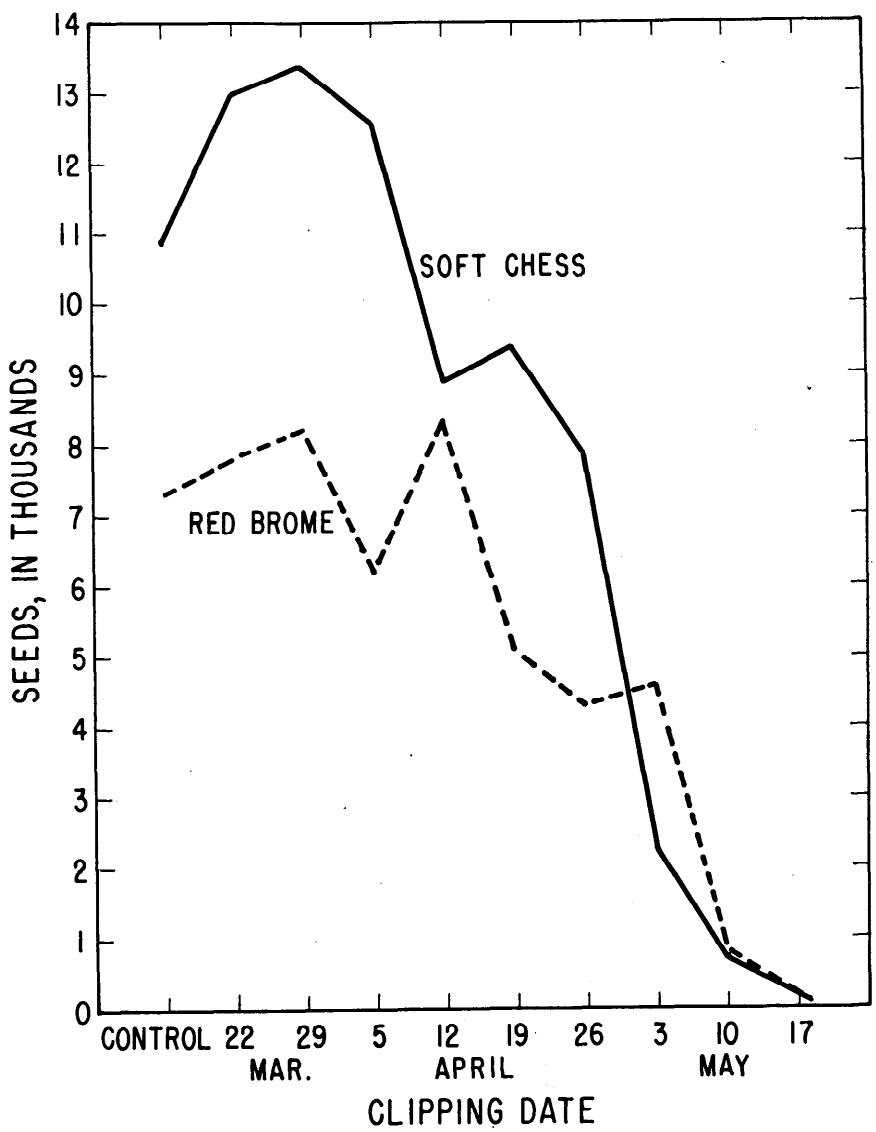

FIGURE 3. Average number of seeds produced per foot of row.

Summary and Conclusions

Herbage removal, timed with regard to the growth characteristics of individual species, offers a means which has not been adequately recognized, for manipulation of vegetation. Differences in behavior among the species of grass make this possible, and permit choice of management practices to encourage or discourage a given species or group of plants.

Range species react differently to grazing treatment. Grazing at such time as to reduce the seed production of one annual species more than another provides a way to limit the reseeding potential and, thus, the prevalence of the species in the vegetation. After herbage removal, soft chess was found to continue tillering and heading much longer than foxtail fescue. In such a comparison it would appear that early grazing could be continued to the growth termination stage of the fescue, thus depressing this species, yet this being early enough to permit later tillering and abundant heading in soft chess.

Under the same environment soft chess and red brome responded differently to the early clippings. Increased heading in the regrowth of soft chess relative to red brome persisted to mid-April, after which heading in both decreased as the season progressed. To markedly affect seed production, grazing would be necessary until the late-season decline in heading was well advanced. At this time not only are fewer heads produced, but the inflorescences are smaller, and mature less seed. The seed produced, however, may retain high germinability and the potential for good seedling vigor.

Animal preferences must be considered in determining the results of vegetation manipulation through herbage removal once these plants have headed out. For example, livestock do not graze the headed

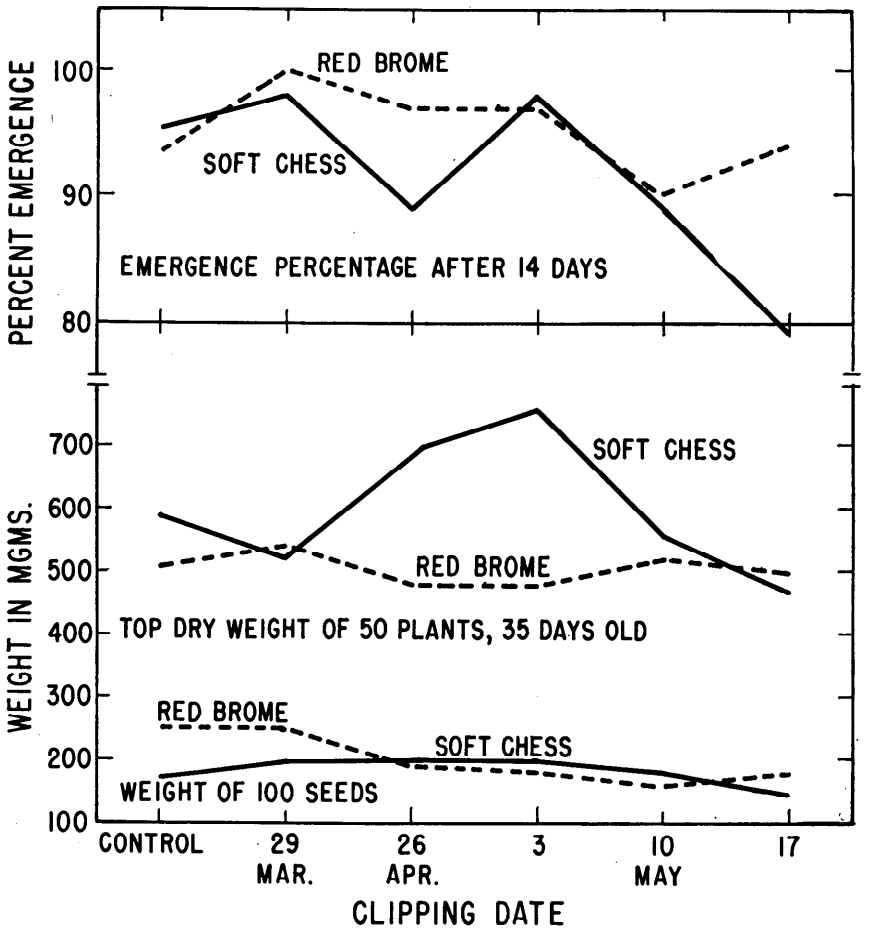

FIGURE 4. Comparison of seedling emergence, seedling vigor, and seed weight in soft chess and red brome.

red brome as they do soft chess because of the obnoxious awns of the former. In effect, this would increase the seed of red brome relative to that of soft chess.

Among the variables which influence the success of herbage removal as a tool in range management are the inherent growth characteristics of the species, plant competition, selective grazing, and weather. Though the degree of control a rancher has over these variables is more or less limited, timed herbage removal, taking into account the growth characteristics of the species and the palatability preference of the grazing animal, can be advantageously employed.

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In Memoriam

HUGH M. BRYAN (1890-1956), range and forestry staff officer of Area 2, Bureau of Land Management, Salt Lake City, died at Rochester, Minnesota, on October 31, 1956, following an operation. This closed a professional career spanning more than 40 years, in which he was one of the pioneers in the development of scientific principles for the conservative management of range lands in Western United States.

A native of Albuquerque, New Mexico, he was educated at the universities of New Mexico, Princeton, and Oxford in England, where he was a Rhodes scholar.

He was employed 5 years (1913-1918) by the U. S. Forest Service.

During World War I he served in the U. S. Army. For 16 years (1919-1935) he was engaged in range livestock operations in New Mexico as employee, owner, or corporate manager of range sheep and cattle outfits which used both private and public ranges.

From 1935-1956 he was employed by the Grazing Service and BLM where he served in various regional and national professional staff assignments related to developmental exploration, administration, and management of public ranges in 10 Western States.

He was a charter member of the American Society of Range Management and has served efficiently on many national and sectional committees.

MR. BRYAN leaves as a monument many notable professional contributions to the advancement of scientific range management. Few men had a more comprehensive understanding of the western range livestock industry and the complex inter-dependent relationships of public and private ranges in Western United States. Few men could as ably expound these subjects to a younger generation or an audience of graziers or laymen. *Milo H. Deming.*