Management implications of herbage weight changes on native rangeland

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ABSTRACT—Range researchers and technicians often calculate herbage production from clippings or estimates made once a year, commonly at the end of the growing season. Such estimates may lead to serious miscalculations unless seasonal changes in herbage weight and differential growth of individual species and plant parts are recognized. Data from black grama and blue grama vegetation types show that peak herbage weight lasts only a short time and that the amount of herbage available for grazing animals for most of the year is considerably less than that present at the peak. In addition, leaves and inflorescences, which are the most palatable and nutritious plant parts, deteriorate more rapidly during the dormant season than culms, the least palatable and nutritious plant parts. These changes have major implications in determining stocking rates, comparing treatments and years, determining utilization, and planning grazing systems.

MOST range researchers and technicians determine herbage production by sampling once during the year. This sampling usually is done after the growing season. Often there is a tacit assumption that once the growing season is complete, herbage weight remains more or less constant for the rest of the dormant season. Many earlier studies (*2, 3, 4, 7, 9*) have shown that herbage weight declines considerably during the dormant season. Recent work in the Grassland Biome of the International Biological Program has shown some of the general patterns of herbage weight changes during the year for a variety of grassland types (*8*).

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This report illustrates some of the consequences of not recognizing the dynamic nature of herbage weight. Examples are drawn from two ranges in New Mexico.

Methods and Procedures

One study area is a desert grassland at the Jornada Experimental Range, 25 miles north of Las Cruces. The other study area is a blue grama (*Bouteloua gracilis*) vegetation type at the Fort Stanton Experimental Range about 70 miles west of Roswell.

The environments of the two areas differ considerably. Average annual precipitation at the Jornada site is 9 inches; at Fort Stanton, 15 inches. Vegetation on the Jornada site is a remnant of the original black grama (*Bouteloua eripoda*) grassland type. Black grama is the dominant species. Paulsen and Ares (*5*) described the Jornada area more completely, as did Pieper, Montoya, and Groce (*6*) in the case of the Fort Stanton site.

The Jornada studies were conducted in 1970, 1971, and 1972. Those at Fort Stanton were conducted during the 1967-68 season. On both areas, all herbage material was clipped at ground level from randomly located quadrats. At Jornada, 40 circular quadrats, 0.5 square meter each, were clipped at each sampling period, while at Fort Stanton 20 rectangular quadrats, 0.31 × 0.62 meter, were

Reprinted from the Journal of Soil and Water Conservation
September-October 1974, Volume 29, Number 5

clipped at each date for each treatment. At Fort Stanton, only herbage produced during the current season was kept. At Jornada, the herbage was divided into current live material, recent dead material, and old dead material. Recent dead material was material produced during the current season that had turned brown. Old dead material was produced during previous seasons. In the dormant season, the herbage weight at Jornada was determined by adding current live material and recent dead material. Samples were collected biweekly during the growing season and monthly during the dormant season. No livestock grazed either area during the studies.

At Fort Stanton, an area that was not treated was compared with another that had been fertilized with 60 pounds of actual nitrogen per acre in the form of ammonium sulfate. In addition to total herbage weight, 20 intact blue grama plants were collected and divided into leaf blade, leaf sheath, culm, and inflorescence at each sampling period. All material was dried at 70°C before weighing.

Results

The standing crop at Jornada increased rapidly during the summer, peaked in early September, then declined rapidly through the dormant season (Figure 1). Average standard error of the mean was about 40 pounds per acre for all three years. The peak standing crop for each of the three years occurred at different times. During the third year, there were actually two peaks. Most standing-peak curves for the Jornada were irregular. This is not surprising, however, considering precipitation variations in desert grassland. During the second year, precipitation at Jornada was low and came late in the growing season. As a result, herbage weight in the second year was much lower than in the other two years, and the peak occurred later than in the other two years. During the third year, considerable rain fell early in the growing season, and plants began to grow earlier than in other years. Much of this early growth consisted of annual forbs. Later in the growing season, perennial grasses contributed a higher percentage of total biomass. The total herbage weights in figure 1 do not reflect dynamics of individual species,

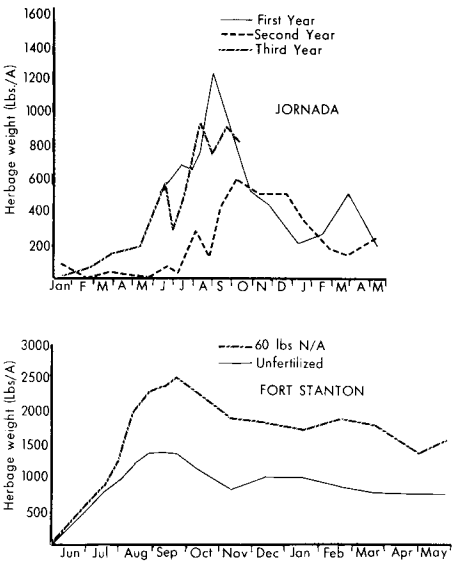

Figure 1. Herbage weight during growing and dormant seasons for a desert grassland (Jornada) and a blue grama range site (Fort Stanton).

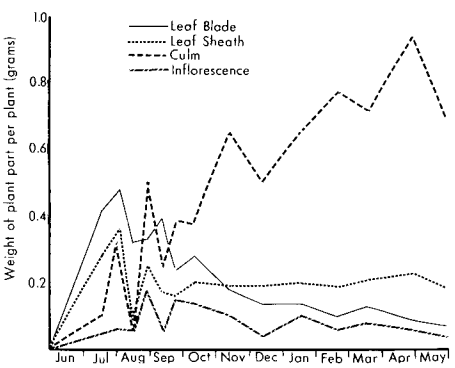

Figure 2. Average weight of blue grama plant parts during year at Fort Stanton.

which may differ considerably from the totals.

At Fort Stanton, the herbage available during the year did not fluctuate as much as at Jornada but reflected some of the same general patterns (Figure 1). Standard error of the mean averaged about 20 pounds per acre for both treatments. Peak herbage weight occurred in September on the unfertilized area and slightly later on the fertilized area. On both areas, herbage weight declined substantially immediately after peak herbage weight and more gradually during the remainder of the dormant season. Total herbage weight was significantly ($P<.05$) higher on the fertilized area than on the unfertilized area after August at Fort Stanton.

Development of individual blue grama plant parts differed considerably (Figure 2). Leaf blades and sheaths began to develop early in the growing season. Culms and inflorescences developed somewhat later. As the season progressed, leaf weight decreased. Blades, sheaths, and inflorescences began to decline in September. However, weight of culms increased considerably throughout the dormant season, probably because the smaller, weaker culms became detached and added to the litter, leaving only the stronger, larger culms to be sampled. At any rate, the culms became much more important in terms of total herbage weight during the dormant season than any other blue grama parts. Most of the differences among plant part weights was significant ($P<0.05$) after September. Fertilizer caused all plant parts to be larger, but the proportionate weight of each part was the same for fertilized and unfertilized plants.

Discussion

These data have several implications for the range manager. In many cases, stocking-rate estimates are based on the amount of forage produced on a particular range. On the unfertilized area at Fort Stanton, the standing crop peaked in September. After this, about 1,360 pounds of herbage declined to only 835 pounds per acre by November, a reduction of about 40 percent. If stocking-rate calculations were based on peak standing crop, as they often are, then the stocking rate would be much heavier than justified by herbage weight averaged over the entire year. For stocking-rate determinations, it would be more desirable to use time-weighted herbage estimates rather than peak-standing crop. However, for most areas these kinds of data are not available. If grazing stimulates regrowth, additional problems are encountered.

Part of the decline in herbage weight after the peak is accounted for by the loss of ephemeral forbs and grasses. Growth of these plants fluctuates widely, depending on soil-water availability, and the herbage must be used during growth or shortly thereafter. Traditional methods of determining range production may not include forbs that grow at periods different from those of main grasses. For example, at Jornada, early spring precipitation during the third year re-

sulted in forb growth, which had largely disappeared by the middle of the summer (Figure 1). Such growth is important for livestock during periods of stress in the desert grassland region.

Many utilization standards are based on height-weight relationships determined at the time of maximum herbage weight for an individual species. Such relationships may not hold throughout the year. There appears to be considerable justification for using the residue method for calculating stocking rates as well as for making adjustments as advocated by Bement (*1*).

Many specific treatments are evaluated on the basis of herbage weight determined only once during the year. These data show that, especially at Jornada, the time of peak-standing crop varies considerably from year to year. Consequently, if comparisons are made from one treatment to another, they need to be made at comparable growth stages so that any differences measured are not a result of differences in herbage weight at different times but are truly treatment differences. In the same way, comparisons from one year to another need to be made at roughly the same time on the herbage weight curve. Otherwise, differences may not reflect yearly differences but simply seasonal differences. At Jornada, the standing crop peaked at different times of the year. It may be much more difficult on this type of rangeland to estimate or to compare treatments than on other areas with more regular precipitation patterns.

On many southwestern ranges, the common grazing system is continuous or year-long grazing. Data shown here reflect how much forage will be available for grazing animals throughout the year under this system. For any type of rotation-grazing scheme, the amount of herbage measured at the end of the growing season does not reflect how much will be available when livestock is moved into the next pasture. The essential measurement is how much herbage will be available for grazing when livestock is moved into an area. For example, on the unfertilized area on Fort Stanton, total herbage weight declined by 43 percent from its peak to its minimum late in the dormant season. If cattle were moved to another pasture under a rotation-grazing system on the assumption that maximum herbage weight was still available, only a little more than half of this really would be available for the cattle at the time they went into the pasture.

A manager considering range fertilization as an improvement practice must be aware that not all herbage produced by fertilization will be available for grazing during the entire year. The measurements at Fort Stanton indicate, however, that considerably more herbage would be available throughout the year with fertilization than without it.

REFERENCES CITED

1. Bement, R. E. 1969. *A stocking-rate guide for beef production on blue grama range.* J. Range Manage. 22: 83-86.
2. Box, Thadis W. 1960. *Herbage production in four range plant communities in south Texas.* J. Range Manage. 13: 72-76.
3. Brockington, N. R. 1960. *Studies of the growth of* Hyparrhenia*—dominant grassland in northern Rhodesia. I. Growth and reaction to cutting.* J. Brit. Grassland Soc. 15: 323-338.
4. Cassady, John T. 1953. *Herbage production on a bluestem range in central Louisiana.* J. Range Manage. 6: 38-43.
5. Paulsen, H. A., and F. N. Ares. 1962. *Grazing values and management of black grama and tobosa grasslands and associated ranges of the southwest.* Tech. Bul. 1270. U. S. Dept. Agr., Washington, D. C.
6. Pieper, Rex D., James R. Montoya, and V. L. Groce. 1971. *Site characteristics on pinyon-juniper and blue grama ranges in southcentral New Mexico.* Bul. 573. New Mex. State Univ. Agr. Exp. Sta., Las Cruces.
7. Ratliff, Raymond D., and Harold F. Heady. 1962. *Seasonal changes in herbage weight in an annual grass community.* J. Range Manage. 15: 146-149.
8. Sims, Phillip L., and J. S. Singh. 1971. *Herbage dynamics and net primary production in certain ungrazed and grazed glasslands in North America.* In Norman R. French [ed.] *Preliminary Analysis of Structure and Function in Grasslands.* Range Sci. Dept. Sci. Ser. No. 10. Colo. State Univ., Fort Collins.
9. Turner, G. T., and G. E. Klipple. 1952. *Growth characteristics of blue grama in northeastern Colorado.* J. Range Manage. 5: 22-28. □