Field Evaluation of Five Grasses Grown on a Saline Soil

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Abstract

Russian wildrye *(Psathyrostachys juncea)*, Altai wildrye *(Leymus angustus)*, creeping foxtail *(Alopecurus arundinaceus)*, and 2 forms of a bluebunch wheatgrass *(Pseuduroegneria spicata)* × quackgrass *(Elytrigia repens)* hybrid (RS-1 and RS-2) were evaluated in 1983 and 1984 for their suitability as forage for beef cattle. Hybrid selections produced 5,554 kg/ha of forage and their yields in 1983 were significantly more than those from the 2 wildryes and creeping foxtail that averaged 2,810 and 4,292 kg/ha, respectively. In 1984, there was not a significant difference among yields for the 5 grasses, but there was a significant increase in yield from 1983 for the 2 wildryes and creeping foxtail. Percent crude protein averaged 16% in the wildryes and 12.5% in the 2 hybrids and creeping foxtail in 1983. However, percent phosphorus averaged .40% in the creeping foxtail and .30% in the hybrids. In 1984, percent crude protein and phosphorus for all 5 grasses were lower than in 1983, but trends were similar. All 5 grasses exceeded the NRC crude protein and phosphorous requirement for a 500-kg lactating cow in 1983. In 1984, only the creeping foxtail and RS-1 hybrid exceeded the phosphorous requirement. In vitro organic matter digestibility averaged 64% in the ryegrasses and 54% in the hybrids for both years. In 1983, all 5 grasses exceeded the metabolizable energy requirement of a lactating 500-kg cow. Based on calculated nutritional index, Russian wildrye and Altai wildrye ranked 1 and 2 with the creeping foxtail and RS-2 hybrid ranking 4 and 5, respectively, in 1983. In 1984, Russian wildrye and the creeping foxtail ranked 1 and 2, and the RS-1 hybrid and RS-2 hybrid ranked 4 and 5.

Evaluating performance of new cultivars and species under a variety of environmental and soil conditions is important in order to develop recommendations for their use (Murray 1984). Species such as Russian wildrye *(Psathyrostachys juncea)*[1], Altai wildrye *(Leymus angustus)*, and creeping foxtail *(Alopecurus arundinaceus)* have been used in the Northern Great Plains. These grasses have proven their value and seed is commercially available. However, scientists at the Crops Research Laboratory[2] at Logan, Utah, are breeding and evaluating superior strains of interspecific hybrids for future introductions. One hybrid, a bluebunch wheatgrass *(Pseuduroegneria spicata)* × quackgrass *(Elytrigia repens)*, has shown potential for being a productive forage species. Field evaluation of this hybrid in comparison with other species under a variety of environments and soil conditions is needed. The objective of this study was to assess the performance of 3 commercially available grasses and 2 new selections of the bluebunch wheatgrass × quackgrass hybrid grown on a saline soil near Miles City, Mont.

Materials and Methods

Study Area

The research was conducted on the Fort Keogh Livestock and Range Research Station of the Agriculture Research Service, USDA located approximately 3.2 km southwest of Miles City, Mont. Soils of the study site have been classified by the Soil Conservation Service[3] as an udorthentic chromustert, a member of a very fine, montmorillonitic, frigid family. Surface (0–15 cm) pH of the soil averages 8.5 and the pH of the subsurface (15–76 cm) is 9.0. Typically these soils have a heavy clay texture throughout the profile and are silty clay or clay comprised of 67% clay, 26% silt, and 7% sand. Because of the excess clay fines and high salt concentration, percolation is slow and shrink-swell is excessive. With drying during the hot summer months, cracks 5–15 cm wide frequently develop in the soil to a depth of 25.4 cm or more. Water permeability is also a serious problem with an estimated penetration rate of not more than 5 cm of water per irrigation.

About 15 years ago, the native Western wheatgrass *(Pascopyrum smithii)* vegetation was plowed, and an attempt made to intensively farm the site for cultivated row crops or alfalfa *(Medicago sativa)*. These crops, particularly alfalfa, wheat *(Triticum aestivum)* and barley *(Hordeum vulgare)*, were not compatible with the adverse characteristics of the soil and almost all efforts at crop production were failures. It was our goal to establish and test yields and nutrient qualities of grasses potentially adapted to this saline soil and determine their relative suitability for sustained productivity in reclaiming this saline area.

Grass Descriptions and Characteristics

Common names, scientific names and seeding rates for the 5 grasses studied are given in Table 1. "Vinall" Russian wildrye and "Prairieland" Altai wildrye are 2 introduced, cool-season, erect bunchgrasses that are winterhardy, drought resistant, salt tolerant and very persistent in the Northern Great Plains (Brown and Wiesner 1984; Asay and Knowles 1985; Lawrence 1976, 1983). "Garrison" creeping foxtail is a perennial grass with dense, vigorous rhizomes that is tolerant of both moderately acid and moderately alkaline soils (Stroh et al. 1978). With optimum soil moisture, fertility and management, all 3 grass species have been reported to produce yields of excellent quality forage (Stroh et al. 1978, Asay and Knowles 1985, Lawrence 1976).

Table 1. Common name, scientific name and seeding rate for the five grasses studied during 1983 and 1984.

Common name	Scientific name[1]	Seeding rate kg/ha
Prairieland Altai wildrye	*Leymus angustus*	5.6
Vinall Russian wildrye	*Psathyrostachys juncea*	9.2
Garrison creeping foxtail	*Alopecurus arundinaceus*	5.6
Bluebunch wheatgrass × quackgrass hybrid	*Pseudoroegneria spicata* × *Elytrigia repens*	4.6
RS-1 hybrid bluebunch wheatgrass caespitose form		
RS-2 hybrid quackgrass rhizomatous form		

[1]Nomenclature on the wildryes and wheatgrass follows that proposed by Dewey (1984).

Over 250 different interspecific hybrids have been produced by plant geneticists at the Crops Research Laboratory, USDA-ARS, at Logan, Utah (Asay and Knowles 1985). One of the most promising hybrids is a cross between quackgrass and bluebunch wheat-

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[1]Nomenclature on the wildryes and wheatgrasses follows that proposed by Dewey (1984).

[2]Maintained by USDA-ARS in cooperation with Utah State University, Logan, Utah.

[3]Unpublished data-described and classified by Soil Conservation Service, Miles City Mont.

grass. It is referred to as the RS hybrid. Two germplasms, RS-1 and RS-2, were released to breeders for seed increase in April 1980 (Asay and Dewey 1981). These 2 selections are characterized by having the vigor and productivity of quackgrass and the attributes and adaptations of bluebunch wheatgrass in semiarid rangelands. Parental clones of the RS-1 and RS-2 germplasms were selected on the basis of general vigor, degree of vegetative spread, leafiness, forage and seed yield, and seed quality. The RS-1 population is essentially caespitose, with limited rhizome development, while the RS-2 population has more rhizomes.

Sampling Procedure

A prototype range improvement machine (RIM) was used to plant the 5 grasses in the late summer of 1981 (Erickson and Currie 1982, Currie et al. 1984). Grasses were seeded in 1.7-ha plots arranged in a randomized complete block with 2 replications. The 5 grasses used in the study were planted during early September on 50-cm row spacing with alfalfa interseeded in alternate rows. Shortly after planting, the field was irrigated to promote seedling emergence.

Measurements of herbage yields and quality were taken on 15 June 1983 and 3 July 1984. Five 0.6 by 10.3-m sampling plots were located perpendicular to drill rows in each of the 2 replications of 5 grasses. A plot harvester was used to remove all herbage above a 10-cm stubble height within individual plots. Harvested samples were then oven dried at 60° C and weighed to estimate herbage production. Two supplementary subsamples were obtained adjacent to harvested plots and composited for chemical analysis. Subsamples were evaluated for nitrogen, phosphorus, and in vitro organic matter digestibility (IVOMD). IVOMD was determined from a modified Tilley and Terry (1963) technique for measuring rumen digestibility. Nitrogen and phosphorous content was analyzed using the Technicon Autoanalyzer[4] (Technicon Autoanalyzer II Methodology, 1977). Nitrogen is reported as percent crude protein (%N × 6.25).

A multiway classification analysis of variance, using a randomized, complete block design (Steel and Torrie 1960), was used to analyze total yields, % crude protein, phosphorus and IVOMD of the grasses. The honestly significant difference (hsd) procedure was used to compare means and a 95% confidence interval calculated for each mean (Steel and Torrie 1960). Data were analyzed separately for 1983 and 1984 because of the difference in sampling dates each year. A paired *t*-test was used to evaluate yearly differences in forage yield.

A nutritional ranking index was calculated to compare the 5 grasses in terms of their overall relative nutritional value. Index values were calculated by summing the crude protein, phosphorus, and IVOMD for each of the 5 grasses and these sums were then ranked relative to individual species performance.

[4]The use of a trade name does not constitute endorsement by USDA-ARS, but is presented for the convenience of the reader.

Results and Discussion

The RS-1 and RS-2 hybrids produced the greatest yields for both years, averaging 5,610 kg/ha (Table 2). Based on the 1983 data, the 2 wildryes were significantly lower in yield, averaging only 2,810 kg/ha while the hybrids averaged 5,554 kg/ha. The creeping foxtail produced 4,292 kg/ha and was intermediate in yield. Although there was not a significant difference in yield among the 5 grasses in 1984, Russian wildrye and creeping foxtail produced the least forage, averaging 4,496 kg/ha and 5,198 kg/ha, respectively, while the RS-1 and RS-2 produced 5,851 and 5,480 kg/ha, respectively. Altai wildrye was intermediate in yield, producing 5,278 kg/ha. Comparison of yields from consecutive years showed a significant ($P>.05$) increase in the 2 wildryes and creeping foxtail in the second year. In contrast, the hybrids did not differ between years (Fig. 1). Asay and Dewey (1981) reported that

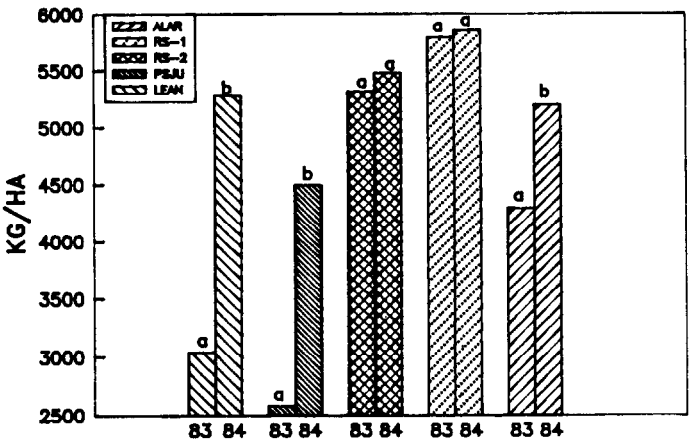

Fig. 1. *Mean herbage yield (kg/ha) of the 5 grasses for 1983 and 1984. Bars with different superscripts were significantly different (p<.05). ALAR = Garrison creeping foxtail, RS-1 and RS-2 = two forms of a bluebunch wheatgrass × quackgrass hybrid, PSJU = Russian wildrye, and LEAN = Altai wildrye.*

forage yields of the RS hybrid were equivalent to those of crested wheatgrass *(Agropyron cristatum)* or Russian wildrye on a surface mine reclamation site near Decker, Montana receiving approximately 30 cm annual precipitation. Also, yields were significantly higher than for most of the other 60 Triticeae species and hybrids in the trial, including western wheatgrass and bluebunch wheatgrass.

Table 2. Crude protein, phosphorus, IVOMD, yields, relative nutritional index, and rank of the five grasses for 15 June 1983 and 3 July 1984. A 95% confidence interval is shown for each mean.

	Percent					
	Crude Protein[1]	Phosphorus	IVOMD	Yield	Index	Rank
1983						
Altai	$16^{a} \pm 1$	$.33^{b} \pm .02$	$65^{a} \pm 1$	$3037^{b1} \pm 603$	81.3	2
Russian	$16^{a} \pm 1$	$.33^{b} \pm .03$	$66^{a} \pm 1$	$2583^{b} \pm 486$	82.3	1
RS-1	$13^{b} \pm 1$	$.31^{cb} \pm .02$	$57^{c} \pm 2$	$5791^{a} \pm 595$	70.3	3
RS-2	$12^{b} \pm 1$	$.30^{c} \pm .02$	$54^{c} \pm 2$	$5316^{a} \pm 606$	66.3	5
Garrison	$12^{b} \pm 1$	$.40^{a} \pm .03$	$57^{c} \pm 2$	$4292^{ab} \pm 487$	69.4	4
1984						
Altai	$10^{a} \pm 1$	$.20^{b} \pm .01$	$59^{ab} \pm 2$	$5278^{a} \pm 595$	69.2	3
Russian	$13^{a} \pm 1$	$.21^{b} \pm .01$	$64^{a} \pm 1$	$4496^{a} \pm 854$	77.2	1
RS-1	$9^{a} \pm 1$	$.24^{b} \pm .02$	$53^{c} \pm 2$	$5851^{a} \pm 825$	62.2	4
RS-2	$9^{a} \pm 1$	$.20^{b} \pm .01$	$52^{c} \pm 1$	$5480^{a} \pm 466$	61.2	5
Garrison	$12^{a} \pm 2$	$.30^{a} \pm .02$	$58^{b} \pm 2$	$5198^{a} \pm 630$	70.3	2

[1]Columns with different superscripts were significantly different ($P=.05$) using hsd analysis.

In 1983, crude protein was greater in the wildryes than in the 2 hybrids and creeping foxtail (Table 2). The creeping foxtail had the highest percent phosphorus, while the hybrid had the lowest, and the wildryes were intermediate in value. Percent crude protein, phosphorus, and IVOMD for the 5 grasses were lower in 1984 than in 1983 but trends were similar. Exceptions to these were noted in the creeping foxtail, which had similar crude protein and IVOMD contents in 1983 and 1984. Also, the RS-2 and the 2 wildryes had proportionately lower phosphorous values than the RS-1. One possible explanation for these lower values in 1984 is that samples were taken about 2 weeks later than they were in 1983. Thus, the grasses were probably more mature and could be expected to have lower values (Vavra and Raleigh 1976). Perez-Trejo et al. (1979) found this occurred in earlier studies and reported a very sharp drop in crude protein content of the RS hybrid between May 15 and June 15, from 26.1 to 13.4%, respectively.

In 1983, crude protein and phosphorous values in all species exceeded the minimum levels of 9 and .22%, respectively, as requirements for a 500-kg cow with average milking ability during the first 3-4 months postpartum (National Research Council 1984). However, in 1984, both RS hybrids just met the 9% protein requirement while the other grasses exceeded the minimum level standard. Only the RS-1 hybrid and creeping foxtail met the .22% phosphorous requirement. In vitro organic matter digestibility was highest in the wild ryegrasses, lowest in the hybrid, and intermediate in creeping foxtail for both years. The RS hybrids averaged 54% IVOMD for both years while the wildryes averaged 64% IVOMD. The creeping foxtail had an intermediate value of 57% for both years. Asay and Dewey (1981) reported that in vitro digestibility and crude protein content of the RS hybrid was intermediate to the parental species.

The requirement for metabolizable energy of a 500-kg cow with an average milking ability during the first 3-4 months postpartum is 2.50 Mcal/kg of dry matter (DM) (National Research Council 1984). An equation developed by Terry et al. (1973) for the prediction of metabolizable energy on a MJ/kg DM basis was derived using IVOMD and crude protein values. The relationship was best expressed by the following equations: Digestible energy = .1233 crude protein + .1705 IVOMD, and metabolizable energy = .815 digestible energy. The MJ/kg DM were converted to Mcal/kg DM. Using the above relationship, we predicted that all grasses exceeded the metabolizable energy requirement of a lactating cow except the RS hybrid samples collected in 1984. In this sample, crude protein and average IVOMD content were 9 and 53%, respectively. However, the RS hybrid did exceed the requirements of a dry pregnant cow during the middle third of pregnancy (1.76 Mcal/kg DM) during 1984 (National Research Council 1984).

Relative nutritional values of the 5 grasses, as determined by the nutritional index, ranked the Russian and Altai wildrye as 1 and 2, respectively in 1983 (Table 2). The creeping foxtail and RS-2 hybrid ranked 4 and 5, respectively, and RS-1 hybrid grass was intermediate in 1983. However in 1984, the Russian wildrye and creeping foxtail ranked 1 and 2, while the RS-1 and RS-2 hybrid ranked 4 and 5, respectively (Table 2). Murray (1984) ranked 14 grass accessions based on a sum of percentages for the largest leaf yield, percent crude protein content, and percent of greatest sheep use. He reported that Russian wildrye and crested wheatgrasses ranked the highest and lowest, respectively, while the RS hybrid ranked intermediate.

All 5 grasses were well adapted to the irrigated saline soil. Yields from the RS hybrids after the establishment year were greater than those from the other grass. However, the third year after planting there was not a significant difference in yields among the 5 grasses. Although information on animal utilization was not obtained, our data on yield and quality show that the wildryes and creeping foxtail were well suited for grazing. They produced ample herbage and had high forage qualities at maturity. The RS hybrid was generally adequate; however, it had a lower nutritional index as it matured. Its high productivity may make it more advantageous for a dual use rather than for grazing only. Thus, a possible management option might be to feed it as hay to dry cows rather than as a pasture grass for lactating animals. Another option would be to cut hay and graze the regrowth. Murray (1984) found that sheep use of the RS hybrid and Russian wildryes increased steadily with the changes in maturity as season advanced. In contrast, the wheatgrasses became less preferred with advancing maturity. Asay and Dewey (1981) reported that preliminary data from feeding and grazing trials indicate that the RS hybrid was readily accepted by sheep and cattle.

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