Evaluation of Four Intermediate Wheatgrass Populations under Grazing

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ABSTRACT

The grazing season in the central and northern Great Plains could be extended by use of adapted cool-season grass pastures for spring and fall grazing to augment the native warm-season range. A grazing trial was conducted to evaluate the forage quality of four intermediate wheatgrass [Thinopyrum intermedium (Host) Barkw. & D.R. Dewey] populations for use in forage–livestock systems. The cultivars Slate and Oahe and two populations selected for improved IVDMD, 'Manska' and NE TI 1, were evaluated. Each population was seeded in the fall of 1987 in three replicated 0.4-ha pastures arranged in a randomized complete block design. Pastures were stocked with three beef yearlings for 28 d in spring 1989 and 42 d in spring 1990 to provide a stocking rate of 7.5 steers ha⁻¹. Duration of grazing was shorter in 1989 because of inadequate soil moisture. Average daily gain (ADG) and gain per hectare were higher (P < 0.10) in 1989 than 1990, despite the lower (P < 0.10) forage availability and lesser number of grazing days in 1989. Steers grazing Manska in 1989 gained 1.59 kg d⁻¹, compared with 1.42, 1.27, and 1.43 for Oahe, Slate, and NE TI 1, respectively. There were no differences (P > 0.10) in ADG or gain per hectare among populations in 1990. The improvement in ADG resulted in 30 to 65 kg more gain per hectare from Manska compared with the other populations in 1989. These results demonstrate the excellent quality of intermediate wheatgrass for grazing livestock and the impact that modest improvements in forage quality can have on animal performance.

INTERMEDIATE WHEATGRASSES [Thinopyrum intermedium (Host) Barkw. & D.R. Dewey] are cool-season perennial grasses that are becoming increasingly important as hay and pasture grasses throughout much of the central and northern Great Plains of the USA and prairie provinces of Canada (Asay and Knowles, 1985). The species has both glabrous (subsp. intermedium) and pubescent (subsp. barbulatum) types, which are known as intermediate and pubescent wheatgrass, respectively. In the central Great Plains where the native rangeland is comprised primarily of warm-season grasses, intermediate wheatgrass is best utilized for spring and fall grazing in a complementary system with native rangeland. Intermediate wheatgrass can provide high quality forage for beef cows (Bos taurus L.) with calves and yearling cattle. It matures at a slower rate than crested wheatgrasses [Agropyron cristatum (L.) Gaertn. and A. desertorum (Fisch. ex Link) Schult.], which are also adapted to this region (Asay and Knowles, 1985). Intermediate wheatgrass has produced higher yields than crested wheatgrass in Nebraska when precipitation exceeded 380 mm (Vogel et al., 1987).

Intermediate wheatgrass is used predominantly as a pasture grass, but no previous research has compared intermediate wheatgrass populations in terms of relative animal performance and productivity. Evidence of differences among populations for IVDMD has been documented. Wurster et al. (1971) reported significant differences in IVDMD between forage of 'Oahe' and 'Greenleaf' intermediate wheatgrass. Vogel et al. (1986) reported substantial genetic variability for IVDMD among intermediate wheatgrass germplasm accessions evaluated in space plantings. In a subsequent study, 34 populations were evaluated in sward plots at three central Great Plains locations, representative of the climatic diversity of the region, to determine the relative magnitude of genotype and genotype × environment interaction effects for forage yield and IVDMD (Vogel et al., 1993b). There were differences among populations for these traits. Genotype × location interaction effects were significant for forage yield, but were not significant for IVDMD, indicating that this trait is stable over environments. Though forage yields were not as consistent as IVDMD, some strains ranked consistently in the top one-third.

The overall objective of this experiment was to determine if two intermediate wheatgrass populations selected for high IVDMD produce superior animal gains and beef production per hectare when grazed by beef yearlings as compared with the two intermediate wheatgrass cultivars currently being used in the central Great Plains. Specific objectives were (i) to determine if there are differences in IVDMD and other measures of forage nutritive value among populations under grazing and (ii) to determine if observed differences in nutritive value among populations result in improved animal performance of growing steers.

MATERIALS AND METHODS

The populations evaluated included the cultivars Oahe, Slate, and Manska and the experimental population NE TI 1. Oahe was released by the South Dakota Experiment Station in 1961, and Slate was released jointly by the USDA-ARS and the Nebraska Experiment Station in 1969 (Hanson, 1972). These cultivars were selected for agronomic characteristics and are widely grown for forage throughout the central and northern Great Plains. Manska was selected out of Mandan 759, a pubescent strain selected from PI 16252 that has wide commercial use but has never been formally released as a cultivar (Berdahl et al., 1993). Manska was developed by the USDA-ARS at Mandan, ND, as a reselection of Mandan 759, which had become contaminated by outcrossing with other varieties and/or seed admixture. It was identified as having improved yield and IVDMD in field evaluations conducted at three locations in Nebraska in 1986 and 1987 (Vogel et al., 1993b). Manska was released by the USDA-ARS, USDA-SCS, North Dakota Agricultural Experiment Station, and the Agricultural Research Division, University of Nebraska (Berdahl et al., 1993). The experimental population NE TI 1, developed by K.P. Vogel, is based on six PI lines that had high yields and high IVDMD in replicated trials (Vogel et al., 1986, 1993b). Plants were selected from the six PI lines (PI 345586, 273732, 273733, 315353, 315067, and 315353).
For high IVDMD and forage yield and were polycrossed to produce NE TI 1, which was then increased another generation. IVDMD and concentrations of CP and NDF by NIRS using the protocol described by Windham et al., 1989. A subset of 60 samples collected from pastures were analyzed to determine significance were made at the 0.10 probability level. Coefficients were, respectively, 0.94, 2.05, and 2.25 for IVDMD; 0.99, 0.56, and 0.47 for CP; and 0.98, 1.29, and 1.66 for NDF.

Pastures were sampled on a weekly basis during the grazing period both years. Herbage mass was determined by clipping 0.74-m² subplots, and subsamples were collected for forage analyses. Samples collected from each pasture were composited, and 0.27-, 0.29-, and 0.23-g subsamples from each pasture were used for the calibration, validation, and independent determinations, respectively. Coefficient of determination ranged from 0.61 to 0.97 for calibration and from 0.71 to 0.97 for validation. Correlation coefficients for the independent set were, respectively, 0.94, 2.05, and 2.25 for IVDMD; 0.99, 0.56, and 0.47 for CP; and 0.98, 1.29, and 1.66 for NDF. Variance analysis was used to assess the statistical significance of these samples. Coefficients of variance were, respectively, 0.54, 0.23, and 0.17 for IVDMD; 0.69, 0.34, and 0.28 for CP; and 0.73, 0.40, and 0.38 for NDF.

Table 1. Dry matter yield and in vitro dry matter digestibility (IVDMD) of four populations of intermediate wheatgrass grown in yield trials near Mead, NE. Pastures were established in the fall of 1987 at the University of Nebraska Agricultural Research and Development Center near Mead on a Sharpsburg silty clay loam soil (fine, montmorillonitic, mesic Typic Argiudolls). The experimental design was a randomized complete block with six replicates. The test contained six populations, including the four subse-

<table>
<thead>
<tr>
<th>Population</th>
<th>1986 Dry Matter Yield (Mg ha⁻¹)</th>
<th>1987 Dry Matter Yield (Mg ha⁻¹)</th>
<th>Mean Dry Matter Yield (Mg ha⁻¹)</th>
<th>1986 IVDMD (%)</th>
<th>1987 IVDMD (%)</th>
<th>Mean IVDMD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oahe</td>
<td>5.3</td>
<td>8.3</td>
<td>6.8</td>
<td>559</td>
<td>649</td>
<td>604</td>
</tr>
<tr>
<td>Slate</td>
<td>5.3</td>
<td>8.2</td>
<td>6.8</td>
<td>549</td>
<td>645</td>
<td>597</td>
</tr>
<tr>
<td>NE TI 1</td>
<td>6.5</td>
<td>8.6</td>
<td>7.5</td>
<td>568</td>
<td>668</td>
<td>618</td>
</tr>
<tr>
<td>Synthetic 2</td>
<td>6.2</td>
<td>8.4</td>
<td>7.3</td>
<td>559</td>
<td>659</td>
<td>609</td>
</tr>
</tbody>
</table>

Small-Plot Verification Trial

Pastures were grazed in 1989 and 1990. Each spring, pastures were burned before grazing to remove any residual herbage from the previous season. Nitrogen fertilizer was applied when new growth began in the spring, at rates of 112 kg N ha⁻¹ in 1989 and 90 kg N ha⁻¹ in 1990. Pastures were grazed in 1989 and 1990. Each spring, pastures were burned before grazing to remove any residual herbage from the previous season. Nitrogen fertilizer was applied when new growth began in the spring, at rates of 112 kg N ha⁻¹ in 1989 and 90 kg N ha⁻¹ in 1990.

Pastures were grazed using similar stocking management as would be used by ranchers for complimentary systems with warm-season grasses. Pastures were grazed in 1989 and 1990. Each spring, pastures were burned before grazing to remove any residual herbage from the previous season. Nitrogen fertilizer was applied when new growth began in the spring, at rates of 112 kg N ha⁻¹ in 1989 and 90 kg N ha⁻¹ in 1990.

Forage samples collected from the small-plot experiment were subsequently reground in a cyclone mill fitted with a 1-mm screen to improve particle size. Forage samples collected from the small-plot experiment were subsequently reground in a cyclone mill fitted with a 1-mm screen to improve particle size.

Herbage production was limited throughout the 1989 grazing period by inadequate soil moisture (Fig. 2). No differences in herbage mass were observed among populations in 1989. Herbage mass was significantly greater in 1987. There were no differences detected among the populations for maturity (data not shown). Differences in herbage mass were observed among populations in 1989. Herbage mass was significantly greater in 1987. There were no differences detected among the populations for maturity (data not shown).
Fig. 1. Precipitation received at Mead, NE, in the months preceding during the 1990 grazing period (Fig. 2) than in 1989. At the initiation of grazing in 1990, approximately twice as much herbage mass was present than in 1989. Herbage mass was initially similar among populations in 1990, but began to decline more rapidly for the improved populations at 24 wk. Since the populations had similar yield potential in small plots, this decline was attributed to greater consumption by grazing livestock.

Fig. 2. Herbage mass of four intermediate wheatgrass populations grazed near Mead, NE, during 1989 and 1990.

Table 2. Average daily and total gains of steers grazing four populations of intermediate wheatgrass.

<table>
<thead>
<tr>
<th>Population</th>
<th>Average daily gain (kg d⁻¹)</th>
<th>Total gain (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oahe</td>
<td>1.42</td>
<td>294</td>
</tr>
<tr>
<td>Slate</td>
<td>1.27</td>
<td>221</td>
</tr>
<tr>
<td>Manska</td>
<td>1.59</td>
<td>329</td>
</tr>
<tr>
<td>NE TI 1</td>
<td>1.43</td>
<td>297</td>
</tr>
</tbody>
</table>

SES of the mean: 0.044 0.097 0.069

Average daily gains and gains per hectare during the 3-yr period were 1.3 kg d⁻¹ and 258 kg ha⁻¹, respectively. Although direct comparisons between the two studies cannot be made, the gains per animal and per hectare for crested wheatgrass were similar to those achieved in the present study. In the crested wheatgrass study, Ruff produced higher gains per hectare over the 3 yr of the study, due to better persistence. In the present intermediate wheatgrass trial, there were no differences in persistence among the populations. Basal cover was determined with an inclined 10-point frame at the beginning of the grazing period both years. There were no differences in basal cover (F² = 21.0; SY = 1.0) among populations or years.

Forage Nutritive Value

Few differences were observed in IVDMD, CP, or NDF among Slate, Manska, and NE TI 1 in 1989 (Fig. 3, 4, and 5); however, IVDMD and CP were lower, and NDF was higher, for Oahe than for the other cultivars throughout the grazing period.

There were few or no differences observed in IVDMD, CP, and NDF among any of the populations during the 1990 grazing period (Fig. 3, 4, and 5). An initial increase in IVDMD occurred during the first week of grazing in 1990, due to a flush of growth brought on by rain (Fig. 1 and 2). Digestibility of the forage at the beginning of the trial was lower than during the previous year.

Differences in animal performance between years were attributed primarily to the large differences in digestible energy of herbage mass as measured by IVDMD. Digestibility of all populations in 1989 was initially >800 g kg⁻¹ ...
Fig. 4. Crude protein concentration of available forage for four intermediate wheatgrass populations grazed near Mead, NE, during 1989 and 1990.

and declined linearly during the grazing period. In 1990, IVDMD of all populations was >700 g kg\(^{-1}\) at the initiation of grazing and also declined linearly with time, although at a slower rate than in 1989. Crude protein concentrations were initially high and remained above adequate levels for growth of yearling steers throughout the grazing period both years (NRC, 1984).

The differences in nutritive value between years can be explained by two factors, which are confounded: maturity of the forage at the initiation of grazing and the effect of drought which occurred in 1989. The negative relationship between maturity and forage quality is widely recognized (Lechtenberg and Hemken, 1985). In 1989, IVDMD of ungrazed forage declined at an average rate of 3.7 g kg\(^{-1}\) d\(^{-1}\). Assuming a similar rate of decline for 1990, IVDMD would be expected to be 44.4 g kg\(^{-1}\) lower at the beginning of the trial that year due to the delay in the initiation of grazing.

Water stress has been demonstrated to increase forage quality in cool-season grasses. Sheaffer et al. (1992) reported that moisture stress increased CP and decreased NDF concentrations in reed canarygrass (*Phalaris arundinacea* L.), smooth bromegrass (*Bromus inermis* Leyss.), orchardgrass (*Dactylis glomerata* L.), and timothy (*Phleum pratense* L.). Bittman et al. (1988) reported that water stress increased the IVDMD of crested wheatgrass and smooth bromegrass.

**CONCLUSIONS**

The results of these experiments demonstrate the excellent quality of intermediate wheatgrass as a forage for grazing livestock, as well as the impact that modest genetic improvements in forage quality can have on animal performance. They also demonstrate that there are factors that affect animal utilization of forages that are not measured by laboratory analyses commonly used to predict forage quality. This research also confirms the necessity of evaluating experimental pasture and range plants in grazing trials prior to release for commercial use. Results of this trial were instrumental in the decision to release Manska as a cultivar.