Evaluation of Range and Meadow Forages at Various Stages of Maturity and Levels of Nitrogen Fertilization[1/]

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Various chemical analyses have been used extensively in evaluating different forages for ruminant animals. In many cases, however, chemical analyses do not reflect the degree to which a forage will be digested by the animal. To determine digestibility of the many forages as they change with stage of maturity and with environmental influences by conventional digestion trials would be a costly and cumbersome process.

In recent years animal workers have become increasingly aware that the performance of the ruminant animal is directly related to the performance of rumen bacteria. Consequently, many studies on ruminant nutrition now emphasize the nutrition of the rumen bacteria themselves. The development of artificial rumen techniques has greatly facilitated these investigations. Although the artificial rumen technique has been primarily used in studying the nutritional requirements and metabolism of rumen micro-organisms, several workers have reported close correlations in the digestibility of forage cellulose between in vitro and in vivo methods (Hershberger et al., 1959; Quicke et al., 1959; LeFevre and Kamstra, 1960; and Taylor et al., 1960). In general, data reported by these workers indicated that in vitro cellulose digestion of a forage could be a very useful index to its nutritive value.

The objectives of this paper were to study the in vitro cellulose digestibility of six range grasses clipped at various dates and to study the in vitro cellulose digestibility of native meadow hay as influenced by date of harvest and rate of nitrogen fertilization.

PROCEDURE

Samples of bluebunch wheatgrass (Agropyron spicatum (Pursh) Scribn.), squirrel-tail (Sitanion hystrix (Nutt.) J. G. Smith), Idaho fescue (Festuca idahoensis Elmer), Junegrass (Koeleria cristata (L.) Pers.), Thurber's

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1/The range portion of this study is a contribution from regional research project W-34.

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3/Jointly operated by the Oregon Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, USDA.

Technical paper No. 1426, Oregon Agricultural Experiment Station.

needlegrass (Stipa thurberiana Piper), and crested wheatgrass (Agropyron desertorum (Fisch.) Schult.) were collected at 6 dates during the summer of 1959 and at 5 dates during the summer of 1960. The samples were all collected at the Squaw Butte summer range.

Native meadow hay samples were harvested at 6 dates from plots fertilized with 0, 80, 160, 240, and 320 pounds of nitrogen per acre. The treatments were replicated 3 times giving a total of 90 samples. Hay samples were collected from the native flood meadow of the Squaw Butte Station during the summer of 1960.

All samples were analyzed for cellulose content by the method of Crampton and Maynard (1938). In vitro cellulose digestion was determined according to procedures described by Hubbert et al. (1958) except that the fermentation period was extended to 48 hours (LeFevre and Kamstra, 1960). Three Hereford steers maintained on a growing ration and fitted with permanent rumen fistulas were used to supply rumen micro-organisms for the in vitro fermentation studies.

RESULTS AND DISCUSSION

In vitro cellulose digestibility for the various range grasses was not materially influenced by date of sampling until after the June 2 date (table 1). After June 2 cellulose digestibility generally decreased with each later sampling. However, during 1959 cellulose digestibility was essentially the same on the July 1 and July 15 dates. Kamstra et al., (1958) reported that in vitro cellulose digestion decreased with increasing plant maturity. These workers also found a negative relationship between lignin content in plants and in vitro cellulose digestion.

Junegrass was usually higher and Idaho fescue was generally lower than other species in cellulose digestibility (table 1). The mean digestibility for each of the grasses during each summer period along with the tests for significance are shown in table 1. Year differences between both species and sampling dates were negligible.

The mean cellulose content of the 6 range grasses studied increased from 23.9% at the earlier clipping date to 30.5% at the later clipping date. The cellulose content was slightly higher during 1960 as compared to 1959. On the other hand, the mean crude protein content of the grasses was slightly higher during 1959 than in 1960. The mean crude protein-content of the grasses decreased from 19.0% at the first sampling date to 5.8% at the last date of sampling.

In vitro cellulose digestion in native meadow hay increased when the date of harvest was delayed from May 4 until May 18, and then declined with each later date of harvest (table 2). Cellulose digestion was lower ($P < 0.05$) at the 240 and 320 pound levels of nitrogen fertilization as compared to the 0, 80, and 160 pound levels. In conducting in vitro studies with several forages fertilized with various rates of nitrogen, Hopkins et al. (1960) found that microbial activity decreased as the level of nitrogen fertilization increased. Further analyses by these workers indicated that the increase in nitrate content in the fertilized forages was the factor which inhibited microbial activity.

The cellulose content of native meadow hay increased and crude protein decreased with date of harvest (figure 1). Nitrogen fertilization increased crude protein and decreased the cellulose content in native hay up to the 240 pound rate (figure 2). The cellulose content of hay fertilized with 320 pounds of nitrogen was essentially the same as that receiving 0 and 80 pounds of nitrogen. Experiments conducted by Rumburg and Cooper (1961) showed that the botanical composition of native meadows composed chiefly of rush and sedge could be changed to grass with high rates of nitrogen fertilizer. A change in botanical composition of the hay occurring at the 320 pound level of nitrogen fertilization could partially explain the variation in cellulose content noted at higher rates of fertilization in this study.

Table 1. In vitro cellulose digestibility of various range grasses as influenced by date of sampling during two summer periods[1/]

Year & date of sampling	Specie						
	Idaho fescue	Bluebunch wheatgrass	Squirrel-tail	Thurber's needlegrass	Crested wheatgrass	Junegrass	Mean[2/]
	%	%	%	%	%	%	%
1959							
4/30	62.0	72.6	72.2	68.7	76.3	74.0	71.0[a]
5/18	65.2	66.6	69.2	68.5	68.3	71.2	68.2[a]
6/2	57.3	62.4	74.0	66.8	68.3	69.9	66.4[a]
6/16	47.2	55.2	59.4	61.5	72.2	66.4	60.3[b]
7/1	45.5	46.5	52.3	57.2	53.0	61.4	52.6[c]
7/15	52.0	37.2	62.6	62.7	48.0	60.7	53.9[c]
Mean[2/]	54.9	56.7	65.0	64.2	64.3	67.3	
1960							
5/11	64.7	71.8	70.0	65.6	74.0	76.8	70.5[a]
5/23	61.4	66.1	70.9	71.8	69.7	71.2	68.5[a]
6/2	61.7	70.5	71.9	71.4	73.3	76.8	70.9[a]
6/16	45.4	50.5	58.7	59.4	65.0	58.3	62.2[b]
8/5	45.6	43.7	52.2	57.9	48.1	63.6	51.8[c]
Mean[2/]	55.8	60.5	64.7	65.2	66.0	69.3	

1/ All values are the average of two determinations.

2/ Means underscored by the same line or with same superscript letters are not significantly different ($P<0.05$).

Table 2. *In vitro* cellulose digestibility of native meadow hay as influenced by date of harvest and rate of nitrogen fertilization[1/]

Date of harvest	Rate of N					Mean[2/]
	0	80	160	240	320	
	%	%	%	%	%	%
May 4	73.6	66.0	72.6	65.6	67.0	69.0[a]
May 18	74.6	67.3	77.5	73.7	75.3	73.7[b]
June 6	73.5	69.2	70.6	60.3	65.6	67.8[a]
June 15	65.1	70.7	68.6	58.2	60.3	64.6[c]
June 29	61.7	63.7	58.2	50.2	51.6	57.1[d]
July 13	59.5	62.4	53.7	48.5	51.2	55.1[e]
Mean	68.0	66.6	66.9	59.4	61.8	

1/ Each value represents the mean of three replications.

2/ Means underscored by same line or with same superscript letters are not significantly different ($P < 0.05$).

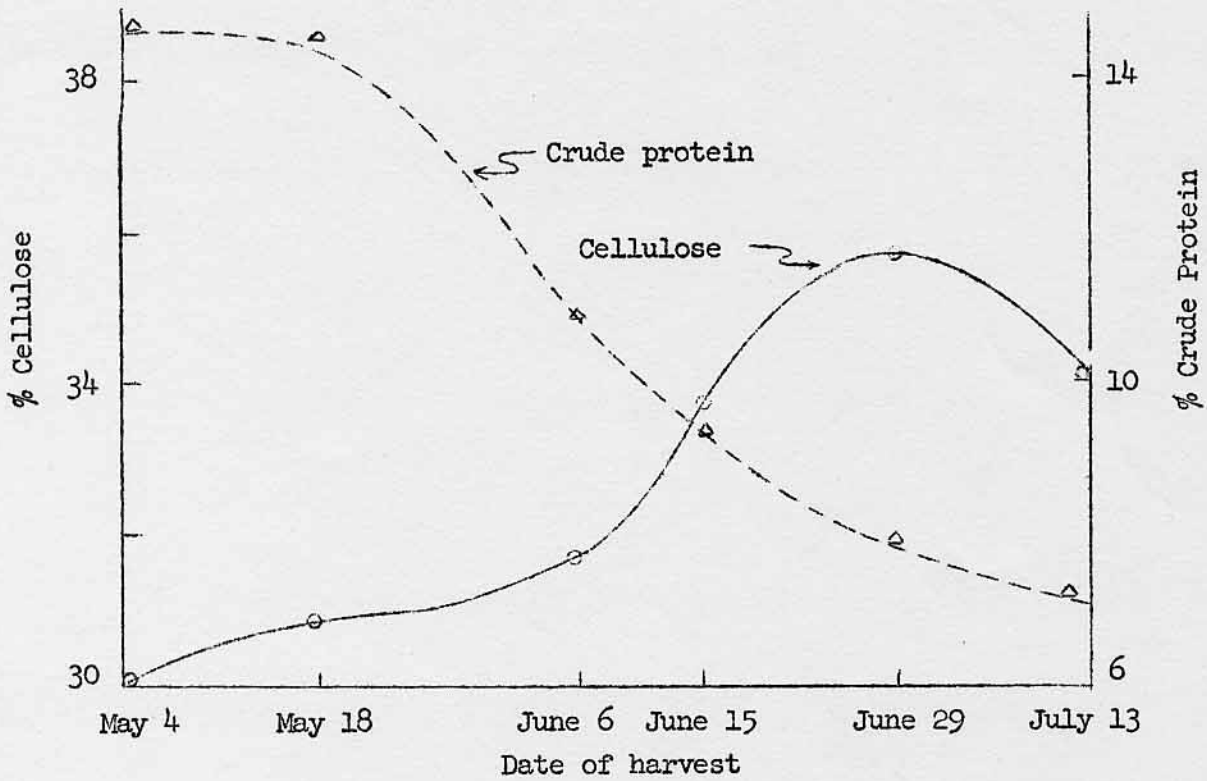

Figure 1. Cellulose and crude protein contents of native meadow hay as influenced by date of harvest.

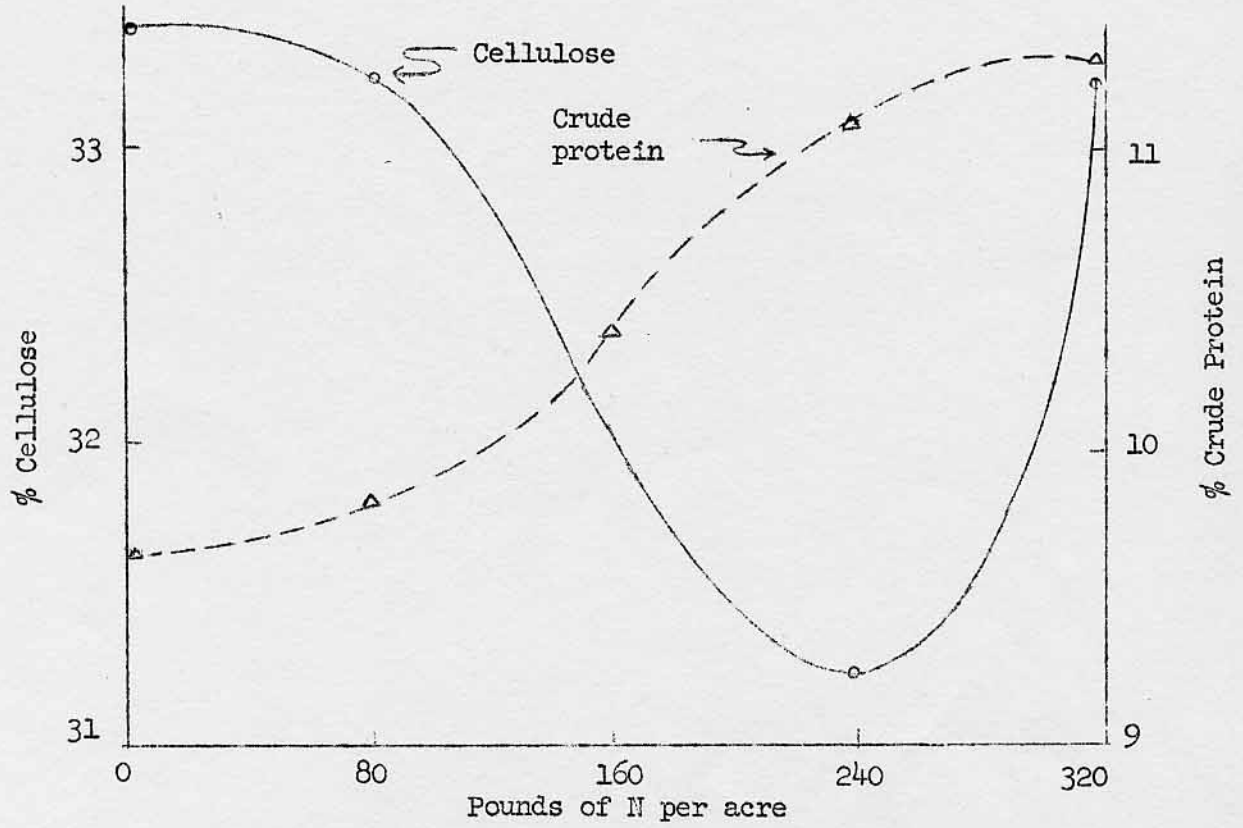

Figure 2. Cellulose and crude protein contents of native meadow hay as influenced by rate of nitrogen fertilization.

SUMMARY

In vitro cellulose digestibility, forage cellulose content, and crude protein values were determined on samples of 6 range grasses sampled at various dates and on meadow hay samples harvested at 6 dates of maturity with 5 rates of nitrogen fertilization.

Cellulose content increased while crude protein values and cellulose digestion decreased with plant maturity in both range and meadow forages. Certain range species were digested at a higher rate than others.

High rates of nitrogen fertilization (240 and 320 pounds of N per acre) depressed in vitro cellulose digestion in meadow hay. Crude protein increased while the cellulose content varied with increasing rates of nitrogen fertilization.

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