Influence of Grazing and Mulch on Forage Growth

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Introduction

IT IS well known that the degree of forage removal affects individual plants, plant succession, forage production, and modifies microclimate and soil. Some investigators have pointed to the necessity of leaving a portion of the plant ungrazed to preclude undue interference with physiological processes. Others have felt that the dead plant "litter" or mulch remaining at the end of the grazing season is of even greater importance than conservative grazing in its effect on soil structure, organic content, soil temperature, moisture, and erosion, and thus upon the growing plants (*2*, *5*, *10*, *11*). While mulch has long been recognized as an important element in range health, specific studies regarding its role have been undertaken rather recently (*7*, *8*). Beutner and Anderson have shown that striking increases in forage production result from rather heavy mulches on semi-desert soils (*1*). Larson and Whitman have indicated a close relationship between litter accumulation and degree of forage removal (*9*).

To investigate some of these relationships and, particularly, the effects of protection and organic mulch on forage production, plot studies were begun in 1941. The study area is located on the North Fork of Little Thompson River, nine miles east of the Town of Estes Park, Colorado, on the Roosevelt National Forest. At the outset, the study was intended to measure the relative rates of recovery of an overgrazed range under protection and under moderate grazing. As the study progressed, certain aspects of spring and summer forage growth became evident, and the apparent effect of mulch accumulation led to the addition of a mulch study.

Design of Study

In the fall of 1941 a one-acre exclosure was fenced in a typical, very closely grazed, small Kentucky bluegrass (*Poa pratensis*) park in the ponderosa pine type at an elevation of 8300 feet. As a result of many years of severe grazing Kentucky bluegrass is the dominant plant in the park. Fringed sagebrush (*Artemisia frigida*) is fairly abundant but other grasses and forbs occur in very small amounts. The original type was, undoubtedly, dominated by mountain muhly (*Muhlenbergia montana*), fescue (*Festuca sp*), and timber danthonia (*Danthonia intermedia*). The exclosure is located in a fairly wide bottom where cattle normally congregate, and has not been grazed since its construction.

In the spring of 1944 an additional plot of three acres was fenced adjacent to the exclosure and was grazed by a cow and calf for three weeks each year in 1944 and 1945. Subsequently, the use has been

one cow and calf for about one month annually. The attempt has been to secure about 50% utilization, by weight. In 1948 there was an undetermined amount of grazing trespass for a short time.

On November 5, 1947, another small plot was fenced on the heavily grazed range, adjoining the ungrazed exclosure. Six areas each containing four square feet were established in this plot. Two of these were treated by applying as mulch all of the vegetation clipped from an eight-square-foot area in the totally protected plot. Two others were treated by applying as mulch the vegetation clipped from four square feet in the ungrazed plot. And the other two plots served as checks. Thus, one set of two plots was full-mulched and another set of two was half-mulched. Additional mulch was applied some distance around the edges to eliminate border effect. The objective was to apply as mulch the vegetation which would accumulate annually on an ungrazed range and on a range utilized about 50%, and to isolate the influence of mulch alone on forage production without introducing the complex effects incident to prolonged protection.

Because of the uniform density and highly homogeneous composition of closely grazed Kentucky bluegrass ranges such as this, it is considered that the rather small sample plots were reasonably adequate. On most bunchgrass ranges it is probable that a greater number of much larger sample plots would be needed.

Method of Study

Beginning in the spring of 1945 forage was clipped from sample plots on the open range and in the protected and moderately grazed areas. Clippings were made annually about June 1. This corresponds with the beginning of the grazing season. These clippings were repeated on other plots in the three areas toward the end of October or first of November each year, or following the close of the grazing season. Also, additional clippings were made at this time in temporary hurdle plots on the open range and in the moderately grazed area. The hurdle plots were moved each spring. It was assumed that the difference in weight between forage clipped in the hurdle plots and on the grazed range represented the amount of forage utilized by cattle during the summer. There is strong support for this approach, as determined by other studies (*5*). Density estimates were made in 1948 by use of the step-point method (*4*). Seed stalk heights were measured each spring and in October 1948.

One half of each of two mulch plots—one full-mulch and one half-mulch—was clipped on June 6, 1948. A similar untreated check plot in this exclosure was also clipped. The other halves of these two mulch plots and another check plot were clipped on October 22, 1948. One mulch plot for each treatment was left unclipped for future studies of cumulative effects.

All clippings were airdried, weighed, and weights converted to pounds per acre.

Results of Study

The perennial grass production for June 1 and November 1 of each year, and forage residue on November 1 on the two grazed areas, are shown in table 1.

By substracting the amount of forage left on the open and moderately grazed ranges from the amount clipped from the respective check plots, annual utilization may be computed. Figured this way, utilization on the open range varied from 61% to 79% with a 4-year average of 71%. Presumably, this represents the limit to which cattle will graze a concentration area of Kentucky bluegrass where

they have access to other forage on steep, rough slopes. Utilization on the moderately grazed range varied from 47% to 65% with a 4-year average of 57% (fig. 1). Each year more forage was grazed in the moderately used plot than was produced on the open range. Also, the amount left at the end of the season was nearly as much as that produced on the open range.

It will be noted that the half-mulch plot by the end of the season had produced 42% more forage, and the full-mulch plot 50% more than the untreated check plot (table 2). Forage production on the moderately grazed and protected plots in 1948 was 113% and 147% greater, respectively, than that on the open range (table 1).

Summer growth is considered especially important on ranges since it determines the amount of available green, nutritious, palatable forage throughout the actual grazing season (*2*). Since records were secured at the beginning and end of the summer grazing season, it was possible to measure the amount of growth made during summer. Figures obtained on summer production are shown in tables 1 and 3.

Other investigators have shown that organic mulch very greatly increases the ability of soil to absorb and retain water (*1, 6*). The impressive response of closely grazed Kentucky bluegrass following the application of mulch suggests that improved soil moisture conditions may have had a strong influence on forage production, especially during the summer. However, contrary to expectation, the full-mulch plot made somewhat less summer growth than the half-mulch plot. Similarly, in 1948 the protected plot made proportionately less summer growth than did the moderately grazed plot, although this was not true during the preceding three years (table 3).

TABLE 1

Production of perennial grass forage

Pounds per acre, airdry weight

	1945		1946		1947		1948		4-YR. AVERAGE	
	June	Nov.	June	Nov.	June	Nov.	June	Nov.	June	Nov.
Open range	346	144	192	128	408	264	515	120	365	164
check plot	—	529	—	512	—	673	—	564	—	569
Moderately grazed	634	384	625	480	793	769	841	420*	723	513
check plot	—	1009†	—	1057	—	1442	—	1201	—	1177
Protected plot	673	1442	1033	1730	865	1922	1009	1393	895	1622

* Undetermined amount of trespass grazing.

† Second full season of protection.

An explanation of the reduced summer growth under full-mulch in 1948 may be suggested by the Estes Park precipitation records. In 1947 precipitation occurred on 61 days for a total of 16.58 inches, and in 1948 on 35 days for a total of 5.28 inches during the period May 1 to October 31. During 1947 there were 26 days when precipitation exceeded .2 inch and 11 days when it exceeded .5 inch. In 1948 precipitation exceeded .2 inch on 9 days and on no day did it exceed .5 inch. Thus, 1947 was characterized by well distributed storms yielding high precipita-

tion and frequently extending over 3 to 7 days. In 1948 precipitation was also very well distributed, but it consisted of repeated very light showers seldom extending beyond two-day periods. It is, therefore, suggested that during dry weather with light scattered showers, heavy mulches intercept more precipitation and result in greater evaporation than lighter mulches. This tends to retard the growth of forage.

Perennial grass density, as estimated by the step-point method (*4*), was 24% on the open range, 40% in the moderately grazed plot, and 62% in the protected plot. The protected plot contains an almost pure stand of Kentucky bluegrass, although Canada bluegrass (*Poa compressa*) is increasing noticeably. Only isolated plants of fringed sagebrush re-

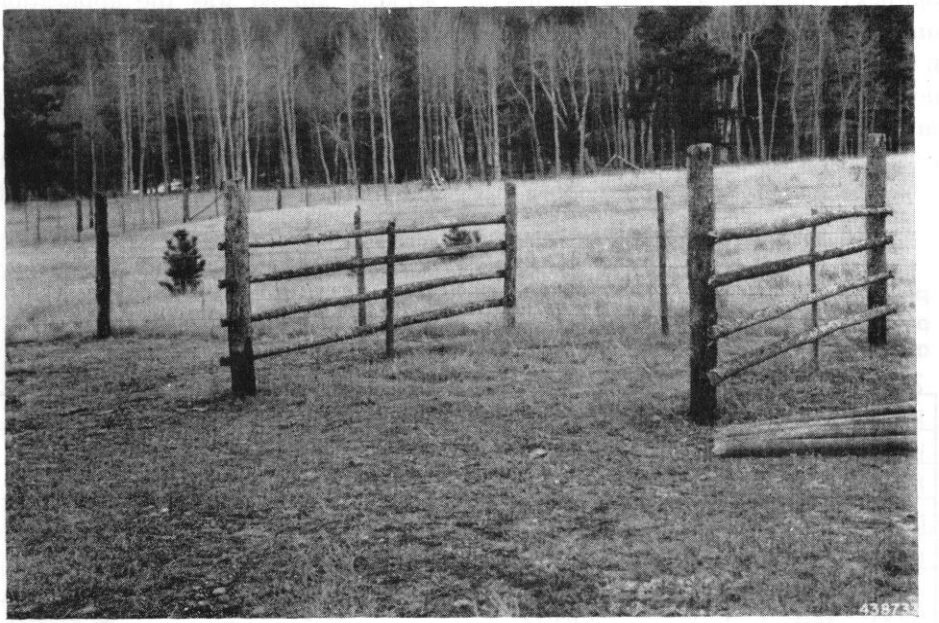

FIG. 1. MODERATELY GRAZED RANGE IN FOREGROUND WITH 384 POUNDS OF FORAGE PER ACRE REMAINING

Area beyond fence protected 4 years with production of 1442 pounds per acre. Roosevelt National Forest, November 16, 1945.

TABLE 2

Effect of mulch on forage production

Pounds per acre, airdry forage

	JUNE 6, 1948	OCTOBER 22, 1948
Check plot	481	577
Half-mulch	529	817
Full-mulch	625	865

TABLE 3

June 1–October 31

Summer forage growth expressed as percentage of total annual growth

	4-YEAR AVERAGE	1947	1948
	%	%	%
Open range	36	39	9
Moderately grazed plot	39	45	30
Protected plot	45	55	28
Untreated mulch check	—	—	17
Half-mulch plot	—	—	36
Full-mulch plot	—	—	28

main. The vegetation in the moderately grazed plot is predominantly Kentucky bluegrass but fringed sagebrush is present in fair amount as large, vigorous plants. Kentucky bluegrass seed stalk heights on June 1 averaged 2.2, 4.4, and 6.3 inches on the open range, moderately grazed plot and protected plot, respectively, for the four years. Comparable heights on October 22, 1948, were 10, 13, and 16 inches n the three areas.

and mulch aid in providing more summer growth.

In the artificial mulch phase of the study the only factor which was consciously altered was the application of grass mulch to a closely grazed range. Since there was close correlation between spring and summer seasonal growth patterns on the ungrazed and moderately grazed plots compared with the full-mulch and half-mulch plots, it is concluded that

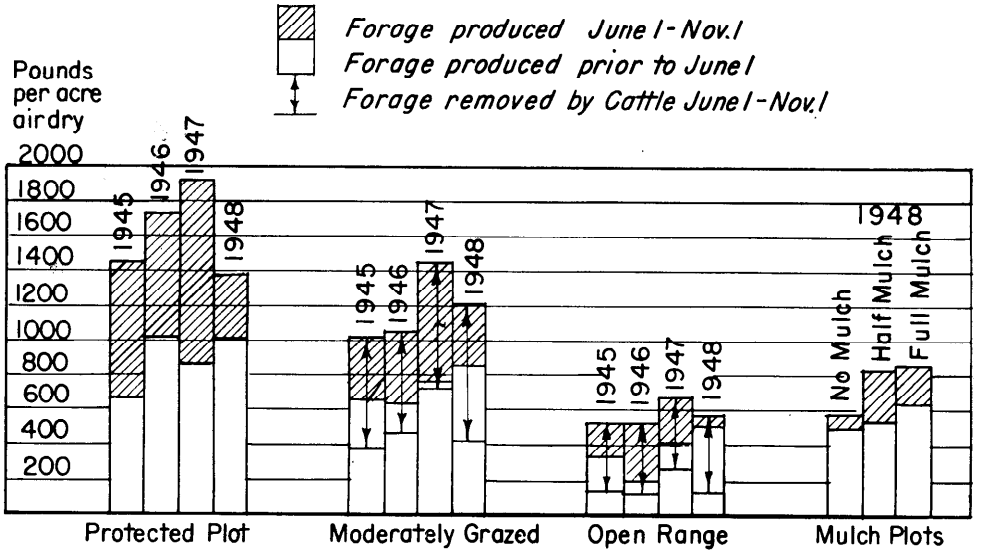

FIG. 2. GRAPHIC PRESENTATION OF DATA IN TABLES 1, 2, AND 3

DISCUSSION

Except under total protection and in very favorable years, less than 50% of total growth takes place during the summer growing season (table 1). Thus, if the objective is 50% utilization, considerable use must be made of the backlog of early spring growth. It appears that good management should provide for a large volume of forage on the range before grazing begins. If growth prior to June 1 is harvested as it develops, summer growth will be less and plans must provide for fewer cattle to harvest the forage crop. The study shows that both lighter use mulch has a major effect on the volume of forage produced, and especially on the important summer forage production. The relatively higher percentage increases in total production on the ungrazed and conservatively grazed ranges as contrasted with the two rates of mulch application is thought to be due to the cumulative effects of several years non-grazing and light grazing, on the plants, on soil and on microclimate, as well as on the continued accumulation of mulch. A comparison of spring growth and summer growth for the three treatments suggests that the effect of prolonged protection or

light use is reflected, principally, in increased spring growth, while mulch may be the principal factor accounting for increased summer growth (fig. 2).

Costello and Turner found that moderate grazing, especially during drought, may result in higher densities than no grazing (*3*). They assign the probable cause to reduction in leaf surface area, lower transpiration rates, and a decreased demand on soil moisture on the grazed range. The present study suggests that the effect of medium and heavy organic mulches in intercepting and dissipating light scattered precipitation may also be an important factor.

This study does not indicate that a light mulch resulting from moderate grazing is more beneficial than a heavy mulch, nor does it indicate that moderate grazing will result in faster range recovery than complete protection. The full-mulch application resulted in considerably more spring growth and also in greater total annual growth than the lighter mulch. Similar results are reflected in forage production in the protected and moderately grazed plots. These results point very sharply to the importance of organic mulch as a major influence in range forage production and indicate that this factor may be fully as important as the physical effects of various rates of grazing on individual plants.

Summary

This study compares total annual as well as spring and summer forage production on heavily grazed, moderately grazed, and ungrazed Kentucky bluegrass range. Also, forage production on heavily grazed range is compared to that on similar areas on which moderate and heavy artificial grass mulches were applied.

A range utilized 57% over a four-year period produced an average of twice as much forage as one utilized 71%. A plot which was ungrazed for seven years produced nearly three times as much forage as an adjacent heavily grazed range. On grazed ranges 55% to 91% of the annual forage growth was produced prior to June 1. As the intensity of grazing decreased, relative summer forage production increased. It is concluded that heavy spring grazing would have been especially detrimental to this range. On the moderately used range more forage was grazed each year than was produced on the heavily grazed range. In addition, nearly as much forage was left on the moderately used range as the heavily grazed range produced each year.

The application of light and heavy mulches to heavily grazed range increased annual forage production 42% and 50%, respectively, the first year. Summer forage growth, however, was somewhat less under full-mulch than under half-mulch. It is concluded that organic mulch such as accumulates naturally on a moderately grazed or ungrazed range may be the most important factor influencing the important summer forage production. It is suggested that during an exceptionally dry summer a heavy mulch may dissipate light precipitation and may result in slightly less summer forage growth. Because of greater total annual growth, a heavy mulch is considered most effective in hastening range recovery, even during very severe drought years.

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