AUM. These discrepancies in AUMs, when calculated to apply to extensive acreages, could mean substantial loss in AUMs or serious overgrazing. Forbs and shrubs indicated less striking variations. Only the unshaded forbs on southern aspects resulted in a 0.6 AUM difference over and above every AUM derived by the agency formula. The agency formulae gave slightly higher values than our improved formulae for sagebrush.

LITERATURE CITED


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Maturity Studies with Western Wheatgrass

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Highlight

Leaf class (number of leaves per plant) and cutting date were considered as indices of maturity of western wheatgrass. Although some early-season effects of leaf class could be demonstrated, cutting date was a better measure of stage of maturity. Cutting date but not leaf class was shown to affect plant fractions and chemical components. The upper portion of the plant was more digestible than the basal portion. No digestibility effect was demonstrated for topographic location or leaf class. Leaf blades removed from plants under heavy grazing were more digestible in vitro than those from lightly-grazed pastures, probably because of later emergence or shorter height.

The nutritional value of a forage appears to be greatly influenced by factors which either cause or accompany plant maturity. The relationship of lignification to maturity and plant digestibility has been extensively studied (Crampton and Maynard, 1958; Patton and Giescker, 1942; Steppler, 1951; Kamstra et al., 1958; Sullivan, 1959). Much less emphasis has been given to the effect of range site, range condition, and relative plant size on lignification, digestibility, and animal utilization. For such studies a method of determining plant maturity becomes necessary. The usual definition of maturity stage by reference to boot, flowering, or seed stalk production cannot be used consistently with range grasses because many of them produce seed only during favorable years. This is especially true of grasses such as western wheatgrass (Agropyron smithii Rydb.), which are not dependent upon seed for reproduction.

This paper considers leaf class and cutting date as indicators of stage of maturity as measured by in vitro cellulose digestibility. The effect of age of tissue on in vitro cellulose digestibility was studied by analyzing upper and lower portions of the plant separately. Individual leaves also were separated according to time of development and analyzed separately.

Experimental

The sampling areas for the 1961 collections of western wheatgrass were located at the Cottonwood Range Field Station 75 miles east of Rapid City. In 1962 additional areas were sampled at the Cottonwood Range Field Station, the Antelope Range 15 miles southeast of Buffalo, and a small prairie area seven miles west of Pierre. Table 1 provides additional information relative to the 1962 collection areas.

In Vitro Cellulose Digestibility.—Sample collections of western wheatgrass were made in 1961 from clayey upland in lightly and heavily grazed pastures in good and poor range condition, respectively, at the Cottonwood Range Field Station. The samples were hand-cut by leaf class (number of leaves per plant) from temporary exclosures on May 11, June 9, and July 14. The leaves were removed from the stem and numbered from the bottom leaf. Sam-
Table 1. Description of range collection areas for western wheatgrass.1

<table>
<thead>
<tr>
<th>Item</th>
<th>Antelope Range Field Station</th>
<th>Cottonwood Range Field Station</th>
<th>Pierre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation (in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ave. annual 13.1</td>
<td>15.1</td>
<td>16.0</td>
<td></td>
</tr>
<tr>
<td>Growing season (Apr.–Sept.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>9.9</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1962</td>
<td>11.4</td>
<td>18.4</td>
<td></td>
</tr>
<tr>
<td>Topographic position</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>upland</td>
<td>run-in</td>
<td>upland</td>
<td>run in</td>
</tr>
<tr>
<td>Range soil group2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>silty</td>
<td>overflow</td>
<td>clayey</td>
<td>overflow</td>
</tr>
<tr>
<td>Range condition2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>good</td>
<td>good</td>
<td>good</td>
<td>excellent</td>
</tr>
<tr>
<td>fair</td>
<td>fair</td>
<td>poor</td>
<td>poor</td>
</tr>
</tbody>
</table>

1There were two replications in each range condition class in each range soil group at each location.
2Range site and range condition were classified according to Soil Conservation Service (1961).

Results and Discussion

Effect of Cutting Date, Grazing Rate, and Blade Position on In Vitro Cellulose Digestibility.—The digestibility of blades 2 and 3 from three-leaved plants cut May 11, 1961 from temporary exclosures in heavily grazed pastures in poor range condition and lightly grazed pastures in good range condition at Cottonwood were compared with the same blade positions on four-leaved plants cut from the same areas on June 9 (Fig. 1). Blades from the May cutting were more digestible than those from June (67.8 vs. 54.9%, P < .01). Blades from heavily grazed pastures were more digestible than those from lightly grazed pastures (56.4 vs. 46.4%, P < .05). The reason for this difference may be that the plants in heavy grazing emerged later and were thus younger or that they were smaller and thus contained less structural material. The younger leaf blade 3 was more digestible than the older leaf blade 2 (60.4 vs. 42.3%, P < .01). The mean squares for interaction were small and were not significant (standard error of the mean, 4.4%).
The digestibility of blades 2, 3, and 4 cut from four-leaved plants in heavy and light grazing at Cottonwood July 9 were compared with the same blade positions from five-leaved plants cut on the same areas at the same date (Fig. 1). A missing value was calculated for blade 2, five-leaved plant, poor range condition (heavy grazing), replication 2 by the method described by Snedecor (1956). Values for blade 2, five-leaved plants are not shown. The top range condition × blade interaction was highly significant (P < .01). In heavy grazing the younger leaves were more digestible, whereas in light grazing the youngest leaf was least digestible. This difference may have been due to death of the terminal shoot which was observed on some plants in light grazing. The cause of death of these terminal shoots was not determined. Blades from heavy grazing were more digestible than those from light grazing (57.2 vs. 44.3%, P < .01). Blades from leaf class five plants appeared to be more digestible than those from leaf class four (55.5 vs. 45.9%). This difference was significant (P < .01) when tested with the pooled error term, but was not significant when tested with the rep × treatment interaction with only 1 degree of freedom for treatment and 1 for error. Likewise, the two younger leaf blades, 3 and 4, (51.2 and 55.2%, respectively) appeared to be more digestible than older leaf blade 2 (45.8%). While these differences were significant (P < .05) when tested with the pooled error term, they were not significant (P < .01) when tested with the rep × treatment interaction with 2 degrees of freedom for treatment and 2 for error. More than two replications were clearly needed to adequately test the leaf class and leaf blade effects. In general, the younger and smaller plants or plant parts were more digestible than older and larger plants or plant parts.

Effect of Plant Portion on In Vitro Cellulose Digestibility.—The digestibility of the top halves of plants cut from shallow clay uplands near Pierre in excellent range condition and from uplands and run-in locations at Antelope Range in August, 1962 were compared with the bottom half of the same plants (Fig. 2). The tops were more digestible than the basal portion (68.5 vs. 50.5%, P < .05). The standard error of the mean was 3.9%. Grazing livestock generally select the upper portion of western wheatgrass plants, especially later in the season.

Effect of Range Site, Range Condition, Sampling Date, and Leaf Class on In Vitro Cellulose Digestibility.—The digestibility of western wheatgrass vigor classes separated into leaf numbers is shown in Fig. 3. Leaf numbers 3, 4, and 5 were collected on July 9 and leaf numbers 6, 7, and 8 were collected on September 12, 1962, from the Antelope Station. Least square means were 60.8% for July and 43.3% for September (P < .01). Differences due to topographic position, range condition, and leaf number were not significant. None of the two-factor interactions were significant. When digestibility of western wheatgrass plants from the same topography, source, vigor class, and leaf numbers was compared by cutting date, the plants became progressively less digestible from June 10 to September 12 (Fig. 4).

Comparison of Carbohydrate Composition, Lignin, Protein, and Ash by Cutting Date and Leaf Class.—With cutting date as the measure of maturity, lignin and cellulose increased, whereas protein and ash decreased as the plants matured. The lignin content approached a value equal to approximately half the cellulose as the growing season progressed (Fig. 5). The only indication that number of leaves per plant was a measure of plant maturity appeared in the June collection. In this collection protein decreased and lignin increased as number of leaves on the plant increased. As such a trend did not appear in any subsequent col-
Fig. 4. Comparison of the in vitro cellulose digestibility of western wheatgrass at different cutting dates collected from the same location, vigor class, and with one leaf class (5 leaves/plant).

lection, the data for Fig. 5 were pooled for leaf classes from each collection. The yield of holocellulose and hemicellulose was higher in July than at other dates. This agrees with the results of Routley and Sullivan (1958) for grass holocellulose. Their work suggested that grass in the flowering stage was higher in holocellulose yield than at the boot stage. Western wheatgrass usually flowers during the third or fourth week of June if flowers are produced. Cellulose also increased in July, which is consistent with the findings of Phillip et al. (1954), who noted an increase in both true and natural cellulose up to the flowering stage in some grasses. The relative proportion of cellulose to hemicellulose did not change markedly with plant maturity (Tomlin et al., 1965).

Comparison of Neutral Sugar Components of Hemicellulose by Cutting Date and Leaf Class.—The neutral sugar components of western wheatgrass hemicellulose were found to be xylose, arabinose, glucose, galactose, and trace amounts of rhamnose at all cutting dates (Fig. 6). Sullivan et al. (1960) noted the presence of minor amounts of rhamnose in the hemicellulose fraction of several grasses. No consistent effect of leaf class on sugar content was noted and similar values resulted when each sugar was totaled for all cutting dates by leaf class. For example, xylose was shown to comprise 34.5, 35.5, 35.5, and 34.8% of the total sugars with 5, 6, 7, and 8 leaved plants, respectively. As indicated in Fig. 6, the quantity of individual sugars was affected by cutting date, however, the same sugars were present in all collections. The same hemicellulose sugars were also present in each leaf class. Xylose was the principal sugar in all preparations followed by arabinose, glucose, and galactose. The amount of arabinose in western wheatgrass hemicellulose decreased while glucose increased.

Fig. 5. Chemical components of western wheatgrass at different cutting dates.

Fig. 6. Neutral sugar components of western wheatgrass at different cutting dates.
Tolerance of Subclover, Rose clover, Hardinggrass, and Orchardgrass to 2,4-D

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Highlight

Species commonly used to seed California rangelands were sprayed with varying rates of the alkanolamine salt of 2,4-D at a number of vegetative growth stages in two different years. Subclover, Hardinggrass, and orchardgrass were not permanently damaged by rates up to 2.0 lb/acre at any of the growth stages tested. Rose clover was tolerant of up to 0.5 lb/acre if sprayed at the proper growth stage but yields were frequently reduced by even lower rates at other growth stages.

Much of the range improvement in the grasslands of cismontane California below 3,000 ft elevation involves the seeding of subclover (Trifolium subterraneum L.), rose clover (T. hirtum All.), and hardinggrass (Phalaris tuberosa L. var. stenoptera (Hack.) Hitchc.). These plants are sown alone or in mixtures to replace the well established, but less productive, annual vegetation. The resident annuals produce an abundance of seed and invariably result in an extremely weedy seedbed in spite of the best preparation. Although many of these annual weeds are grasses, the weeds in a new seeding on a seedbed prepared by cultivation are often predominantly broadleaves. Common among these are mustard (Brassica spp.), radish (Raphanus spp.), yellow star thistle (Centaurea solstitialis L.), filaree (Erodium spp.), and fiddleneck (Amsinckia spp.). There is a need for a selective herbicide to control these weeds.

The reaction of rose clover to 2,4-D (2,4-dichlorophenoxyacetic acid) was demonstrated by Williams and Leonard (1959). Both the propylene glycol butyl ether ester of 2,4-D and the alkanolamine salt of 2,4-D, applied at the rosette, early bud, and early bloom stages, caused significant reduc-