Factors Influencing Herbage Weight Of Idaho Fescue Plants

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Among the factors affecting the herbage weight of an Idaho fescue (*Festuca idahoensis*) plant are leaf height, basal area, and number of flower stalks. These three factors change in absolute value from one location to another on the livestock ranges in the Big Horn Mountains of north-central Wyoming. Since each factor is easily measured, the part each contributes to herbage weight can be determined. The needed data were collected during a single growing season from 1,150 fescue plants found on three plant-soil conditions. Idaho fescue was used in the analysis because it is an important forage species on these livestock ranges (Hurd and Kissinger, 1952).

[1]*Central headquarters maintained in cooperation with Colorado State University at Fort Collins. Research reported here was conducted in cooperation with the University of Wyoming at Laramie.*

Methods

Twenty-three areas ranging from 7,200 to 9,000 feet in elevation were sampled. These areas were lightly grazed pastures approximating 40 acres in size and livestock exclosures containing ¼ to 3 acres. Exclosures had been protected from livestock grazing for 1 to 16 years and the pastures had been lightly grazed for 20 years or more. Deer and elk had access to all but one sample area.

Fifty Idaho fescue plants were measured and clipped at each sample area. Ten plants were taken at regular intervals along each of five transects. Maximum basal leaf height was measured to the nearest 0.1 inch; basal area was estimated to the nearest square centimeter (Pearse, 1935); and flower stalks were counted on each of the 50 plants. Plants were clipped at ground level and all herbage from a 10-plant transect was placed in the same paper bag, air-dried, and then weighed to the nearest 0.1 gram.

Sample areas were classified by vegetation and the kind of

Table 1. Relative importance of factors affecting herbage weight as indicated by partial correlation coefficients.

Partial correlation coefficients[1]	Grass-forb cover		Sagebrush cover
	Granitic soils	Sedimentary soils	Sedimentary soils
$r_{12.34}$	0.897	0.631	0.524
$r_{13.24}$	.556	.324*	.606
$r_{14.23}$	.558	.685	.439

[1] 1 = Herbage weight; 2 = Leaf height; 3 = Basal area; 4 = Number of flower stalks

*Not significant at 5% level; all other coefficients significant at 1% level.

parent material, either sedimentary or granitic rocks, from which the soils were derived. The vegetation was divided into two broad categories: grass-forb, and big sagebrush (*Artemisia tridentata*); sagebrush always had a perennial grass-forb understory.

Results

The relationship of herbage weight to maximum leaf height, basal area, and number of flower stalks was clearly evident. These three independent factors, when combined, produced multiple correlation coefficients of 0.967 for the grass-forb-granitic soil type, 0.930 for the grass-forb-sedimentary soil type, and 0.926 for the sagebrush-sedimentary soil type. The three combined independent factors account for 86 to 94 percent of the variation in herbage weight of the Idaho fescue plants. (Correlation coefficient squared equals percent variation accounted for.) The remaining 6 to 14 percent of the variation in herbage weight is attributed to factors not measured in this study.

The relative importance of the independent factors is indicated by the coefficients of partial correlation found in Table 1. Leaf height was more closely associated with herbage weight of those fescue plants growing on granitic soils than was either basal area or number of flower stalks. However, no significant differences between the coefficients were noted within the other two plant-soil conditions.

The grass-forb-sedimentary soil condition produced plants having, on the average, larger basal areas, longer leaves, heavier herbage, and more flower stalks than the plants in the other two conditions. Differences between values are often real, as shown in Table 2. Reasons for these differences may lie in the productivity, depth, and moisture holding capacity of the soils and, if so, are beyond the scope of this study.

Average basal area, leaf height, and herbage weight were not correlated with the number of years the plants had been protected from livestock grazing or had been grazed lightly. This conclusion was based on the data from 10 sample areas on the granitic soils, 8 areas with sagebrush cover, and 5 areas with the grass-forb-sedimentary soil condition. The period of protection or of light grazing ranged from 1 to 16 years, 2 to 16 years, and 4 to 20 years for the three groups of sample areas. Lack of correlation does not imply that an individual fescue plant will or will not increase in basal area or produce longer leaves or produce more herbage under protection. Those points were not studied. The results show only that there was no correlation between length of the protection period and the size of the average fescue plant (basal area, leaf length, and herbage weight) in each of the 10 locations on the granitic soils. Current soil moisture and fertility, growing conditions, and use prior to protection may exert stronger influence on basal area, leaf height, and herbage weight than exclusion of livestock or light grazing.

Frequency distribution curves of basal area classes show a distinct positive skewness. As seen in Figure 1, a tail of the distribution curve extends to the right.

Table 2. Average maximum leaf height, basal area, herbage weight, and number of flower stalks for Idaho fescue plants in three plant-soil conditions

Item	Grass-forb cover		Sagebrush cover	Columns significantly different*
	Granitic soils (a)	Sedimentary soils (b)	Sedimentary soils (c)	
1. Leaf height (inches)	5.3	8.2	7.7	a&b, a&c
2. Basal area (sq. cm.)	7.9	10.6	6.3	b&c
3. Weight (grams, air-dry)	1.04	3.46	1.61	a&b, b&c
4. Weight per sq. cm. (grams air-dry)	0.13	0.32	0.24	a&b, a&c
5. Plants with flower stalks (pct.)	19	58	27	a&b
6. Flower stalks per plant in item 5 (No.)	3	15	5	a&b, b&c

*5% level of confidence or better.

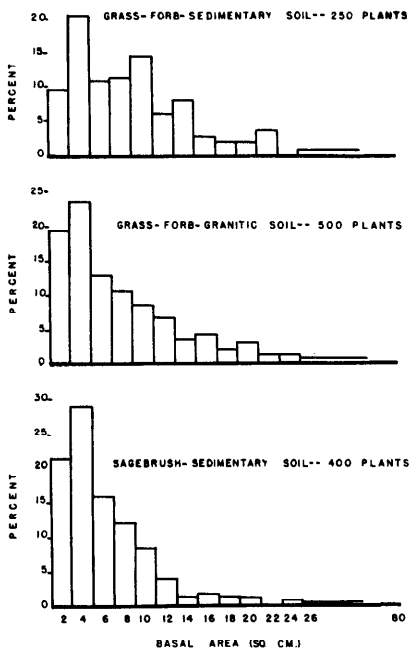

FIGURE 1. Frequency distribution of basal area classes for Idaho fescue plants.

For all three plant-soil types the greatest percentage of plants was in the 4-square-centimeter basal area class. As seen in Table 2, the average basal area for the plant-soil conditions was considerably larger—7.9, 10.6, and 6.3 square centimeters.

Discussion

Number of flower stalks and herbage weight were most closely correlated in the grass-forb-sedimentary soil condition. On this type, 58 percent of the fescue plants produced flower stalks compared to 19 and 27 percent in the other two plant-soil types. If there had been more plants with flower stalks or more flower stalks per plant in each plant-soil type, as there are in some years, then flower stalk numbers might have a still greater influence on herbage weight. Further analysis, however, showed that number of flower stalks and leaf height were highly correlated in all three plant-soil types. In contrast, number of flower stalks and basal area were not correlated in two of the three plant-soil types. This suggests that factors influencing flower stalk production also influence leaf height. Hence, an increase in flower stalks would be accompanied by an increase in leaf height and the relative influence of these variables upon herbage weight could remain unchanged.

Herbage weight or weight per unit area such as a square centimeter may best represent the combined quantitative factors used to express plant vigor. Here, such things as leaf and flower stalk height, number of leaves and flower stalks, and thickness or diameter of culms and leaves are accounted for. Leaf height has been used to express vigor (Parker 1951, Short and Woolfolk 1956). The results of the present study show that leaf height and herbage weight are highly correlated. Therefore, leaf height appears to be a reliable index to vigor, providing weight is accepted as the combined vigor expression.

Idaho fescue plants growing in the three plant-soil types sometimes differ in certain characteristics. As found in Table 2, there are some real differences in maximum leaf height, basal area per plant, herbage weight per plant, herbage weight per square centimeter of basal area, and in flower stalk numbers. These differences may be due to variations in current growing conditions (which seems unlikely), major environmental conditions such as soil depth, soil moisture relationships, and soil fertility, or perhaps the differences reflect genetic variations. Irrespective of what the cause may be, the differences among plant-soil types should be recognized if leaf heights, basal area, herbage weight, and number of flower stalks are used to evaluate the plants' response to a grazing treatment.

Summary

The relationships of leaf height, basal area, and number of flower stalks to herbage weight were determined with 1,150 Idaho fescue plants growing on 3 plant-soil conditions in the Big Horn Mountains, Wyoming. When these 3 independent factors were combined, they accounted for 86 to 94 percent of the variation in herbage weight. Individually, leaf height was highly correlated with herbage weight as was number of flower stalks. The latter, however, was not always as important a contributor to herbage weight as was leaf height.

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Thirteenth Annual Meeting!

The Thirteenth Annual Meeting of the American Society of Range Management will be held at Portland, Oregon, February 2-5, 1960. Headquarters for the meeting is the Multnomah Hotel. Note that the meeting will be one week later than usual.