


Seasonal Changes in Herbage Weight in an Annual Grass Community

RAYMOND D. RATLIFF AND HAROLD F. HEADY
Research Assistant1 and Associate Professor, School of Forestry, University of California, Berkeley, Calif.

Herbage production is important to all concerned with range land. The range conservationist aims to grow the largest amount that can be used efficiently. The rancher must do the harvesting. The research worker tries to evaluate the herbage production processes. All are interested in the rate of herbage growth, the maximum production reached, and the decline in available herbage during the dry season. Much research into the California annual type stipulates sampling at the time of maximum weight. If the moment of maximum herbage weight is short, a lengthy period of sampling may confound normal seasonal changes with pasture or treatment differences. A normal decline of herbage weight following maturity is a loss of forage that may be falsely attributed to grazing.

This study was concerned with the problems of how long herbage weights of species and of the plant community remained at or near maximum and the magnitude and speed of the loss in herbage weight in the dry season.

Seasonal weight changes in the annual type have been documented. Heady and Torell (1959) show an increase in herbage weights from February to May and a decline sometime before July. Heady (1960) stated that seed and leaf shattering, insects, rodents, and other causes resulted in a decrease in forage during the dry period. Wagon, Guilbert, and Hart (1959) noted that the availability of broad-leaved plants to livestock is reduced as the plants crumble and distegrate. Hormay and Talbot (1961) reported that Idaho fescue (Festuca idahoensis) lost about 20 percent of its maximum weight by October 1st. Odum (1960) found that in a stable community, production was offset by a decrease in dead material as a new crop developed.

The grazing value of the annual species differs considerably, during the dry period. Wild oats (Avena fatua) is of low value due to its high fiber content and its "rapid decline in protein and minerals following maturity" (Sampson, Chase, and Hedrick, 1951). Soft chess (Bromus mollis) in contrast to wild oats, is the most valuable of the annual grasses during the dry season because of the unshattered seed retained (Bentley and Talbot, 1951). These authors also stated that most forbs are of little value when they "dry and crumble". California burclover (Medicago hispida) is a notable exception.

Hutchison and Kotok (1942) show that all species do not become dry at the same time. In 1939 soft chess was 58 percent dry at the time foxtail fescue (Festuca megalura) was 84 percent dry. While some species may dry earlier than others, rapid drying of the vegetation takes place, usually in May, with the rise in temperature and depletion of soil moisture (Bentley and Talbot, 1951).

An ungrazed wild oats community located in the Tilden Park region of the Berkeley hills was used for the study.

Methods

The experimental design consisted of 15 clusters, each with 20 one-square-foot plots. One plot of each cluster was clipped on each of 20 dates. Sampling started on March 13, 1960, and continued at about weekly intervals until June 25. After this, samples were taken at biweekly intervals until August 20.

Plots were hand clipped, with the shears held on the ground, so that stems were cut off as close to the soil surface as possible. During clipping, care was taken to prevent the loss of unshattered material. Leaf fragments and
seeds on the ground, while often available to livestock, are usually not available to the research worker, due to the time involved in their collection. Thus, no attempt was made to clean the soil surface of shattered material.

Clipped samples were air-dried for two weeks, stored, and later separated into species or species groups. Only current growth was considered. All samples were dried at 84°C for 24 hours and then weighed to the nearest 1/100 gram.

**Results**

Wild oats made up at least 65 percent of the vegetation by weight at all times. The community was, however, far from uniform. Herbage weights of the community and of wild oats, California burclover and red-stem filaree (Erodium cicutarium) varied greatly between clusters and within clusters (Table 1). Soft chess, rip-gut brome (Bromus rigidus) and Italian ryegrass (Lolium multiflorum) varied significantly between clusters. Further statements about changes in herbage weights are based on significant differences between dates of sampling.

**Community Weights**

Considering the community, the most rapid growth occurred from April 2 to 9 (Figure 1) and during this week, 17 percent of the maximum weight was produced. The maximum weight of herbage, 60 grams per square foot, was obtained on May 21. Around this, there was a period from May 7 to 28 when herbage weights were nearly static. On June 5 the weight of herbage had dropped 23 percent or 3.3 percent per day. Losses for the remainder of the study were 22 percent, and the total loss in herbage weight on August 20 was 45 percent of the maximum.

**Wild Oats**

Because wild oats made up so much of the weight, the production curve for it is similar to the one for the whole community. Almost 19 percent of the maximum weight was produced between April 2 and 9. Weights were nearly static from May 7 to 28; the peak weight of herbage, 48 grams per square foot, was obtained on May 21. Twenty-nine percent of the yield had been lost by June 5, which was a loss of 4 percent per day. Final loss by wild oats on August 20 was 44 percent.

**Soft Chess**

The maximum weight of soft chess, obtained on April 24, was 0.6 grams per square foot. Twenty-six percent of this maximum was produced from April 9 to 16, the period of most rapid growth. The values for May 21 and June 25 are the only ones significantly below the maximum. The final value, which is 36 percent below the peak, is not significantly lower because of large variations in the small quantities of soft chess in the community. Soft chess probably loses weight no faster than most other annual grass species, but more work is needed with this species.

**Table 1. Analyses of variance of herbage weights given as mean squares.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Between clusters</th>
<th>Within clusters</th>
<th>Date of sampling</th>
<th>error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14 df.</td>
<td>19 df.</td>
<td>19 df.</td>
<td>247 df.</td>
</tr>
<tr>
<td>Afa</td>
<td>614.40**</td>
<td>196.58**</td>
<td>2,481.88**</td>
<td>68.07</td>
</tr>
<tr>
<td>Bmo</td>
<td>3.26**</td>
<td>.27</td>
<td>.53*</td>
<td>.31</td>
</tr>
<tr>
<td>Bri</td>
<td>17.21**</td>
<td>9.05</td>
<td>11.19*</td>
<td>6.55</td>
</tr>
<tr>
<td>Lmu</td>
<td>88.02**</td>
<td>8.51</td>
<td>70.32**</td>
<td>12.16</td>
</tr>
<tr>
<td>Bad</td>
<td>5.85**</td>
<td>1.31</td>
<td>1.14</td>
<td>1.92</td>
</tr>
<tr>
<td>Lup</td>
<td>11.91**</td>
<td>.74</td>
<td>.92</td>
<td>.73</td>
</tr>
<tr>
<td>Mhi</td>
<td>11.66**</td>
<td>3.43**</td>
<td>5.66**</td>
<td>.83</td>
</tr>
<tr>
<td>Eci</td>
<td>1.86**</td>
<td>.67*</td>
<td>1.54**</td>
<td>.40</td>
</tr>
<tr>
<td>Others</td>
<td>.42</td>
<td>.27</td>
<td>.50**</td>
<td>.25</td>
</tr>
<tr>
<td>Community</td>
<td>369.00**</td>
<td>223.78**</td>
<td>3,792.92**</td>
<td>47.16</td>
</tr>
</tbody>
</table>

*Abbreviations of plant names as follows:

Afa: Avena fatua
Bmo: Bromus mollis
Bri: Bromus rigidus
Lmu: Lolium multiflorum
Mhi: Medicago hispida
Eci: Erodium cicutarium

**Significant at 5 per cent**

**Significant at 1 per cent**
Rip-gut Brome

Rip-gut did not compose less than 1.8 or more than 7 percent of the herbage produced by the community on different dates. Twenty-five percent of its peak weight was produced from April 2 to 9, and its peak weight on July 9 was 3.1 grams per square foot. Lateness of the peak was due to the chance occurrence of a high value. As with soft chess, the variations in weight of rip-gut were large. However, based on the results and phenological records, the herbage weight of rip-gut appeared to have been nearly static from April 16 to just after July 9. Herbage weight on July 23 was 61 percent below the peak, a loss of 4.6 percent per day. Losses from July 23 to August 20 were 20 percent of the peak, and the total loss of weight by rip-gut was 84 percent.

Ryegrass

Ryegrass was the second most abundant species in the community; however, its percentage of the herbage was never more than 15.3. It was more evenly distributed than soft chess or rip-gut, hence the curve is smoother. The peak weight of 7.6 grams per square foot was obtained on May 28. Forty-eight percent of this maximum weight was produced from April 16 to 24. The value on June 11 was significantly below the peak; otherwise, weights of ryegrass were nearly stable from April 24 to July 9. Loss of weight amounted to 28 percent of the maximum, or 2 percent per day, for the two weeks from July 9 to 23. The loss at the end of the study was 2 percent more than for wild oats and 38 percent less than for rip-gut. Eighteen percent of the peak weight was lost from July 23 to August 20.

Burbclover and Filaree

The earliest period of rapid growth was from March 28 to April 2, when both California burclover and red-stem filaree grew most rapidly. During this period, burclover produced 33 percent and filaree 44 percent of their maximum weights. The peak for burclover came one week later, May 7, than the peak for filaree, which was on April 30. Maximum weights for burclover and filaree were 1.7 and 1.1 grams per square foot, and their peak percentages of the community herbage were 5.9 and 3.2 respectively.

Weights of burclover were nearly stable from April 2 to May 21. Burclover lost 5.4 percent of the peak weight per day between May 21 and 28, a total of 38 percent. This rate of loss is exceeded only by filaree, which lost 11.4 percent of its maximum weight per day, 79 percent total, from May 7 to 14. Results and phenological records indicate that weights of filaree were probably stable from April 16 through May 7.

After their initial dives, burclover lost 32 percent and filaree 20 percent of their maximum weights by August 20. Final losses were 70 percent and 99 percent of the maximum weights of burclover and filaree respectively. The large percentage loss of filaree is due to near completion of both seed and leaf shatter by the end of the study. Shading of filaree by taller plants resulted in its producing longer, weaker stems than normal. The beating effect of the taller species brought about by winds contributed to the loss of filaree, and only bare stems and stumps remained on August 20.

Summary and Discussion

The periods of most rapid growth extended from March 28 to April 24. Filaree and burclover led the parade, followed by wild oats and rip-gut, then by soft chess, and last by ryegrass.

Except for burclover, the static period of maximum herbage weight was roughly from the time of seed development to the start of seed dispersal. For burclover it was from the onset of flowering to the time of leaf shatter.

Initial loss of weight of filaree was twice as fast and that of ryegrass half as fast as any other species. Speed of weight loss became less in all cases after this initial loss.

Percentage loss of herbage weight at the end of the study was least for soft chess. Wild oats, ryegrass, and the community lost about 10 percent more of their peak weights than soft chess. Filaree lost nearly all of its yield, rip-gut over 80 percent, and burclover over two-thirds of its yield of herbage.

Wild oats and ryegrass were sufficiently abundant in the community to merit the conclusion that they would react in the same way in other areas. Information presented for the other species should be considered only as guide-lines because they were very minor constituents of the community studied.

Obviously, the pattern of seasonal changes in herbage weight will vary from year to year. The time the maximum weight is reached, the length of the static period, the speed of weight loss, and the extent of weight loss during the dry season are all influenced by environmental factors, and prediction of the patterns can be made only in general terms.

From this study we were able to conclude the following about seasonal change in herbage weight in the California annual type without grazing. Presumably these conditions also occur with grazing.

1. Some species start their most rapid growth earlier than others, and some lose weight earlier than others.

2. Once the peak weight is reached for a species, there is a period during which weight remains reasonably constant, but it is not the same length for different species.
3. Initial losses in herbage weights are usually the most rapid; later losses occur more gradually.

4. The period of constant weight for a community will vary in length and starting date depending upon species composition.

5. The total loss in weight for a community will depend mainly upon its species composition. If the community is largely filaree the loss (for the research worker, but perhaps not for the cow) will probably be earlier, more rapid and more complete than it will be with a community composed largely of grass.

6. These data suggest that sampling for herbage weight must be carefully coordinated with species composition and with stage of growth and so designed that normal seasonal weight losses are not confounded with forage eaten by livestock.

LITERATURE CITED


When Illinois was Range Country, City Dwellers had “Christmas Beef”, and the USDA was Born — 1862

E. J. DYKSTERHUIS

Range Conservationist, USDA, Soil Conservation Service, Lincoln, Nebraska.

A hundred years ago the U. S. Department of Agriculture was created and President LINCOLN appointed ISAAC NEWTON as Commissioner at $3000.00 per annum. An introduction to federal range literature just before 1862, and to USDA contributions in and immediately following 1862 can perhaps in small measure help to commemorate the passing of this centennial year.

There had been scattered brief mentions of range prior to 1862 in the annual volumes on Agriculture by the U. S. Patent Office, which preceded the annual volumes published by the USDA. Thus, in 1855 CHARLES FOSTER of Marion County, Tennessee, wrote, for the Patent Office annual, about his range on the Cumberland Mountains, stating, “As a grazing region, I know of none equal to it. Indeed, thousands of cattle and hogs are fat-

tended on the range... circumstances are such that cattle can be wintered without feed.”

In the Patent Office report of 1858 there is a two-page proposal to introduce the Tartarian yak to utilize ranges of the high plains for the benefit of the Indians. To quote: “By the introduction of the yak and its presentation to the chiefs of our Indian tribes existing on the borders of the Great Plains lying east of the Rocky Mountains, the condition of these people would certainly be ameliorated.” The suggestion followed the none too encouraging comments on climate of the area a year earlier by WILLIAM GILPIN in the 1857 volume.

He had stated, “During a temporary prevalence of moist atmosphere, in the spring, the delicate ‘Gramma’ and ‘Buffalo’ grasses flourish, and are cured into hay upon the ground by the gradually returning drought.” GILPIN’s description of the plains climate — “a temporary prevalence of moist atmosphere, in spring... gradually returning to drought”—is the equal of our contemporary references to rains with only 30 percent moisture. He nonetheless added, “It is upon this... that the buffalo finds his winter food, subsisting upon it without regard to latitude; and here, also, are found vast numbers of wild horses, the elk, the antelope, and numerous other animals peculiar to the continent.”

In general, authors of articles for stockmen in these decades were concerned with livestock breeding and with replacing the wild (native) grasses with domesticated species familiar to them, or with exotic “wonder plants.” Also, much was written about the desirability and means of planting trees on the prairie.

Yet, even in the 1860 volume on agriculture of the Patent Office, the REV. C. W. HOWARD of Georgia, referring to a list of Texas grasses, forwarded to him by MR. GIDEON LINCECUM of Long Texas, wrote as follows: “The comments of this gentleman on these different grasses cannot but be read with interest by the