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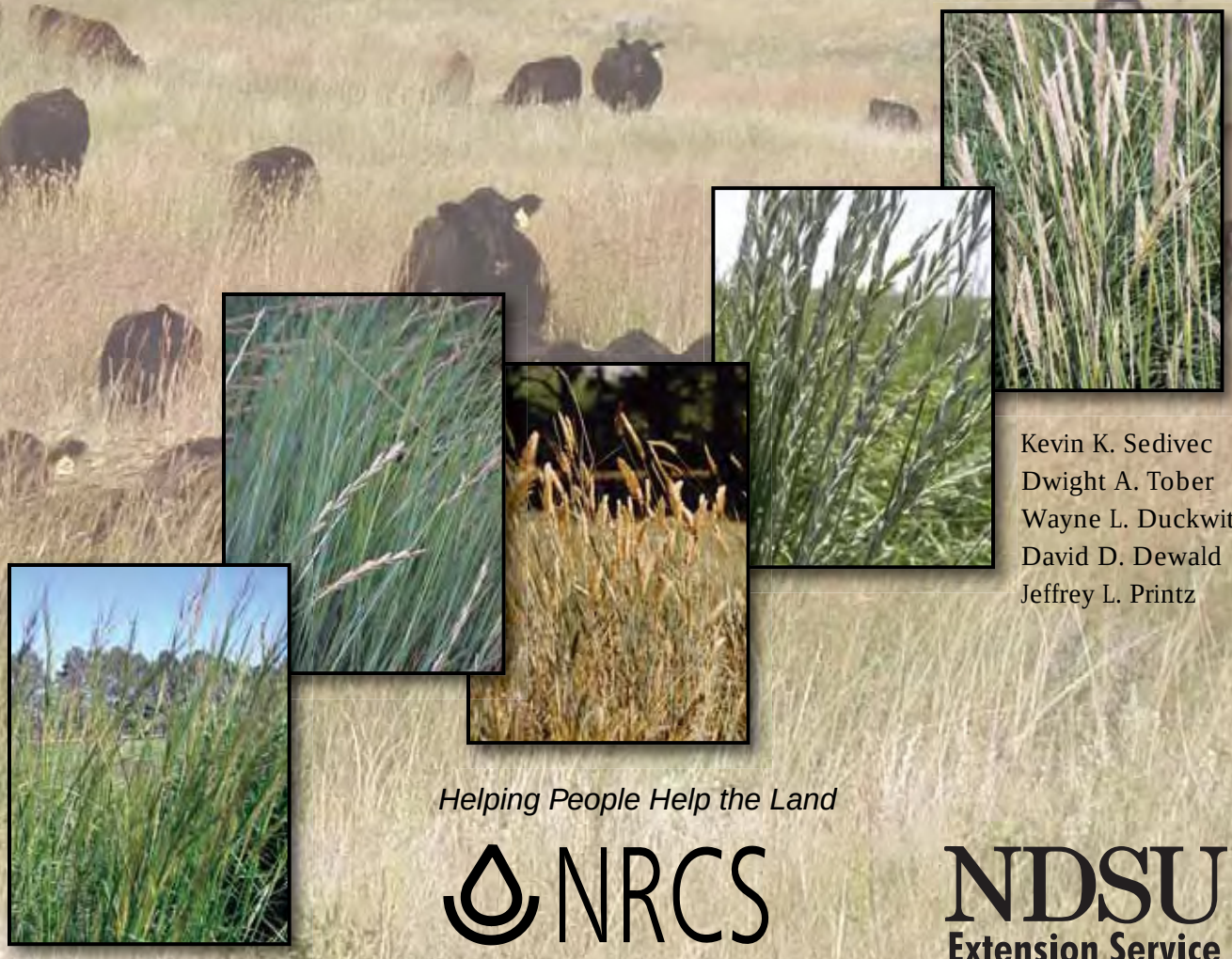
Grasses
for the Northern Plains

Growth Patterns, Forage Characteristics and Wildlife Values

Volume I - Cool-season



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Helping People Help the Land

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U.S. Department of Agriculture
Natural Resources Conservation Service

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Contents

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Background cover photo: Kenny Miller, Fort Rice, N.D. All other cover photos: NRCS and North Dakota Extension Service. Seed photos: E. Brent Turnipseed, Ph.D., professor/director, Seed Testing Laboratory, South Dakota State University, Brookings.

Introduction

Grasses commonly are planted as a permanent forage for livestock production, cover type for wildlife habitat and conservation practices for soil protection, providing a major staple in the diets of domestic and wild herbivores, habitat structure for many wildlife species and ground cover to stabilize soils. Both cool- and warm-season grasses are utilized, depending on the resource needs and objectives of the land manager. Cool-season grasses are defined as plants that produce the major portion of their growth during late spring/early summer, with a second growth occurring in late summer or early fall, depending on moisture conditions. Warm-season grasses produce most or all of their growth during the late spring to early fall period. This publication will concentrate on selected cool-season grasses, listing the most pertinent releases adapted to the Northern Plains.

Selection of the proper species and variety is an important step when choosing a grass seeding mixture. Grass species and varieties differ in growth habitat, productivity, forage quality, drought resistance, tolerance to grazing, winter hardiness, seedling vigor, salinity tolerance and many other characteristics. Therefore, selection should be based on the climate, soils, intended use and planned management. Planting the proper selection also can provide long-term benefits and affect future productivity of the stand.

This publication is designed to summarize the growth patterns; forage characteristics, including nutritional value and herbage production; plant performance characteristics, including seedling and plant vigor, weed competition, stand density, stand rating, plant height, disease and seed production; salinity tolerance; fiber content; wildlife values; and the list of varieties suited to the Northern Plains region for a select group of cool-season grasses studied in a field experiment trial near Hettinger, N.D., and Fort Pierre, S.D. Perennial grasses were studied during a period of eight years beginning in 1990 under different environmental conditions. Recommended seeding rates and specific guidelines can be obtained by consulting your county conservation district, Natural Resources Conservation Service or Extension Service office.

Grass Species and Varieties

The original study included 101 accessions/varieties of 33 different species that were evaluated for emergence, weed competition, stand density, plant height, disease, seed production and vigor from 1992 to 1997 at Hettinger, N.D., and 1990 to 1995 at Fort Pierre, S.D. (USDA NRCS 1997). Twenty of these cool-season grasses were selected for further study based upon popularity and future potential at the Hettinger site to study growth patterns, forage characteristics and fiber content from 1995 through 1997 (Table 1). Fourteen were introduced exotic grasses, five native to North America and one introduced native grass-hybrid cross. This second study will be further referenced throughout the remainder of this document as the "Growth Pattern and Nutritional Study (GPNS)". The USDA PLANTS database was used for taxonomic nomenclature (USDA NRCS 2006a).

Study Area

This research and demonstration project was conducted on private land (T129, R96, Sec 24, SE1/4) south of Hettinger, N.D., and public land (T5, R31, W1/2SW1/4SE1/4 Sec 5) northwest of Fort Pierre, S.D. All grass species and varieties were planted on a Vebar-Flasher soils series near Hettinger and Promise soil series near Fort Pierre. Vebar-Flasher soils are classified as fine sandy loam complex, slopes 3 percent to 9 percent, shallow, somewhat excessively drained and prone to erosion (Ulmer and Conta 1987). Promise soil is classified as clay with nearly level slope, somewhat poor drainage, moderate levels of organic matter and poor tilth (Borchers 1980).

One hundred one different varieties or experimental lines were seeded in 6-foot by 25-foot plots on April 6, 1992, near Hettinger and April 9, 1990, near Fort Pierre

Table 1. List of grass species and variety of each cool-season grass tested near Hettinger, N.D., 1995-1997.

Grass Species	Common Name	Release
Elymus trachycaulus ssp. trachycaulus	Slender wheatgrass	Revenue
Pascopyrum smithii	Western wheatgrass	Rodan
Pseudoroegneria spicata ssp. spicata	Bluebunch wheatgrass	Goldar
Pseudoroegneria spicata ssp. spicata/ Elytrigia repens	Bluebunch wheatgrass/quackgrass hybrid	NewHy
Thinopyrum elongatum	Tall wheatgrass	Alkar
Thinopyrum intermedium	Intermediate wheatgrass	Manska
Thinopyrum intermedium	Intermediate wheatgrass	MDN-759
Thinopyrum intermedium	Intermediate wheatgrass	Oahe
Thinopyrum intermedium	Intermediate wheatgrass	Reliant
Agropryon cristatum	Crested wheatgrass	Ephraim
Agropryon desertorum	Crested wheatgrass	Nordan
Agropryon cristatum/desertorum	Crested wheatgrass	HyCrest
Leymus cinereus	Basin wildrye	Magnar
Leymus angustus	Altai wildrye	Prairieland
Psathyrostachys junceus	Russian wildrye	Mankota
Psathyrostachys junceus	Russian wildrye	Bozoisky Select
Bromus inermis	Smooth bromegrass	Rebound
Bromus inermis	Smooth bromegrass	Cottonwood
Bromus biebersteinii	Meadow bromegrass	Regar
Nassella viridula	Green needlegrass	Lodorm

Plots near Fort Pierre, South Dakota.

Plots near Hettinger, North Dakota.

on three replicates using a randomized complete block design. Seeding rate varied with species but followed recommended seeding rates as specified in the NRCS Technical Guide (USDA NRCS 2006b).

Climate

North and South Dakota are at the geographic center of North America. This results in a continental climate characterized by continuous air movement and large annual, daily and day-to-day temperature changes. Relative humidity is low and precipitation tends to be irregular in time and distribution.

Approximately 70 percent to 75 percent of the annual precipitation falls during the summer months,

with 50 percent falling during May, June and July in North and South Dakota. A drought is defined as a prolonged period of time receiving less than 75 percent of the average precipitation, causing the plants to suffer from lack of water (Vallentine 1990). Only 1997 was considered a drought year at Hettinger, with 1995 and 1996 above average and 1993 and 1994 slightly below average (Table 2). Drought conditions occurred at Fort Pierre in 1990 and 1994, with 1995 well above average (Table 3). The years 1991, 1992 and 1993 had nearly average rainfall at Fort Pierre.

Table 2. Monthly precipitation at Hettinger Research Extension Center for 1992-1997.

Month	1992	1993	1994	1995	1996	1997	Average
January	0.26	0.47	0.59	0.20	0.56	0.05	0.36
February	0.00	0.25	0.15	0.42	0.31	0.18	0.22
March	0.82	0.45	0.57	0.75	0.95	0.32	0.64
April	0.51	0.85	0.95	1.18	1.02	3.68	1.37
May	2.13	1.37	0.80	6.07	5.20	1.16	2.79
June	4.34	4.39	2.39	2.88	2.45	3.79	3.37
July	3.81	4.90	3.02	2.21	0.86	1.16	2.66
August	1.95	0.73	0.34	3.71	0.53	0.73	1.33
September	0.33	0.19	1.39	0.44	4.09	0.25	1.12
October	0.36	0.17	3.94	1.27	0.55	0.89	1.19
November	1.58	0.87	0.61	0.49	1.59	0.39	0.92
December	0.30	0.52	0.06	0.15	0.72	0.05	0.30
Totals	**16.39**	**15.16**	**14.80**	**19.77**	**18.83**	**12.65**	**16.27**

Table 3. Monthly precipitation from the official weather station at Fort Pierre, S.D., for 1992-1997.

Month	1992	1993	1994	1995	1996	1997	Average
January	0.02	0.28	0.72	0.28	0.40	0.40	0.46
February	0.33	1.33	0.62	0.76	0.62	0.33	0.68
March	0.74	0.63	1.23	1.81	0.18	0.98	0.89
April	2.33	2.74	0.27	2.62	1.73	3.37	1.94
May	1.73	6.26	0.65	1.57	1.82	3.74	2.71
June	2.13	3.36	3.69	3.38	2.03	4.42	3.76
July	2.25	0.55	6.04	3.78	3.40	2.28	2.15
August	1.03	1.07	2.42	0.64	1.12	1.74	2.00
September	0.89	0.81	1.41	1.35	0.31	0.92	1.32
October	0.54	1.41	0.29	0.44	3.21	4.82	1.11
November	0.09	0.40	1.33	1.20	0.03	0.56	0.47
December	0.26	0.11	0.20	0.37	0.29	0.16	0.59
Totals	**12.34**	**18.95**	**18.87**	**18.20**	**15.14**	**23.72**	**18.08**

Herbage Production from the Growth Pattern and Nutritional Study (GPNS)

Annual herbage production differed (P<0.1) between years for all entries except Russian wildrye, the Bozoisky Select variety. Differences occurred due to variability and timing of year-to-year precipitation. Tall wheatgrass and basin wildrye produced the greatest amount of herbage production in 1995 (Table 4). Total precipitation was 23 percent above the long-term average and growing season precipitation (April to September) was 29 percent above the long-term average in 1995.

The Manska and MDN-759 intermediate wheatgrass varieties were the highest producing grasses in 1996, followed by Altai and basin wildrye (Table 4). Annual and growing season precipitation was slightly above average, 17 percent and 11 percent, respectively, compared with the long-term averages in 1996. The 1996 precipitation was closest to the long-term average among the three study years. Herbage production for tall and slender wheatgrass, basin wildrye, Russian wildrye (Mankota) and both smooth bromegrass varieties was reduced by 50 percent or more in the nearly average precipitation year, 1996, compared with the wet year, 1995. Although no grass species produced more herbage in the normal moisture year, compared with the wet year, crested wheatgrass (Ephraim) was only 7 percent less productive in 1996, compared with 1995. Bluebunch wheatgrass and Russian wildrye (Bozoisky Select) were lower in herbage production in 1996, compared with 1995, by 14 percent and 17 percent, respectively. All other grass varieties were reduced by 30 percent to 50 percent in 1996, compared with 1995.

Table 4. Cumulative herbage production pounds per acre (lb/ac) of selected cool-season grasses from the Growth Pattern and Nutritional Study near Hettinger, N.D., in 1995-1997.

Species	Variety	1995	1996	1997	Mean
Basin wildrye	Magnar	7,332	3,480	4,932	5,248
Tall wheatgrass	Alkar	7,748	3,108	2,892	4,583
Pubescent wheatgrass	Manska	5,840	4,080	2,812	4,244
Altai wildrye	Prairieland	5,172	3,548	3,280	4,000
Intermediate wheatgrass	Reliant	6,132	3,000	2,652	3,928
Crested wheatgrass	Nordan	4,948	3,388	3,252	3,863
Pubescent wheatgrass	MDN-759	5,320	3,720	2,320	3,787
Intermediate wheatgrass	Oahe	5,452	2,840	2,548	3,613
Slender wheatgrass	Revenue	4,988	2,040	2,680	3,236
Bluebunch wheatgrass	Goldar	3,988	3,412	1,920	3,107
Western wheatgrass	Rodan	4,360	2,572	2,292	3,075
Crested wheatgrass	HyCrest	4,492	2,480	2,108	3,027
Meadow bromegrass	Regar	4,428	3,028	1,572	3,009
Crested wheatgrass	Ephraim	3,268	3,028	2,108	2,801
Smooth bromegrass	Cottonwood	4,188	1,988	1,600	2,592
Green needlegrass	Lodorm	3,932	2,080	1,680	2,564
Bluebunch/Quackgrass	NewHy	3,508	2,188	1,720	2,472
Russian wildrye	Bozoisky Select	2,680	2,228	2,228	2,379
Smooth bromegrass	Rebound	3,628	1,680	1,748	2,352
Russian wildrye	Mankota	3,560	1,560	1,480	2,200
LSD (P<0.1)		1,532	828	912	

The driest year in the GPNS was 1997. Annual and growing season precipitation was 22 percent and 17 percent below the long-term average, respectively. Basin wildrye and slender wheatgrass were the only species unaffected by the drier conditions, compared with the 1996 cumulative production levels. Basin wildrye and slender wheatgrass cumulative production in 1997, compared with 1996, was 42 percent and 31 percent higher, respectively. The drier conditions had the greatest negative impact on bluebunch wheatgrass (56 percent reduction), meadow bromegrass (48 percent reduction), and intermediate wheatgrass Manska and MDN-759 (31 percent and 38 percent reduction).

Field Evaluation for Plant Characteristics of the Original Study

Each accession/variety was evaluated for stand emergence, weed competition, stand density, plant height, disease, seed production and vigor at Hettinger, N.D., and Fort Pierre, S.D. (Tables 5 and 6). Emergence and stand uniformity evaluations were conducted seven weeks after seeding and rated 1 for excellent, 5 for fair and 9 when no emergence occurred. Weed competition was rated on July 21, 1992, and Aug. 17, 1993, at Hettinger and Aug. 5, 1990, and Aug. 4, 1991, at Fort Pierre and rated 1 for none, 5 for moderate and 9 for severe. Density estimates (percent of full rows in sample frames) were collected July 21, 1992, and Aug. 17, 1993, at Hettinger and Aug. 14, 1990, and May 21, 1991, at Fort Pierre, with 100 percent equaling a full frame. Stand rating within plot was conducted Aug. 16, 1994; Aug. 30, 1995; July 31, 1996; and July 30, 1997, at Hettinger and Aug. 11, 1994, at Fort Pierre, with rating of 1 excellent, 5 fair and 9 poor. Plant height average (in inches) was recorded Aug. 17, 1993; Aug. 30, 1995; and July 31, 1996, at Hettinger and Aug. 5, 1992; Aug. 4, 1993; and Aug. 1, 1995, at Fort Pierre. Disease problems (primarily stem and leaf rust) were recorded Aug. 17, 1993, at Hettinger and Aug. 5, 1992; Aug. 4, 1993; and Aug. 11, 1994, at Fort Pierre, with a rating of 1 for none, 5 for moderate and 9 for severe. Seed production potential (using number of culms as an indicator) was recorded Aug. 17, 1993; Aug. 16, 1994; and July 31, 1996, at Hettinger and Aug. 5, 1992, and Aug. 4, 1993, with a rating of 1 for excellent, 5 for fair and 9 for poor. Vigor (overall plant health) was recorded Aug. 30, 1995;

Visual differences between two intermediate wheatgrass varieties at the Hettinger plot.

July 31, 1996; and July 30, 1997, at Hettinger and Aug. 1, 1995, at Fort Pierre, with a rating of 1 for excellent, 5 for fair and 9 for poor. Herbage production was clipped annually for five consecutive years with a forage harvester at each study site in July and August (USDA NRCS 1997). All samples were weighed with subsamples collected and oven dried at 140 F for 48 hours. Subsamples were weighed to the nearest 0.1 gram and converted to lb/ac.

Plant Description, Growth Patterns, Nutritional Quality and Use Potential for the Growth Patterns and Nutritional Study

These selected cool-season grasses were analyzed for nutritional quality and plant growth pattern. Above-ground biomass yields were estimated for each variety by sampling April 26, May 15, June 1, June 15, July 1, July 20, Aug. 20, Sept. 15 and Oct. 1 in 1995, 1996 and 1997. Standing vegetation was clipped at 0.5 inch from ground level from each subplot of each variety using a 0.25 m2 frame placed in its designated quadrat as randomly selected for each clipping period. Vegetation was placed into a paper bag with clipping date and physiological growth stage recorded at each clipping period. All samples were oven dried at 140 F until weight was constant and weighed to the nearest 0.1 gram.

Nutritional quality and forage production were determined from ungrazed, nonmowed cool-season grass clippings at the nine periods throughout the growing season beginning in late April and ending in early October. Each of the grass varieties was tested for dry matter, ash, crude protein (CP), acid detergent fiber (ADF), neutral detergent fiber (NDF), phosphorus and calcium. All samples were ground through a 1 mm screen in a Wiley mill and analyzed at the North Dakota State University Animal and Range Sciences nutritional laboratory. Dry matter, ash and ADF were determined following standardized procedures (AOAC 1990), NDF using procedures described by Robertson and Van Soest (1982) and CP using the Kjeldahl Auto System II (AOAC 1990). Total digestible nutrients (TDN) were determined for each grass species using the net energy lactation (NEL) formula involving ADF in the model [4.898 + (89.796 x NEL), where NEL = 1.085 - (0.0124 x percent ADF)]. Forage production was determined for each of the grass varieties for each clipping period to determine peak herbage production and time period.

Table 5. Field evaluation of cool-season grasses used for pasture, rangeland, wildlife habitat and protection of surface and groundwater at Hettinger, N.D., from 1992 to 1997.

	Emergence[1]	Weed Competition[2]		Stand Density[3]		Stand Rating[4]				Plant Height[5]			Disease[6]	Seed Production[7]			Vigor[8]		
Species/variety	92	92	93	92	93	94	95	96	97	93	95	96	93	93	94	96	95	96	97
Fairway Wheatgrass																			
Parkway	2	2	2	53	75	3	3	2	3	28	21	22	2	2	6	8	4	3	4
Kirk	3	3	2	52	68	3	3	3	2	31	29	25	2	1	4	5	3	2	4
Ephraim	3	4	2	40	59	3	4	3	3	26	25	21	2	3	5	7	4	4	5
Ruff	4	3	2	48	69	3	3	2	2	29	25	17	2	2	5	8	2	3	4
NU-ARS AC2	4	2	2	48	66	3	2	3	2	29	25	19	2	2	5	7	2	4	4
Crested Wheatgrass																			
Summit	3	3	2	45	62	3	4	3	2	30	31	29	2	2	3	4	2	2	3
Nordan	4	4	3	41	66	3	3	3	2	31	33	21	2	2	3	6	3	3	3
Fairway x Crested																			
HyCrest	3	3	2	42	68	3	3	3	3	32	28	29	2	1	4	4	2	3	3
CD-II	3	3	1	40	61	3	4	3	2	28	27	29	2	2	3	5	3	2	4
Intermediate Wheatgrass																			
Chief	3	5	2	52	60	1	2	2	2	42	38	32	2	1	5	5	1	3	2
Clarke	3	3	2	60	75	2	2	3	2	42	33	38	2	2	5	6	2	4	2
Reliant	2	1	1	58	77	1	2	2	2	44	35	33	2	1	5	6	3	3	3
Oahe	2	2	1	56	61	2	2	3	2	42	35	28	2	2	6	7	3	3	3
Slate	1	2	1	64	70	2	1	2	2	43	38	29	2	2	4	7	3	3	3
Haymaker	2	2	2	58	60	1	1	2	2	44	41	28	2	1	3	6	1	3	3
Pubescent Wheatgrass																			
Greenleaf	3	3	2	56	67	2	1	3	2	44	37	27	2	2	7	8	2	3	4
MDN-759	3	2	1	55	64	2	3	4	2	42	35	26	2	2	5	7	3	5	4
Manska	2	2	1	44	63	1	2	3	2	41	33	30	2	2	4	8	2	4	4
Tall Wheatgrass																			
Orbit	3	5	2	49	61	2	2	3	3	48	52	32	2	2	4	5	2	3	4
Alkar	3	5	2	40	66	3	4	4	2	46	47	33	2	2	4	5	3	2	4
Platte	3	4	1	54	63	2	2	3	2	51	45	34	2	2	3	6	2	4	3
Smooth Bromegrass																			
Magna	3	3	1	40	77	1	1	3	2	35	37	24	2	2	5	6	2	4	3
Manchar	3	3	2	42	76	1	4	3	3	32	33	27	2	2	4	5	4	4	4
Rebound	4	3	1	44	80	1	3	2	2	31	35	32	2	3	8	7	3	3	4
Cottonwood	5	3	1	38	80	1	2	2	2	33	37	26	2	3	6	6	2	4	4
Lincoln	3	2	2	44	76	2	2	2	2	30	31	31	2	3	7	7	3	4	5
Meadow Bromegrass																			
Fleet	2	2	1	53	76	1	1	3	2	34	18	23	2	4	8	8	2	4	5
Paddock	3	2	1	54	73	2	2	2	2	32	15	17	2	6	8	8	3	3	5
Regar	3	4	1	33	74	2	2	3	2	29	19	14	2	7	9	8	2	4	6

Table 5. Continued

Species/variety	Emergence[1]	Weed Competition[2]		Stand Density[3]		Stand Rating[4]				Plant Height[5]			Disease[6]	Seed Production[7]			Vigor[8]		
	92	92	93	92	93	94	95	96	97	93	95	96	93	93	94	96	95	96	97
Smooth x Meadow hybrid																			
AC Knowles	4	3	2	8	64	4	3	3	3	34	32	29	2	3	6	6	3	3	5
Russian Wildrye																			
Mayak	5	4	3	40	57	3	3	3	4	40	19	17	2	4	9	8	4	5	5
Swift	5	5	2	26	53	3	3	3	3	40	23	14	2	5	9	7	3	4	5
Cabree	4	3	2	36	63	4	5	4	4	37	13	13	2	3	9	8	4	4	5
Mankota	6	5	3	41	56	4	4	3	3	42	25	24	2	3	8	7	4	4	5
Bozoisky Select	5	4	2	40	56			4	4	46	25	22	2	2	8	8	3	5	5
Altai Wildrye																			
Prairieland	3	3	2	40	66	1	3	4	4	38	23	29	2	8	8	6	3	3	4
Pearl	3	4	2	33	66	3	4	3	6	38	20	29	2	7	7	7	4	2	5
Eejay	3	5	3	31	62	2	2	4	3	38	27	31	2	8	8	8	2	3	4
Basin Wildrye																			
Trailhead	3	2	2	32	72	4	3	3	4	40	33	41	7	7	7	6	3	3	5
Magnar	4	6	2	26	57	3	5	4	4	44	36	43	4	6	6	6	3	2	3
Bluebunch Wheatgrass																			
Goldar	1	4	2	57	79	2	2	2	2	27	14	18	2	7	8	7	3	3	5
Secar	1	3	2	61	80	3	3	2	2	28	28	23	3	6	8	7	4	3	4
NewHy hybrid	3	3	2	53	64	2	2	4	2	38	26	26	2	3	7	5	4	3	3
Green Needlegrass																			
Lodorm	4	6	2	45	67	2	4	3	3	36	35	28	2	2	3	4	2	3	4
SD-93	3	4	2	23	56	4	4	3	3	35	33	28	2	3	3	3	2	2	3
Western Wheatgrass																			
Walsh	4	4	2	50	74	1	1	2	2	24	25	17	2	7	8	8	3	4	5
Rodan	3	4	1	53	79	1	1	3	2	26	22	24	2	6	8	7	2	3	3
Flintlock	3	4	2	36	54	1	1	2	2	31	29	25	2	6	8	7	1	3	3
Slender Wheatgrass																			
Revenue	3	2	2	71	64	2	3	4	5	39	35	31	2	1	1	3	2	3	3
Adanac	2	2	2	69	62	2	2	3	5	37	33	26	3	1	1	3	2	3	5
Pryor	4	3	2	35	50	4	4	4	4	33	33	22	3	2	2	4	3	3	4
Primar	2	2	2	40	62	3	2	4	5	36	33	22	2	2	2	4	2	3	4

[1]Emergence and stand uniformity seven weeks after seeding (May 21, 1992). Rating: 1=excellent, 5=fair, 9=no emergence.
[2]Weed competition (July 21, 1992, and Aug. 17, 1993). Rating: 1=none, 5=moderate, 9=severe.
[3]Density estimate (percent of full rows in sample frames). 100 percent equals full frame (July 21, 1992, and Aug. 17, 1993).
[4]Stand within plot (Aug. 16, 1994; Aug. 30, 1995; July 31, 1996; and July 30, 1997). Rating: 1=excellent, 5=fair, 9=poor.
[5]Plant height average in inches (Aug. 17, 1993; Aug. 30, 1995; and July 31, 1996).
[6]Disease (primarily stem and leaf rust) problems (Aug. 17, 1993). Rating: 1=none, 5=moderate, 9=severe.
[7]Seed production potential, using number of culms as an indicator (Aug. 17, 1993; Aug. 16, 1994; and July 31, 1996). Rating: 1=excellent, 5=fair, 9=poor.
[8]Vigor (overall plant health), (Aug. 30, 1995; July 31, 1996; and July 30, 1997). Rating: 1=excellent, 5=fair, 9=poor.

Table 6. Field evaluation of cool-season grasses used for pasture, rangeland, wildlife habitat and protection of surface and groundwater at Pierre, S.D., from 1990 to 1995.

	Emergence[1]	Weed Competition[2]		Stand Density[3]		Stand Rating[4]		Plant Height[5]			Disease[6]			Seed Production[7]		Vigor[8]
Species/variety	90	92	93	90	91	94	95	92	93	95	92	93	94	92	93	95
Fairway Wheatgrass																
Parkway	3	2	1	46	59	3	2	16	28	27	2	2	4	5	2	2
Kirk	2	2	2	46	62	3	3	17	31	28	3	2	4	6	3	2
Ephraim	3	2	2	34	50	4	3	14	27	27	3	2	3	7	4	3
Crested Wheatgrass																
Summit	3	2	1	35	48	4	3	16	30	28	4	2	4	7	2	3
Nordan	3	2	1	35	56	3	3	19	31	30	3	2	3	4	3	2
Fairway x Crested																
HyCrest	3	2	1	34	53	3	3	19	31	34	3	2	3	5	2	2
CD-II	3	1	1	32	56	3	3	21	33	32	2	2	4	5	2	2
Intermediate Wheatgrass																
Chief	3	2	2	37	39	3	2	32	39	39	2	2	4	3	3	2
Clarke	4	3	1	28	31	3	2	30	37	36	2	2	4	3	3	2
Reliant	3	1	2	49	56	3	2	32	39	41	2	2	4	3	3	3
Oahe	3	2	1	46	57	3	1	34	43	41	3	2	4	2	3	2
Slate	4	1	1	44	51	3	2	32	41	41	2	2	5	3	3	2
Haymaker	2	1	1	61	61	3	2	34	43	43	2	2	4	2	3	1
Pubescent Wheatgrass																
Greenleaf	3	2	2	19	35	4	2	32	39	37	2	2	5	3	3	2
MDN-759	3	1	1	39	54	2	2	33	38	41	2	2	4	2	3	2
Manska	2	1	1	45	53	2	2	31	39	39	2	2	4	2	3	2
Tall Wheatgrass																
Orbit	4	3	2	31	33	4	4	30	48	48	1	2	3	5	3	2
Alkar	4	3	1	35	33	3	3	30	43	48	2	2	3	5	3	1
Platte	3	3	1	35	43	4	3	31	43	45	2	2	3	4	3	1
Smooth Bromegrass																
Magna	3	3	1	46	50	3	2	21	33	33	1	2	3	6	3	3
Manchar	3	1	1	46	42	3	3	25	33	27	2	2	3	6	3	5
Rebound	3	2	1	32	41	3	2	25	35	33	1	2	3	8	3	2
Cottonwood	3	1	1	23	50	2	2	17	35	33	1	2	3	8	3	2
Lincoln	3	1	2	42	52	2	2	18	37	33	1	2	3	7	3	3
Meadow Bromegrass																
Fleet	2	2	1	35	53	3	3	24	38	33	2	2	3	7	3	2
Paddock	2	1	1	32	58	4	2	20	36	33	2	2	3	7	5	3
Regar	4	1	2	25	40	5	3	27	39	35	2	2	3	8	3	2
Smooth x Meadow hybrid																
AC Knowles	3	2	2	41	49	4	4	23	35	31	2	2	3	5	3	4

Table 6. Continued

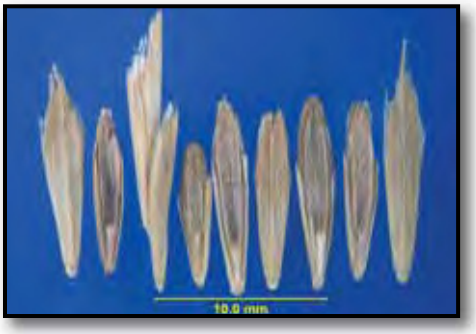
Species/variety	Emergence[1]	Weed Competition[2]		Stand Density[3]		Stand Rating[4]		Plant Height[5]			Disease[6]			Seed Production[7]		Vigor[8]
	90	92	93	90	91	94	95	92	93	95	92	93	94	92	93	95
Russian Wildrye																
Mayak	3	2	1	30	57	3	3	10	39	36	3	2	3	9	6	3
Swift	3	1	1	29	40	3	3	12	43	33	2	2	3	9	5	3
Cabree	3	2	1	35	49	3	3	11	42	38	2	2	3	9	6	3
Mankota	3	2	1	32	51	3	3	13	45	40	2	2	3	9	4	3
Bozoisky Select	3	1	1	24	45	3	3	13	48	38	2	2	3	9	3	2
Altai Wildrye																
Prairieland	1	4	4	38	47	5	6	19	42	43	2	2	3	9	3	4
Pearl	2	5	4	38	46	6	6	16	38	41	1	2	3	9	3	4
Eejay	2	7	7	24	20	7	6	18	40	32	2		4	9	3	3
Basin Wildrye																
Trailhead	7	6	5	3	11	6	6	21	42	43	6	7	6	9	5	5
Magnar	4	4	6	6	19	6	7	21	49	44	3	4	7	9	3	4
Bluebunch Wheatgrass																
Goldar	3	8	8	24	25	8	9	15	24	20	3	2	5	9	5	2
Secar	6	9	8	0	5	7	7	20	33	33	3	4	3	4	3	2
Green Needlegrass																
Lodorm	6	5	5	22	38	3	4	27	43	38	1	2	3	4	3	2
SD-93	4	6	6	27	33	4	5	29	36	39	1	2	3	4	3	3
Western Wheatgrass																
Walsh	4	1	1	50	32	6	5	16	29	23	2	3	6	9	8	4
Rodan	4	2	1	53	32	6	5	16	29	23	2	3	6	9	8	4
Flintlock	4	1	1	36	32	6	5	16	29	23	2	3	6	9	8	4
Slender Wheatgrass																
Revenue	--	9	--	--	--	8	8	--	0	30	--	0	6	--	0	3
Adanac	3	2	2	45	55	4	4	22	27	34	2	2	4	6	3	2
Pryor	3	2	2	28	56	5	4	26	35	31	2	3	4	6	2	3
Primar	3	1	3	52	49	5	5	26	--	--	2	3	3	3	3	3

[1]Emergence and stand uniformity seven weeks after seeding (May 22, 1990). Rating: 1=excellent, 5=fair, 9=no emergence.
[2]Weed competition (Aug. 5, 1990, and Aug. 4, 1991). Rating: 1=none, 5=moderate, 9=severe.
[3]Density estimate (percent of full rows in sample frames). 100 percent equals full frame (Aug. 14, 1990, and May 21, 1991).
[4]Stand within plot (Aug. 11, 1994). Rating: 1=excellent, 5=fair, 9=poor.
[5]Plant height average in inches (Aug. 5, 1992; Aug. 4, 1993; and Aug. 1, 1995).
[6]Disease (primarily stem and leaf rust) problems (Aug. 5, 1992; Aug. 4, 1993; and Aug. 11, 1994). Rating: 1=none, 5=moderate, 9=severe.
[7]Seed production potential, using number of culms as an indicator (Aug. 5, 1992, and Aug. 4, 1993). Rating: 1=excellent, 5=fair, 9=poor.
[8]Vigor (overall plant health), (Aug. 1, 1995). Rating: 1=excellent, 5=fair, 9=poor.

Meadow Bromegrass

Meadow bromegrass was collected in Turkey and introduced into the United States in 1949. It is less rhizomatous than smooth bromegrass, with leaves and stems pubescent. Meadow bromegrass is a long-lived bunch grass used extensively for pasture and hay land. Unlike smooth bromegrass, it is deep rooted with basal tillers, making it capable of strong summer growth and regrowth following grazing or haying events. It is less aggressive than smooth bromegrass and retains a better balance with alfalfa in grass-alfalfa mixtures. Seeds of meadow bromegrass are similar in appearance to smooth bromegrass seeds but are almost twice the size and have much larger awns.

Seeds germinate readily, with seedling vigor good, and seedlings establish well. Meadow bromegrass can be grown under dryland conditions in areas receiving greater than 14 inches of annual precipitation, but performs best with 16 inches or more of precipitation or with irrigation. With drier conditions, field selection is critical and should be limited to soils with higher water-holding capacity (e.g., loams and clay loams).



Herbage Production

Similar yields from the original study were recorded among Regar, Fleet and Paddock meadow bromegrass on field trials from Hettinger, N.D., and Fort Pierre, S.D. No differences were found among varieties in any year, with a five-year mean production of 1,231, 1,204 and 1,328 lb/ac for Fleet, Paddock and Regar, respectively, near Hettinger. No differences were found among varieties in any year, with a five-year mean production of 1,182, 1,398 and 1,743 lb/ac for Fleet, Paddock and Regar, respectively, near Fort Pierre. AC Knowles (smooth x meadow bromegrass hybrid) was similar or lower yielding than all meadow bromegrass releases in these studies.

Cumulative herbage production from the GPNS for Regar was 4,428 lb/ac when growing season precipitation was greater than 16 inches (Table 4). During a dry year when growing season moisture was less than 11 inches, cumulative herbage production was 1,572 lb/ac. Meadow bromegrass was not very drought tolerant or water use efficient, providing good growth when moisture was good to high. In a drier climate receiving an average of 16 inches of annual precipitation or less, meadow bromegrass was less productive than smooth bromegrass.

Growth Patterns

Regar was an early maturing grass, reaching peak standing crop in early July in 1996 and 1997, and mid to late July in 1995. Regar has no yearly differences in percent of total growth produced per clipping for any clipping date. On average, about 10 percent of the plant growth occurs in April and 47 percent by late May or early June. On average, Regar achieves the highest level of standing crop by early July. Although this grass will continue to grow throughout the remainder of the growing season, the loss of the current year's growth is greater than any gain of new growth at this study area.

Meadow bromegrass

Releases	Date Released	Released By	Statement of Use
Cache	2004	ARS, Logan, Utah	Improved forage yields compared with Regar and Fleet and better persistence than Fleet.
MacBeth	2001	MSU, Bozeman, Mont.	Excellent seed yield, similar forage yield to other releases.
Montana	2000	MSU, Bozeman, Mont.	Improved seed yields compared with Regar and Paddock, with fast recovery following defoliation or cutting.
AC Knowles	2000	AAF, Canada	Interspecific hybrid between smooth bromegrass and meadow bromegrass. Higher yields than Paddock, but less than smooth bromegrass.
Fleet	1987	Canada Dept. of Ag.	Similar to Regar in forage yield and Saskatoon, Saskatchewan regrowth characteristics. Higher seed yields compared with Regar.
Paddock	1987	Canada Dept. of Ag.	Similar habitat of growth and forage Saskatoon, Saskatchewan yields to Regar and Fleet. Leaves slightly wider and seed yields greater than Regar.
Regar	1966	SCS, Aberdeen, Idaho	Rapid seed germination. Lacks basal leaves with good regrowth. The first variety released and provides the standard from which all new varieties were compared.

This created a continuing decline of standing biomass below the peak level when not mowed or grazed. In mid-September, meadow bromegrass had a 1.5 percent increase in standing biomass compared with late August; then it declined in October.

Nutritional Quality

Meadow bromegrass is highly nutritional and a palatable forage for all classes of livestock. Individual plants of Regar that were in the vegetative to pre-boot growth stage had a crude protein (CP) content of 10 percent or greater. Once the plant reaches the seed-set stage, CP content drops to 7 percent and continues to decline as it matures. Regar, in terms of all standing material combined, was at 4 percent CP in October when cured on the stem.

Total digestible nutrients (TDN) of Regar were above 56 percent when the plant was in the vegetative through seed-hardening growth stage. TDN dropped below 50 percent in late August when mature. The TDN content was at 46 percent in October and November.

Fiber Content

Fiber content of Regar was lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased quickly until the pre-boot stage (28.7 percent to 38 percent), then remained at a similar level until mid-August, peaking at 49.2 percent by early October.

Regar ranked 14th out of the 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. Harvesting maximum levels of fiber occurs from early to late July, with 1,003 pounds of ADF produced per acre. Meadow bromegrass would be considered one of the most efficient cool-season grasses, reaching peak herbage and fiber production in early July, when CP and TDN are at or above the minimum levels of a lactating cow.

Performance Characteristics

Meadow bromegrass varieties were studied for emergence and stand uniformity seven weeks after seeding, weed competition, stand density, stand rating, plant height, disease, seed production and vigor (Tables 5 and 6). Fleet established more readily than Regar or Paddock and had a higher stand density the first year. After the establishment year, performance characteristics were similar among varieties. Although Fleet showed improved seed production in the first year following establishment at Hettinger, overall seed production was poor for all varieties.

Salinity Tolerance

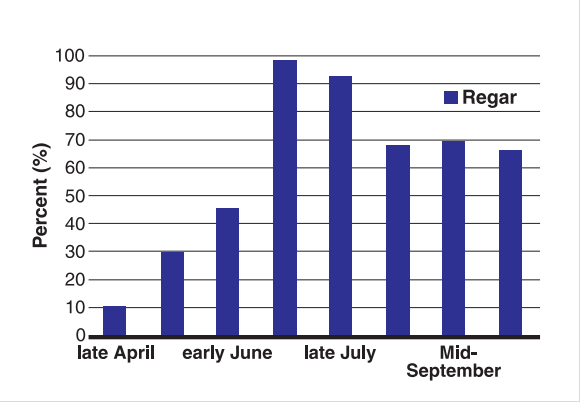
The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated meadow bromegrass as moderate for salt tolerance. When comparing meadow bromegrass with salt-tolerant grass species, electroconductivity (EC) was 4 to 10 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass have an EC rating of 13 to 26 mhos/cm. Alfalfa has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (2003) rates meadow bromegrass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

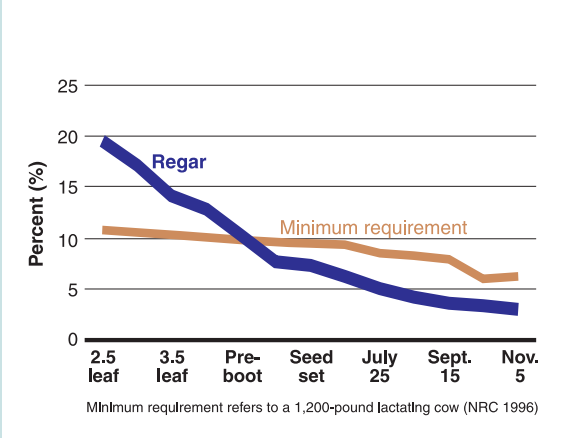
Meadow bromegrass will provide excellent grazing in May, June and early July. When comparing growth patterns and nutritional value, livestock grazing from early May through early July will optimize forage use and nutrient content. Total digestible nutrients will be adequate only through July, with crude protein becoming deficient by early July. A rotational grazing system can extend immature plant growth through late September or early October, increasing nutritional quality and palatability.

Recommended Grazing Season:
early May to early July.

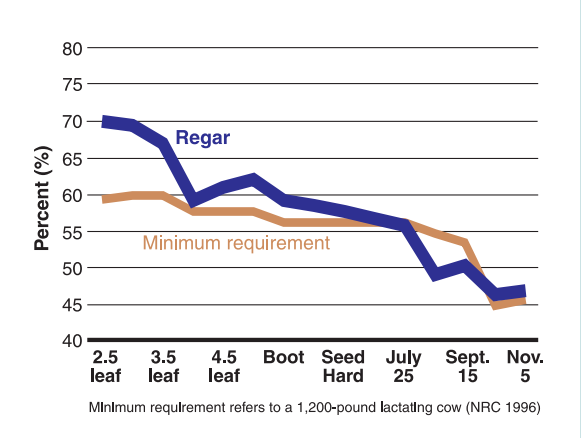
Meadow bromegrass



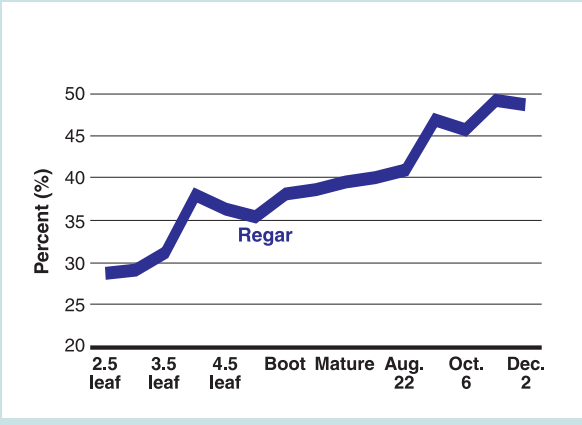
Percent of average peak standing biomass (3,009 lb/ac) for meadow bromegrass



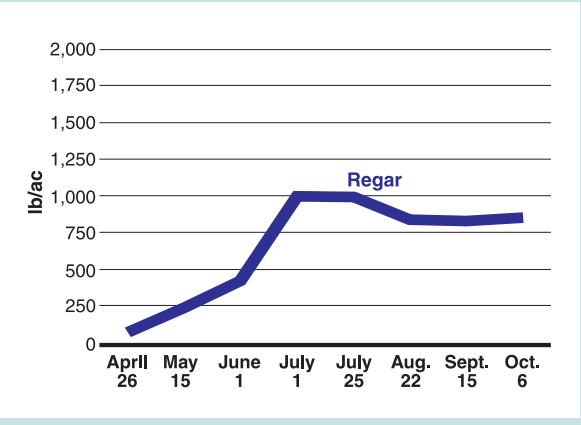
Crude protein content of meadow bromegrass



Total digestible nutrient content for meadow bromegrass



Acid detergent fiber content of meadow bromegrass



Pounds of acid detergent fiber produced per acre for each period of meadow bromegrass

Hay Value

Meadow bromegrass will make good hay because of its high palatability; however, since most leaf tissue is basal, capturing a high proportion of plant tissue will be lower than upright grasses. Meadow bromegrass would be recommended as the first choice for pasture use and hay land a second option, especially in dry climates and years. Meadow bromegrass will make a better hay-type grass in higher moisture areas and a poorer one in dry areas. Meadow bromegrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 56 percent) for winter feed and early July to maintain CP and TDN levels for nonlactating animals. When optimizing quality with production (lb + CP), meadow bromegrass should be harvested by late June for optimal harvest efficiency.

Meadow bromegrass makes excellent hay when planted with alfalfa. Alfalfa supports the drooping leaves of the meadow bromegrass, creating a grass/alfalfa mixture that is maintained in the second and third cuttings.

Recommended Haying Time: late June for a nonlactating ration, and optimum quality and production; mid-June for a lactating ration, optimum quality and lower production.

Wildlife Value

Meadow bromegrass was moderately to highly productive in normal to wet years, compared with other cool-season grasses, and low producing in dry years. This grass will provide good cover in the spring due to its aggressive spring growth; however, cover in the fall will be fair due to a 35 percent to 40 percent loss of standing crop. However, since meadow bromegrass is a bunch grass, it will provide higher structure when dormant, compared with smooth bromegrass. When used in conjunction with forbs and legumes (e.g., alfalfa) it can provide adequate grassland nesting bird habitat.

Meadow bromegrass is a very palatable grass that provides good growth in the spring and lush regrowth throughout the summer, depending on moisture availability. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is sufficient. Regrowth is very palatable to Canada geese. Birds and rodents eat its large seeds. Use by native pollinators is limited.

Cover Value

Spring:	Good
Summer:	Good
Fall:	Fair
Winter:	Fair

Forage Value

Spring:	Excellent
Summer:	Fair
Fall:	Good
Winter:	Fair
Regrowth:	Excellent

Smooth Bromegrass

Smooth bromegrass was introduced into the United States in the 1880s from Europe. It is a long-lived, sod-forming rhizomatous grass used extensively for pastures, hay land and soil conservation. It has a slight constriction on the leaf blade about midway from tip to collar, forming a W or M shape. It is considered an aggressive grass that often is planted with alfalfa for hay production. It tends to increase or invade adjacent undisturbed areas, especially idle lands.

Seeds of smooth bromegrass are similar in appearance to meadow bromegrass seeds but are half the size and have shorter awns. Seeds germinate readily, seedling vigor is good and seedlings establish well. Smooth bromegrass can be grown under dryland conditions in areas receiving greater than 14 inches of annual precipitation, but performs best with 16 inches or more of precipitation or with irrigation. With drier conditions, field selection is critical and should be limited to soils with higher water-holding capacity (e.g., loams and clay loams).

The southern types mature earlier than northern types and have an aggressive root system. It has good seedling vigor and is easy to establish. Cottonwood is a vigorously spreading, drought-tolerant variety. Rebound is a selected variety for greater recovery from haying or grazing.

Smooth bromegrass

Type	Release	Date Released	Released By	Statement of Use
Southern	**AC Rocket**	2001	Agricor United	Drought tolerant, vigorous growth, very leafy for higher forage quality, high forage yields.
Southern	**AC Knowles hybrid** (smooth bromegrass X meadow bromegrass)	2000	AAF, Canada	Interspecific hybrid between smooth bromegrass and meadow bromegrass. Higher yields than Paddock meadow bromegrass but less than smooth bromegrass.
Southern/ intermediate	**Badger**	1990	University of Wisconsin	Excellent seed production, high forage yields, excellent resistance to seedling and foliar disease.
Southern	**Radisson**	1989	Ag. Canada, Saskatoon, Saskatchewan	Testing in Saskatchewan, Canada, showed forage yields similar to Carlton and Magna and seed yields lower than Carlton and Magna and similar to Baylor and Rebound.
Northern	**Bravo**	1983	Maple Leaf Mills Forage Division	Average forage yields. Maturity date similar to Saratoga and Baylor.
Intermediate	**Signal**	1983	Ag. Canada, Saskatoon, Saskatchewan	Similar to Magna in growth habit, taller than Carlton. Forage production similar to other varieties. Roots are slightly less strongly creeping. High seed yields and seed quality.
Northern	**Jubilee**	1979	Maple Leaf Mills Forage Division	Hardiness similar to Lincoln and Carlton, excellent seedling vigor and rate of establishment. Recovers rapidly after cutting. Very good seed yields. Slightly lower invitro-digestibility than other varieties.
Southern	**Rebound**	1978	South Dakota, AES	Less spreading and growth habit than Saratoga. Fewer reproductive tillers than Saratoga. Good regrowth recovery after cutting. Winter hardiness similar to Carlton. Good forage yields but lower seed yields than other varieties in western Canada trials.
Southern	**Barton**	1975	Land O' Lakes	Improved forage yield, rate of recovery, seed size, seedling vigor and leaf disease resistance compared with Lincoln.
Southern/ intermediate	**Magna**	1968	Ag. Canada, Saskatoon, Saskatchewan	High seed quality and higher seed yields than southern types. Yields in western Canada are similar to or above those of southern types, but regrowth yields are somewhat lower.
Southern	**Cottonwood**	1979		Drought-tolerant, rapidly spreading variety.
Northern	**Polar**	1965	Alaska, AES	Superior in winter hardiness and yield compared with other northern types. Superior lodging resistance, less aggressive spreading habit of growth. Early maturity.
Southern	**Baylor**	1962	Rudy-Patrick Co.	Leafy and high forage production, disease resistant, good stand establishment, good recovery after cutting. Improved production of high quality seed. Same maturity as Lincoln.

Type	Release	Date Released	Released By	Statement of Use
Southern	**Saratoga**	1955	Cornell University, AES	High seedling vigor, early spring growth, higher yielding than Lincoln. Similar to Lincoln in seed yield and quality. Similar to Lincoln in resistance to brown spot and leaf scald.
Southern	**Elsberry**	1954	USDA-SCS, Elsberry, Mo.	High forage and seed yields, disease resistant, early maturity and excellent recovery after cutting.
Intermediate	**Manchar**	1943	USDA- SCS, Pullman, Wash.	Good seedling vigor, good forage production and seed yields. Recovers rapidly after cutting.
Southern	**Lincoln**	1942	Nebraska, AES	Good seedling vigor and ease of establishment. Rhizomatous sod forming. More aggressive than northern types of smooth bromegrass.
Northern	**Carlton**	1961	Canada Department of Agriculture	Typical of northern type of smooth bromegrass.

Herbage Production

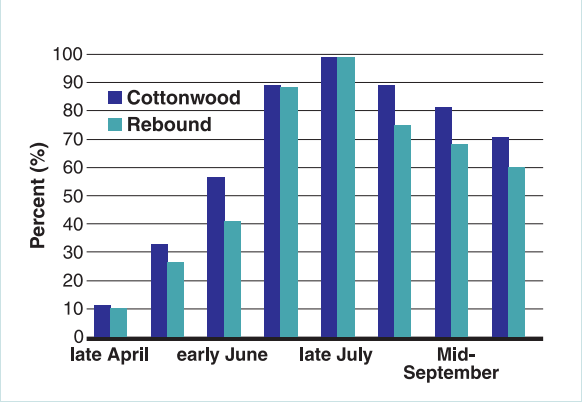
Similar yields from the original study were recorded among Rebound, Cottonwood and Lincoln smooth bromegrass on field trials from Hettinger, N.D. On average, all three varieties produced greater yields than Magna and Manchar in all years. A five-year mean production was 1,740, 1,661, 1,568, 1,293 and 1,160 lb/ac for Lincoln, Rebound, Cottonwood, Magna and Manchar, respectively, near Hettinger. No differences were found among the Lincoln, Magna, Cottonwood and Rebound varieties in any year near Fort Pierre, S.D., with a five-year mean production of 1,863, 1,855, 1,823 and 1,514 lb/ac, respectively. The Manchar variety was lower than Lincoln in 1995, with a five-year mean production of 1,360 lb/ac. AC Knowles (smooth x meadow bromegrass hybrid) was similar or lower yielding than all smooth bromegrass releases in these studies.

Cumulative herbage production from the GPNS ranged from 3,628 to 4,188 lb/ac for Rebound and Cottonwood, respectively, when growing season precipitation was greater than 16 inches (Table 4). In a dry year when growing season moisture was less than 11 inches, cumulative herbage production ranged from 1,600 to 1,748 lb/ac for Cottonwood and Rebound, respectively. Neither variety appears to be very drought tolerant or water efficient and provided good growth when moisture was high. Development of pasture or hay land with smooth bromegrass would be recommended in areas with good moisture, a minimum of a 16-inch annual precipitation zone or water collection area.

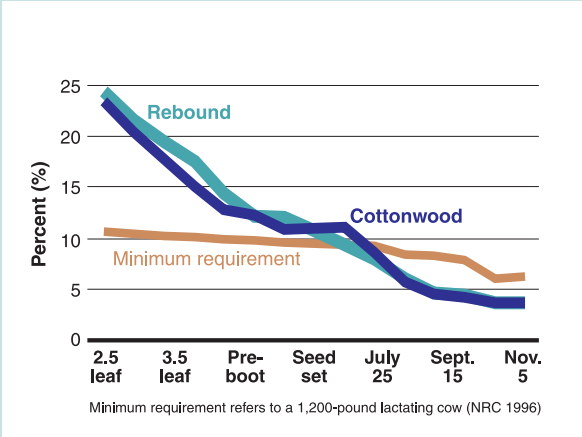
Growth Patterns

Both Cottonwood and Rebound possess vigorous growth in the spring, reaching peak standing crop in late July during all three years. On average, about 10 percent of the plant growth occurs in April, with more than 41 percent of Rebound's and 57 percent of Cottonwood's growth occurring by late May or early June. Cottonwood is a more aggressively growing smooth bromegrass variety in May. Both smooth bromegrass varieties achieved the highest level of standing crop by late July. They had no yearly differences in percent of total growth produced per clipping period for any clipping date. Although this grass will continue to grow throughout the

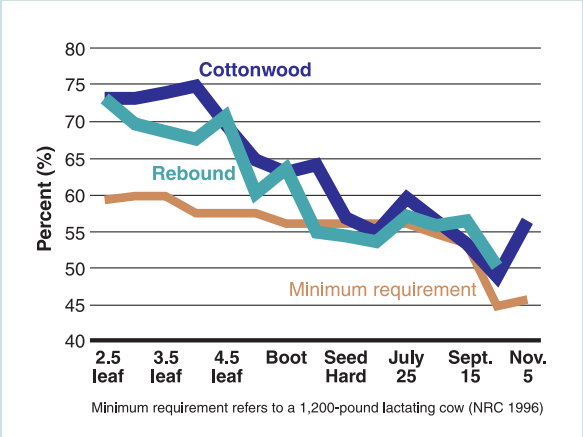
Smooth bromegrass



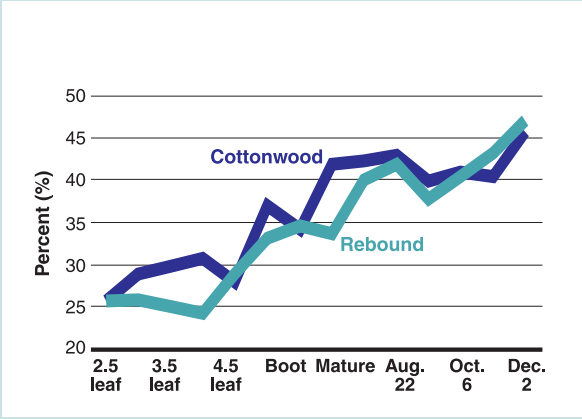
Percent of average peak standing biomass for smooth bromegrass Cottonwood (2,592 lb/ac) and Rebound (2,352 lb/ac)



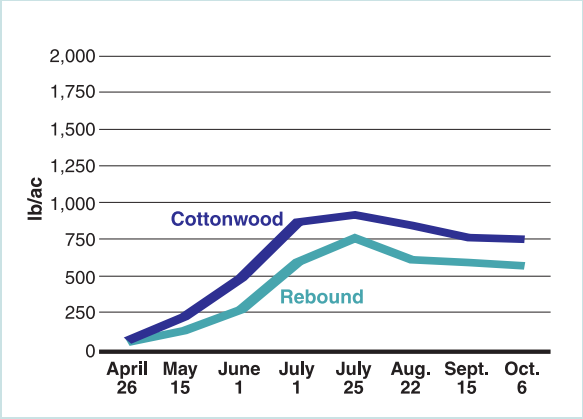
Crude protein content of smooth bromegrass



Total digestible nutrient content for smooth bromegrass



Acid detergent fiber content of smooth bromegrass



Pounds of acid detergent fiber produced per acre for each period of smooth bromegrass

remainder of the growing season, the loss of the current year's growth is greater than any gain of new growth at this study area. This loss creates a continuing decline of standing crop below the peak level. Neither Cottonwood nor Rebound had an increase in biomass production in mid-September, as recorded with Regar meadow bromegrass in this trial.

Nutritional Quality

Both Cottonwood and Rebound were similar in crude protein content (CP) with little to no differences in CP at any time throughout the clipping periods. Both varieties remained at or above the 10 percent CP from the vegetative through seed-set growth stages, dropping below 10 percent at the seed-hardening stage. Smooth bromegrass was one of the few cool-season grasses to maintain a CP at 5 percent or greater when fully matured and cured.

Total digestible nutrients (TDN) were similar between the two varieties throughout the first half of the growing season. TDN for Rebound remained at 64 percent at the seed-set stage, while Cottonwood was at 55 percent at this growth stage. The TDN for both varieties was at or above 53 percent throughout the growing season, only dropping below 50 percent after early October.

Fiber Content

Smooth bromegrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) in Rebound was lower than Cottonwood in the vegetative growth stage, but similar from the pre-boot stage through maturation and senescence. ADF increased rapidly after the 4.5-leaf stage (28 percent to 29 percent), peaking at 46 percent and 47 percent in Rebound and Cottonwood, respectively, by early October.

Cottonwood ranked 16th and Rebound 20th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, smooth bromegrass would not be recommended. Harvesting maximum levels of fiber occurs in late July for both varieties, with an average of 916 and 757 pounds of ADF produced per acre for Cottonwood and Rebound, respectively. Smooth bromegrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, when TDN is at or above and CP slightly below the minimum levels of a lactating cow.

Performance Characteristics

Magna, Manchar, Rebound, Cottonwood and Lincoln smooth bromegrass varieties and the AC Knowles hybrid were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor (Tables 5 and 6). Emergence, stand density and stand rating were similar for all varieties. No disease problems were found and plant height and seed production were comparable for all entries. The AC Knowles hybrid generally was rated lower in stand ratings, compared with the other smooth bromegrass entries.

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated smooth bromegrass as moderate for salt tolerance. The electroconductivity (EC) was 5 to 10 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates smooth bromegrass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

Smooth bromegrass, irrelevant of variety, will provide excellent grazing in May, June and early July. When comparing growth patterns and nutritional value, livestock grazing from early May through early July will optimize forage use and nutrient content. Although TDN will be adequate throughout much of the growing season, crude protein will become deficient by mid-July unless sufficient plants are present in the vegetative stage.

Recommended Grazing Season: early May to early July.

Hay Value

Smooth bromegrass will make excellent hay because of its high palatability. Irrelevant of variety, smooth bromegrass will make a good hay-type grass in good to high moisture areas. Smooth bromegrass should be cut by late June to maintain good CP (9.5 percent to 11 percent) and TDN (> 56 percent) for winter feed and early to mid-July to maintain minimum CP and TDN levels for nonlactating animals. Harvest efficiency was different between the two varieties studied. When optimizing quality with production (lb + CP), both varieties can be harvested in late June or early July to optimize harvest efficiency. Cottonwood was 13 percent more efficient than Rebound in capturing CP and production (lb of CP/acre) in this study.

Recommended Haying Time: late June or early July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration and optimum quality, with slightly lower production.

Wildlife Value

Smooth bromegrass was moderately productive in normal to wet years, compared with other cool-season grasses, and low producing in dry years. This grass will provide good cover in the spring due to its vigorous early growth; however, cover in the fall will be fair due to the 35 percent to 40 percent loss of herbage production and loss of rigidity, providing limited winter cover. When used in conjunction with legumes (e.g., alfalfa), it can provide good nesting bird habitat. To maintain vigor, it will need management on a routine basis. Prescribed burning or light disking once every three to five years will improve plant vigor, resulting in improved cover for grassland nesting birds.

Smooth bromegrass is a very palatable grass that provides good growth in the spring and lush regrowth in the fall, depending on moisture availability. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is sufficient. Early spring growth and regrowth is very palatable to Canada geese. Birds and rodents eat its seeds. Use by native pollinators is limited.

The invasive tendencies of smooth bromegrass into native habitats may impact wildlife habitat negatively. Smooth bromegrass does not have the rigidity of most native species, lessening its winter cover value. This trait reduces its value for spring nesting sites for grassland nesting birds, especially in heavy snow winters.

Cover Value

Spring:	Good
Summer:	Good
Fall:	Fair
Winter:	Poor

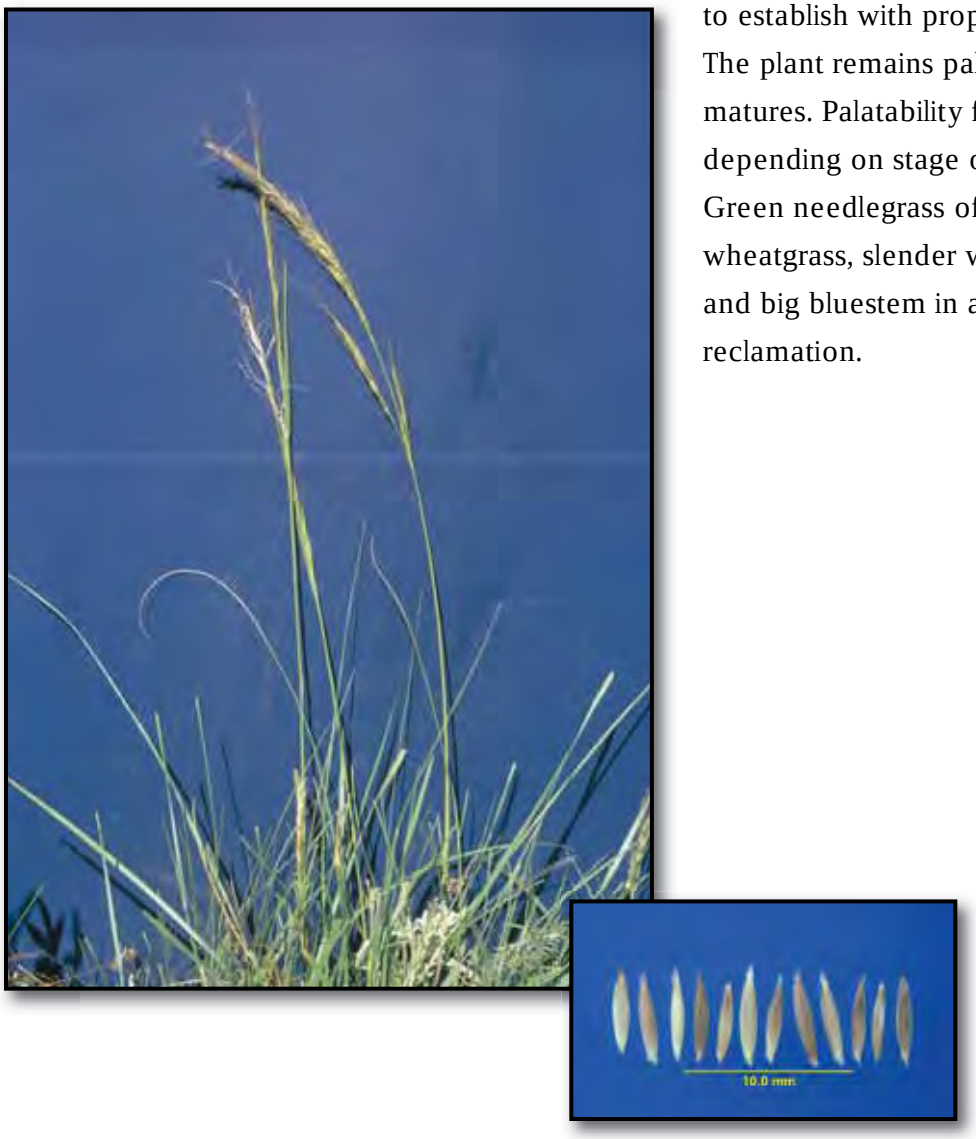
Forage Value

Spring:	Excellent
Summer:	Fair
Fall:	Good
Winter:	Fair
Regrowth:	Good

Green Needlegrass

Green needlegrass is native to North America and abundant on loamy ecological sites in mid- to high-serial plant community conditions. It is adapted to grow on most loam, sandy loam and clay loam ecological sites. It is a cool-season grass that grows 16 to 24 inches tall, depending on soil type and region, with good yields when sufficient moisture is available. It is considered a very palatable grass, used primarily for pasture and rangeland.

Green needlegrass is a perennial bunch-type grass used for revegetating loamy soils, conservation plantings and, to a limited degree, hay land. It has good seedling vigor and is easy to establish with proper seedbed preparation. The plant remains palatable to livestock as it matures. Palatability for hay is good to excellent, depending on stage of maturity when harvested. Green needlegrass often is seeded with western wheatgrass, slender wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation.



Herbage Production

Green needlegrass makes fair to good hay and good to excellent pasture in areas where moisture is fair to excellent. Similar yields were recorded in the original study between both green needlegrass varieties (Lodorm and SD-93) on field trials from Fort Pierre, S.D., in all five years. No differences were found between both varieties at the Hettinger, N.D., site in all five years. The five-year mean production was 1,495 and 1,231 lb/ac for Lodorm and SD-93, respectively, near Hettinger. The five-year mean production was 1,141 and 1,003 lb/ac for Lodorm and SD-93, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Lodorm was 3,932 lb/ac and it ranked as the 15th most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,680 lb/ac, and it was 2,080 lb/ac when growing season moisture was about 14 inches. Lodorm ranked 15th, 16th and 17th among the 20 cool-season grass varieties studied in 1995 through 1997. Lodorm was considered below average for productivity among all grasses studied, irrelevant of moisture conditions. Green needlegrass is an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 14 to 24 inches.

Growth Patterns

Lodorm is a slow-growing cool-season grass in the spring, producing 33 percent of its total growth by June 1. Much of the plant's growth occurs in June, with more than 47 percent of its growth occurring in this month. Peak production occurs from late July to late August, with much of the standing biomass maintained through early October. Green needlegrass would make good pasture for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability. Green needlegrass would make fair to good hay if harvested by early July; however, production was low, compared with other exotic grasses.

Nutritional Quality

Lodorm was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, by the seed-set stage of development, CP was below 10 percent and it was below 7 percent by late July in the maturing plant. The CP of the mature plant dropped below 5 percent by mid-August and about 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July during seed development. TDN never dropped below 50 percent until early October, when TDN content was 48.9 percent. Both CP and TDN were low in the mature plants in mid-July, dropping below the requirement of a lactating 1,200-pound cow at this time in the mature growth phase.

Green needlegrass

Releases	Date Released	Origin	Statement of Use
AC Mallard Ecovar	2002	Alberta, Saskatchewan, Canada	No major differences compared with other varieties.
Lodorm	1970	North Dakota	Selected for low seed dormancy. No other distinguishing traits from other varieties. Comparable in forage and seed yields.
SD-93	Experi-mental	South Dakota	Similar to Lodorm.

Fiber

Green needlegrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) of Lodorm increased linearly throughout the growing season, ranging from 29 percent in the 2.5-leaf stage to 47 percent by early October.

Lodorm ranked 15th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, green needlegrass would rank as a below-average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from Lodorm will occur from late July to early October, averaging peak production of 988 pounds of ADF per acre in late August. Green needlegrass was one of the few grasses to maintain a peak from late July through October. Green needlegrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July and maintaining TDN content at or above the minimum levels of a lactating cow through late July.

Performance Characteristics

Lodorm and SD-93 were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence was rated good and stand density counts were comparable with other high-rated species. Weed competition was rated moderately high at both locations. Stand ratings were good. They had no disease problems. Seed production and vigor were rated good at both sites.

Salinity Tolerance

The PLANTS database (USDA NRCS 2003) rated green needlegrass as medium for salinity tolerance. For comparison, tall wheatgrass and slender wheatgrass are rated as high and alfalfa is rated as low. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates green needlegrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

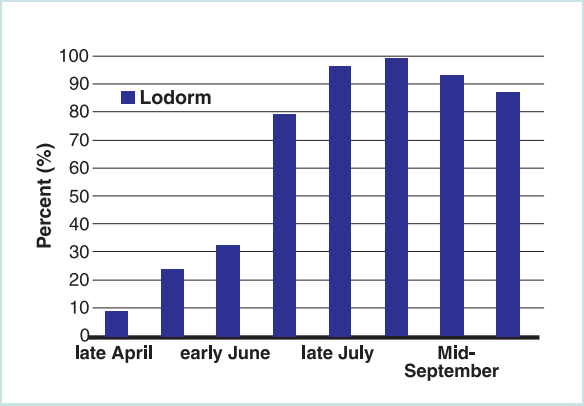
Green needlegrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 33 percent of the potential plant growth occurs by early June, with peak herbage production occurring from late July through mid-September. Lodorm grows most vigorously in June, with more than 47 percent of its growth occurring in this month. Lodorm retains more than 88 percent of the standing crop into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, crude protein and total digestible nutrients will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

Recommended Grazing Season:
early June through early October.

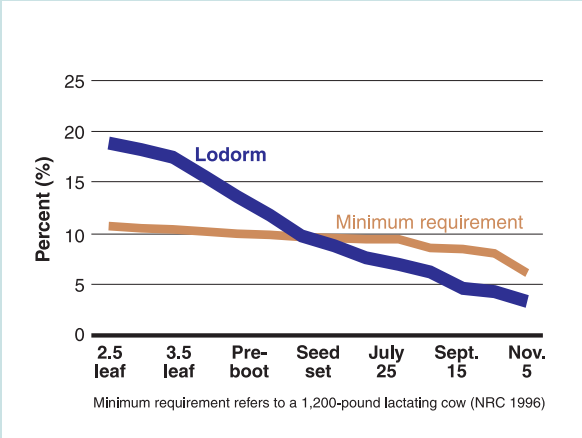
Hay Value

Green needlegrass will make fair to good hay if harvested before the seed-set stage; however, only 65 percent to 75 percent of its growth will occur by this growth stage. Also, green needlegrass is classified as a midstature plant, with much of the foliage produced close to the ground surface, leaving a higher than desired level of unharvestable forage. Green needlegrass

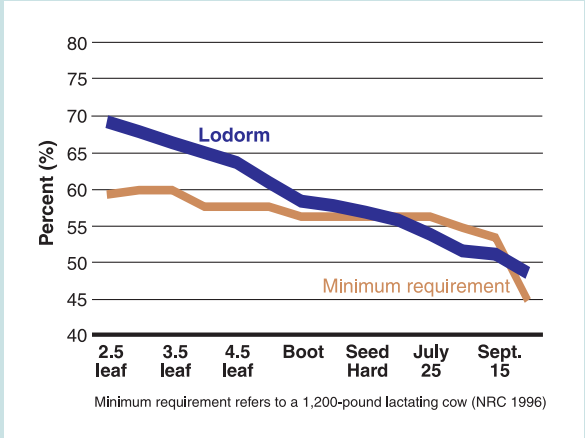
Green needlegrass



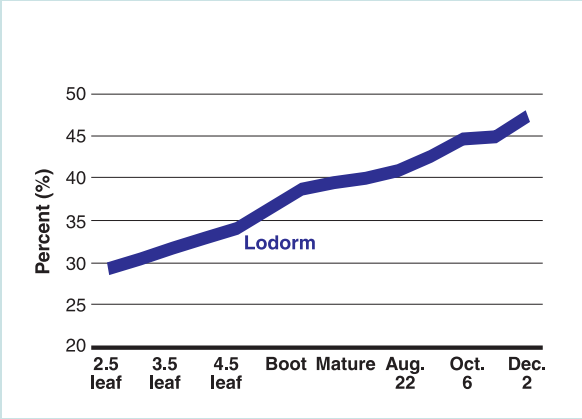
Percent of average peak standing biomass (2,564 lb/ac) for green needlegrass



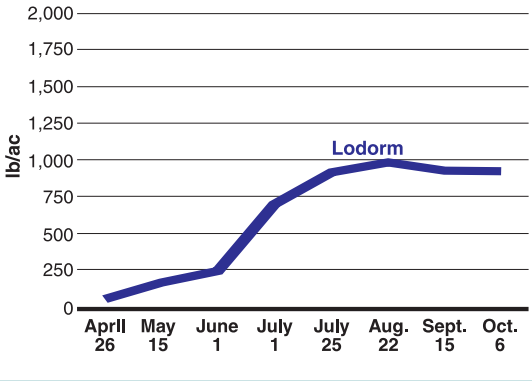
Crude protein content of green needlegrass



Total digestible nutrient content for green needlegrass



Acid detergent fiber content of green needlegrass



Pounds of acid detergent fiber produced per acre for each period of green needlegrass

is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Green needlegrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), green needlegrass should be harvested by late June to optimize harvest efficiency.

Recommended Haying Time: not highly recommended; early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Green needlegrass is a below-average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. Green needlegrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with native forbs, it provides structural diversity and insect populations for brood habitat.

Green needlegrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair into the dormant season, depending on plant maturation. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value	
Spring:	Good
Summer:	Excellent
Fall:	Good
Winter:	Fair

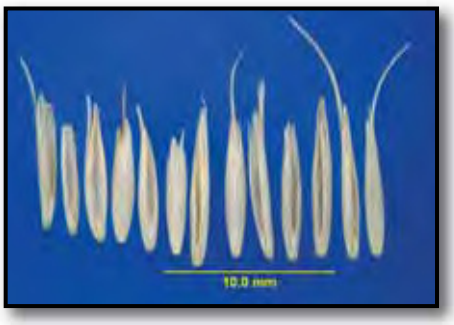
Forage Value	
Spring:	Excellent
Summer:	Good
Fall:	Good
Winter:	Fair
Regrowth:	Good

Bluebunch Wheatgrass

Bluebunch wheatgrass is native to North America and found on shallow and thin soils in xeric (dry) regions. It is adapted to grow on most dry soils. It is a cool-season grass that grows 12 to 24 inches tall, depending on soil type. It is considered a palatable wheatgrass, used primarily for pasture and rangeland.

Bluebunch wheatgrass is a perennial bunch grass used for revegetating native sites in drier climates. Bluebunch wheatgrass hybrid is used for revegetating alkaline and saline soils for grazing purposes. It has fair seedling vigor and needs one to two growing seasons to establish. The plant, especially the hybrid variety, becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending on stage of maturity when harvested. Bluebunch wheatgrass often is seeded with little bluestem, blue grama and green needlegrass in a mixture for native grass reclamation.

Bluebunch wheatgrass



Herbage Production

Bluebunch wheatgrass makes fair hay and good to excellent pasture in areas where moisture is fair to good. The bluebunch and quackgrass (*Agropyron repens*) hybrid (NewHy) is more adapted to other ecological sites and moisture regimes. Similar yields were recorded in the original study among all bluebunch wheatgrass varieties, including the quackgrass hybrids (Goldar, Secar and NewHy) in field trials from Fort Pierre, S.D., in all years. All three varieties died by the third year of the study near Fort Pierre. No differences were found among the three varieties at the Hettinger, N.D., site in all five years. The five-year mean production was 1,471, 1,431 and 1,395 lb/ac for Goldar, NewHy and Secar, respectively, near Hettinger. The two-year mean production was 166, 137, and 125 lb/ac for Secar, Goldar and NewHy, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production at the GPNS for bluebunch wheatgrass (Goldar) was 3,988 lb/ac and it ranked as the 15th most productive grass in this study. In a dry year when growing season moisture was less

Bluebunch wheatgrass

Species	Release	Date Released	Origin	Statement of Use
Pseudoroegneria spicata ssp spicata	**Anatone**	2003	Washington	Rapid establishment. High forage production. Ability to survive and thrive under dry conditions at or above 10 inches of rainfall.
Pseudoroegneria spicata ssp spicata	**P-7 Selected Germplasm**	2001	Idaho, Nevada, Oregon, Utah, Washington, and British Columbia, Canada	High genetic diversity.
Elytrigia repens var repens x Pseudoroegneria spicata	**NewHy hybrid**	1993	ARS, Logan, Utah	A hybrid-hybrid cross of bluebunch wheatgrass and quackgrass. More upright and significantly less rhizomatous than quackgrass. Tolerates heavier grazing pressure than bluebunch wheatgrass. Excellent palatability. Salinity tolerance similar to tall wheatgrass. Protein content and digestibility is equivalent or superior to other wheatgrasses.
Pseudoroegneria spicata ssp spicata	**Goldar**	1989	Washington	Rapid establishment. High forage production. Drought tolerant but grows best in areas receiving 12 inches or greater rainfall.
Elymus wawawainsis	**Secar**	1980	Idaho	Originally misidentified as bluebunch wheatgrass. It recently has been identified as a Snake River wheatgrass. Fair to good seedling vigor. One of the most drought- tolerant native perennial grasses available. Can survive with 8 inches of rainfall.
Pseudoroegneria spicata ssp inermis	**Whitmar**	1946	Washington	Good seedling vigor, long lived, drought tolerant. High forage and seed yields. Performs best in areas receiving 12 inches or greater rainfall.

than 11 inches, cumulative production was 1,920 lb/ac, and it was 3,412 lb/ac when growing season moisture was about 14 inches. Goldar ranked 15th, fifth and 14th among the 20 cool-season grass varieties studied in 1995 through 1997. Goldar was considered below average for productivity among all grasses studied in wet and dry years and above average during the 14-inch growing season moisture condition.

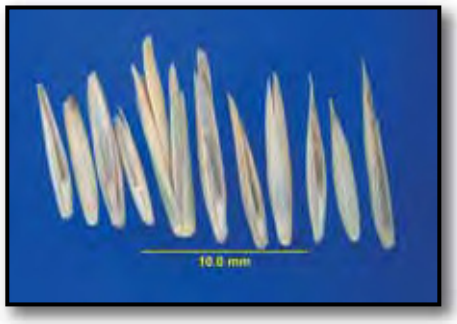
When growing season precipitation was greater than 16 inches, cumulative herbage production at the GPNS for NewHy was 3,508 lb/ac and it ranked as the 18th most productive grass in the trial. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,720 lb/ac, and it was 2,188 lb/ac when growing season moisture was about 14 inches. NewHy ranked 18th, 15th and 15th among the 20 cool-season grass varieties studied in 1995 through 1997. NewHy was considered below average for productivity among all grasses studied in this trial, irrelevant of moisture conditions.

Bluebunch wheatgrass will provide an excellent grass for native plant reclamation areas and re-establishment of pasture and rangeland with annual precipitation of 8 to 16 inches. NewHy will provide an excellent grass for reclamation areas and pasture development in saline and alkaline sites with annual precipitation of 14 to 22 inches.

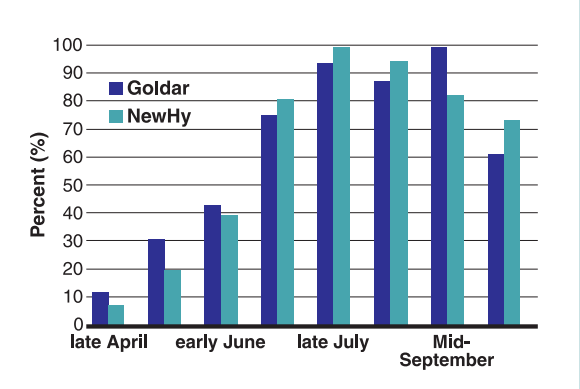
Growth Patterns

Goldar is a moderately aggressive spring growing cool-season grass, producing slightly more than 30 percent of its total growth by mid-May and more than 43 percent of its total growth by early June. NewHy is slower to grow in early May, reaching similar growth potential by early June. Both Goldar and NewHy reach about 80 percent of their growth potential by early July, peaking in late July through mid-September. Bluebunch wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability.

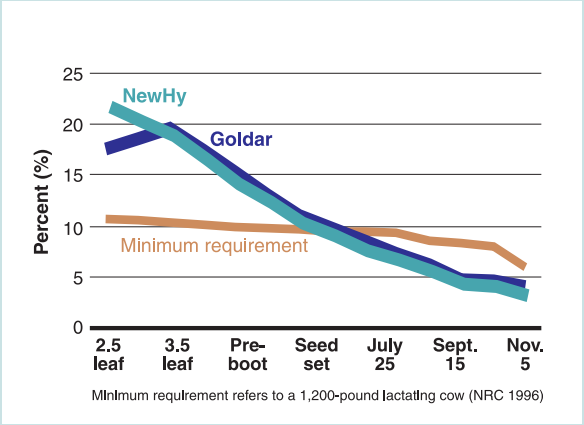
Bluebunch wheatgrass hybrid (NewHy)



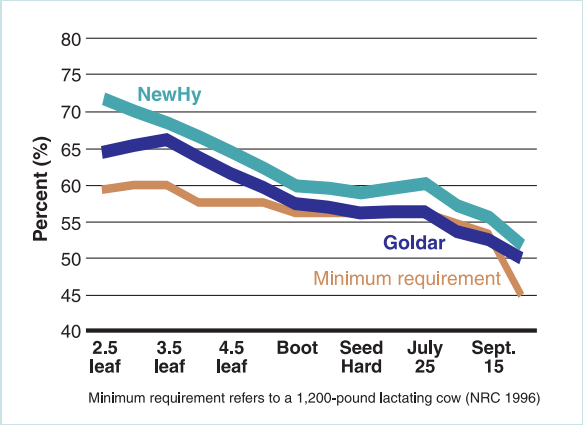
Bluebunch Wheatgrass



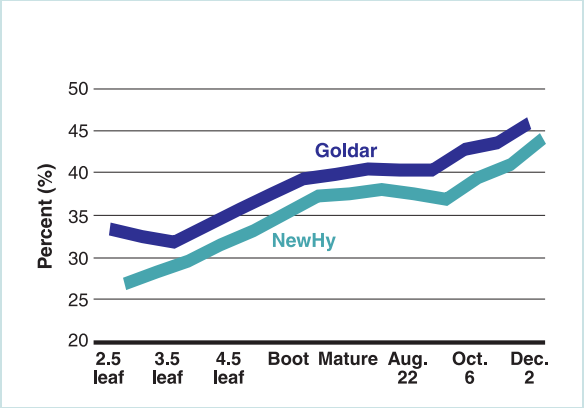
Percent of average peak standing biomass for bluebunch wheatgrass Goldar (3,107 lb/ac) and bluebunch wheatgrass/ quackgrass hybrid NewHy (2,472 lb/ac)



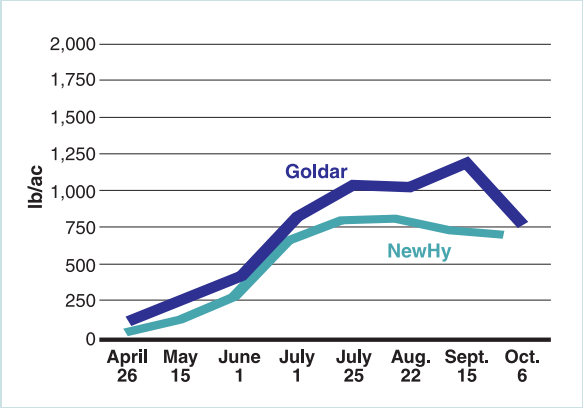
Crude protein content of bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Total digestible nutrient content for bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Acid detergent fiber content of bluebunch wheatgrass and bluebunch wheatgrass/quackgrass hybrid



Pounds of acid detergent fiber produced per acre for each period of bluebunch wheatgrass and bluebunch wheatgrass/ quackgrass hybrid

Bluebunch wheatgrass would make fair to good hay if harvested by late June or early July; however, production was low, compared with exotic grasses.

Nutritional Quality

Goldar and NewHy were very similar in nutritional quality - high in crude protein content (CP) - during the vegetative growth stages in May and early June. However, by the seed-set stage, CP was below 10 percent, and it was below 7 percent by late July when mature. The CP of the mature plant dropped below 5 percent by mid-August and below 4 percent when fully mature.

Both Goldar and NewHy maintained total digestible nutrients (TDN) above 55 percent until late August or mid-September. Total digestible nutrients never dropped below 50 percent through early October. Although CP was low by mid-July in mature plants, TDN remained high through early October or later.

Fiber

Goldar and NewHy were similar to all other cool-season grasses, with fiber content lowest at the 2.5- to 3.5-leaf stages, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season after the four-leaf stage, ranging from 29.5 percent in the vegetative stage to 49.5 percent by early October.

Goldar ranked ninth and NewHy 18th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, bluebunch wheatgrass would rank as an average fiber producer and NewHy a poor fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from bluebunch wheatgrass will occur in mid-September, averaging peak production of 1,184 pounds of ADF per acre, respectively. Harvesting maximum levels of fiber from NewHy will occur from late July to late August, averaging peak production of 795 to 806 pounds of ADF per acre, respectively. Goldar and NewHy would be considered moderately efficient cool-season grasses, reaching peak herbage and fiber production in late July through mid-September, maintaining TDN content at or slightly below the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

Performance Characteristics

Goldar, Secar and NewHy were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. NewHy is a hybrid between bluebunch wheatgrass and quackgrass. All three varieties established fairly well and were very similar in most performance characteristics, with good stand density counts and stand ratings at the Hettinger location. They had no disease problems. Goldar and Secar established more quickly on the lighter soils at the Hettinger site, compared with the heavy clay soil at the Fort Pierre site, where stand densities and ratings were low and weed competition rated high. The hybrid NewHy performed much better at the Fort Pierre site, compared with Goldar and Secar. Seed production was better for NewHy.

Salinity Tolerance

Salinity tolerance for bluebunch wheatgrass is rated as low by the PLANTS database (USDA NRCS 2003). For comparison, tall wheatgrass and slender wheatgrass are rated as high and alfalfa is rated as low. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates bluebunch wheatgrass as having a poor salt tolerance, based on the sodium adsorption ratio (SAR) values. However, the NewHy hybrid has half the parentage of quackgrass, and the Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated NewHy as very high for salt tolerance, with an electroconductivity (EC) measurement of 13 to 26 millimhos per centimeter (mmhos/cm), which was the same as for beardless wildrye and tall wheatgrass. Section IV of the North Dakota NRCS Field Office Technical Guide rates NewHy as having good salt tolerance, based on the SAR values.

Grazing Value

Bluebunch wheatgrass and NewHy would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. About 40 percent of the potential plant growth occurs by early June, with peak herbage production occurring from late July through mid-September. Bluebunch wheatgrass and NewHy grow most vigorously in May and June, with 60 percent to 70 percent of the growth occurring in these months. Bluebunch wheatgrass retains 60 percent to 70 percent of the peak standing crop into early October. When comparing growth pattern and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, CP and TDN will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

Recommended Grazing Season:
early June through early October.

Hay Value

Bluebunch wheatgrass will make fair to good hay and NewHy good hay if harvested before the seed-set stage, with 60 percent to 80 percent of plant growth occurring by this growth stage. Bluebunch wheatgrass is classified as a midstature plant, with much of the foliage close to the ground surface, leaving a higher than desired level of unharvestable forage. Bluebunch wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. NewHy could be used as a monoculture for hay in site-specific situations. Bluebunch wheatgrass and NewHy should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), bluebunch wheatgrass and NewHy should be harvested by late June to optimize harvest efficiency.

Recommended Haying Time: bluebunch wheatgrass is not highly recommended; however, NewHy would be recommended in high-saline areas. Harvest by early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Bluebunch wheatgrass and NewHy were average-producing grasses in dry and wet years, compared with other cool-season grasses. Bluebunch wheatgrass provides good cover on upland ecological sites all year due to its upright structure and standing residue. Bluebunch wheatgrass provides medium-sized structure that is somewhat retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with forbs and legumes, Bluebunch wheatgrass and NewHy will provide structural diversity and insect populations for brood habitat.

Bluebunch wheatgrass and NewHy are palatable grasses in the spring and summer, becoming less palatable as they mature. These grasses will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair into the dormant season. They have limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value

Spring:	Good
Summer:	Excellent
Fall:	Good
Winter:	Fair

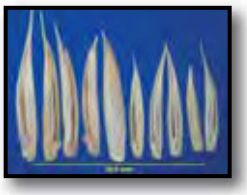
Forage Value

Spring:	Excellent
Summer:	Good
Fall:	Good
Winter:	Fair
Regrowth:	Fair

Crested Wheatgrass

Crested wheatgrass was introduced into the United States in 1906 from Russia and Siberian steppe habitats. The scientific name of crested wheatgrass is *Agropyron cristatum* (L.) Gaertn. (Poaceae). Wheatgrasses (Triticeae), including crested wheatgrass, frequently hybridize and often produce fertile crosses. Crested wheatgrass readily crosses with desert wheatgrass (*A. desertorum*) to produce fertile hybrids such as the variety HyCrest. Some taxonomists do not consider crested and desert wheatgrass to be distinct species.

Crested wheatgrass is a long-lived bunch grass used extensively for hay, pastureland and soil conservation. It has excellent seedling vigor and ease of establishment. The fairway types (e.g., Ephraim) are shorter, leafier and have fewer tendencies to form large clumps with age. Fairway types frequently are recommended for dryland lawns in areas receiving less than 13 inches of precipitation. Standard types (e.g., Nordan) tend be more productive than fairway types; however, they become clumpy under a haying program. HyCrest is a type of hybrid crested wheatgrass obtained by crossing standard and fairway types.



Standard (5 on left) and **Fairway** (5 on right)

Crested wheatgrass

Type	Species	Release	Date Released	Released by	Statement of Use
Fairway	*Agropyron cristatum*	**NU-ARS-AC2**	2002	ARS, Lincoln, Neb.	Greater average forage yields than other fairway types of crested wheatgrass. Yields equaled that of standard types of crested wheatgrass varieties. Averages 6 inches shorter in height than standard types of crested wheatgrass. Recommended for pasture and hay land.
Fairway	*Agropyron cristatum*	**RoadCrest**	1998	ARS, Logan, Utah	Significantly more rhizomatous than Ephraim. Recommended for use in low-maintenance turf applications.
Hybrid	*Agropyron cristatum x desertorum*	**HyCrest II**	1996	ARS, Logan, Utah	Increased growth characteristics under cold temperatures. Replaces the variety HyCrest.
Fairway	*Agropyron cristatum*	**Douglas**	1994	ARS, Logan, Utah	Larger seed sizes than other varieties. Excellent seedling vigor. Produces less forage than other varieties but is leafier and remains green longer into the growing season. Requires 13 to14 inches or more of annual precipitation. Not recommended for turfgrass applications.
Hybrid	*Agropyron cristatum x desertorum*	**HyCrest**	1984	ARS, Logan Utah	Easier to establish than standard or fairway types. Long- term production exceeds fairway types and equal to standard types of crested wheatgrass. Leaves and stems are coarser and more abundant than fairway types.
Fairway	*Agropyron cristatum*	**Ephraim**	1983	FS, Provo, Utah	Recommended for low-maintenance turf. Rhizomatous spreading roots form dense sod.
Fairway	*Agropyron cristatum*	**Ruff**	1974	ARS, Lincoln, Neb.	Rapid seed germination and easily established. Forage yields similar to Nordan. Superior resistance to root rot.
Fairway	*Agropyron cristatum*	**Parkway**	1969	Canada Dept. of Ag., Saskatoon, Saskatchewan	Good seed production and lodging resistance. Not recommended for turf applications. Recommended for hay and pasture seedings.
Standard	*Agropyron desertorum*	**Nordan**	1953	ARS, Mandan, N.D.	Very good forage yields. Good seedling vigor and very good drought tolerance.
Standard	*Agropyron desertorum*	**Summit**	1953	Canada Dept. of Ag., Saskatoon, Saskatchewan	Good seed yield and seed quality. Similar to other standard types.

Herbage Production

Crested wheatgrass makes excellent hay and pasture in areas where moisture is low to good and on many types of soils. Similar yields in the original study were recorded between the standard varieties (Nordan and Summit) of crested wheatgrass on field trials from Hettinger, N.D., and Fort Pierre, S.D. Similar yields were recorded among the fairway varieties (Parkway, Ephraim and Ruff) on field trials from Hettinger; however, Parkway was superior at Fort Pierre. The standard varieties were the superior-producing crested wheatgrasses, followed by the fairway/standard cross (HyCrest). The fairway varieties were lower producing among the crested wheatgrass varieties at both Hettinger and Fort Pierre, with the exception of Parkway at Fort Pierre. A five-year mean production was 2,012 and 1,919 lb/ac for Summit and Nordan at Hettinger, respectively, and 1,380 and 1,548 lb/ac at Fort Pierre, respectively. A five-year mean production was 1,391, 1,271 and 1,057 lb/ac for Ruff, Ephraim and Parkway at Hettinger, respectively, and 1,137, 1,107 and 1,614 lb/ac at Fort Pierre, respectively. The five-year mean production was 1,521 and 1,580 lb/ac for HyCrest at Hettinger and Fort Pierre, respectively. NU-ARS AC2 had the highest five-year mean production of the fairway wheatgrasses at Fort Pierre (1,647 lb/ac) and Hettinger (1,803 lb/ac).

In the GPNS, cumulative production was 3,268 lb/ac for Ephraim, 4,492 lb/ac for HyCrest and 4,948 lb/ac for Nordan when growing season precipitation was greater than 16 inches. In a dry year when growing season moisture was less than 11 inches, cumulative herbage production was reduced by 4 percent for Nordan, 15 percent for HyCrest and 30 percent for Ephraim, compared with a normal year of precipitation. During this normal year of precipitation, cumulative production ranged from 3,388 lb/ac for Nordan and 3,028 lb/ac for Ephraim to 2,480 lb/ac for HyCrest. All three varieties appear to be drought tolerant or water efficient; however, Nordan and HyCrest were more productive when moisture conditions were above average. Development of pasture or hay land with crested wheatgrass would be recommended in areas with fair to good moisture conditions and growing season precipitation ranging from 8 to 14 inches. When growing season precipitation is greater than 14 inches, other cool-season grasses will provide greater production with similar or higher quality.

Growth Patterns

All three varieties have vigorous growth in the spring, with 9 percent to 16 percent of total growth occurring in April and 40 percent to 46 percent of growth by late May or early June. Peak biomass production occurred for all three varieties in early July to late August, depending on moisture. Nordan and Ephraim maintained peaked standing crop levels until early October. HyCrest did not reach peak standing crop until late July, losing standing crop by mid-August, with only 50 percent of total weight remaining by early October. In comparison, both Nordan and Ephraim maintained 70 percent to 75 percent of peak standing crop in early October. All three varieties would make excellent pasture for spring and early summer grazing (early May to late June), based on growth patterns.

Nutritional Quality

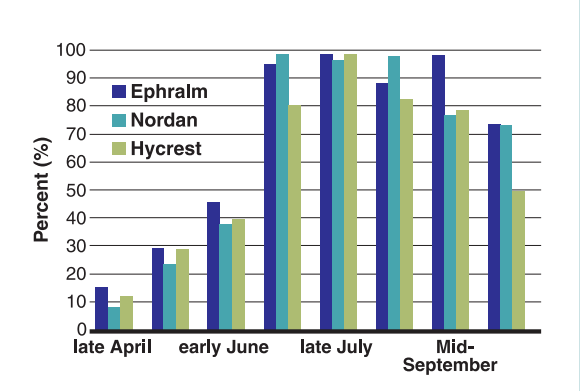
Ephraim and Nordan were 2 percent to 3 percent higher in crude protein content (CP) than HyCrest during the vegetative growth stage; however, all three varieties were similar in CP from July through November. All three varieties were at or above the 10 percent CP until the seed-set stage, dropping below 7 percent CP by the third week in July when plants were mature and cured. All three varieties had a CP of 5 percent or less by mid to late August when fully mature.

Total digestible nutrients (TDN) varied among varieties throughout the growing season; however, all three varieties were greater than 60 percent TDN through the boot stage of development. Nordan and HyCrest maintained a 55 percent TDN throughout the growing season, with all three less than 50 percent by early October.

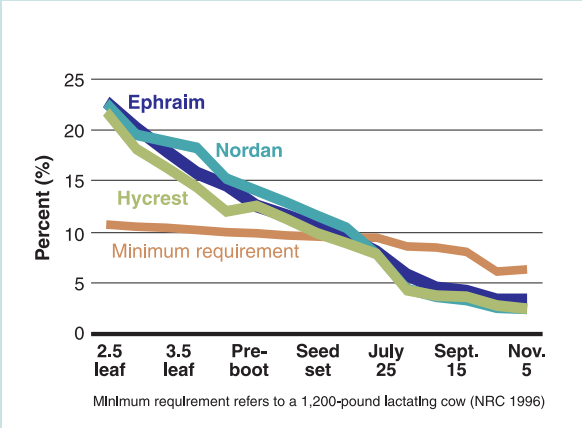
Fiber Content

Crested wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) was similar for all three varieties (Ephraim, Nordan and HyCrest) tested during all growth stages, with the exception of the three- to four-leaf stage. ADF increased gradually throughout the growing season, with no upward or

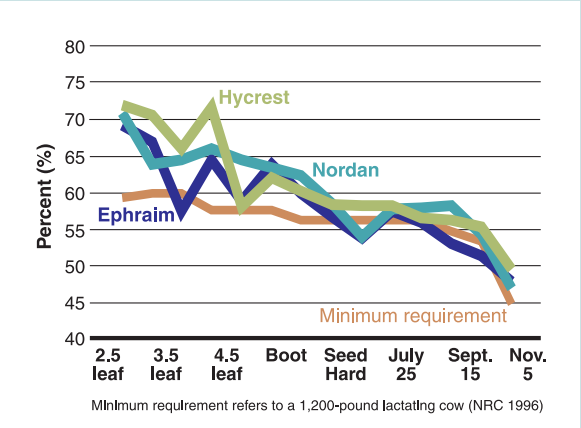
Crested wheatgrass



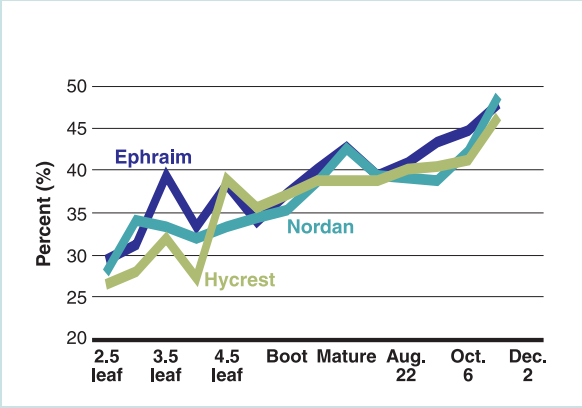
Percent of average peak standing biomass for crested wheatgrass Ephraim (2,801 lb/ac), Nordan (3,863 lb/ac) and Hycrest (3,027 lb/ac)



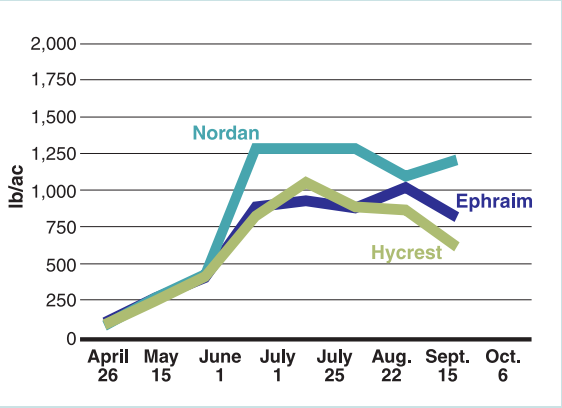
Crude protein content of crested wheatgrass



Total digestible nutrient content for crested wheatgrass



Acid detergent fiber content of crested wheatgrass



Pounds of acid detergent fiber produced per acre for each period of crested wheatgrass

downward spikes, and ranged from 26 percent to 29 percent in the 2.5-leaf stage to 46 percent to 49 percent by early October.

Nordan ranked sixth, HyCrest 11th and Ephraim 13th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, crested wheatgrass ranks average when compared with other cool-season grasses, with the Nordan variety above average. Harvesting maximum levels of fiber occurs throughout July and into August for Nordan, averaging 1,289 and 1,287 pounds of ADF produced per acre in early July and mid-August, respectively. HyCrest peaked in late July at 1,057 pounds of ADF produced per acre, while Ephraim peaked in early July, maintaining this peak ADF production through mid-September at 1,017 lb/ac. Crested wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in early July to mid-September when TDN is at or above and CP slightly to well below the minimum levels of a lactating cow.

Performance Characteristics

Parkway, Ephraim, Ruff, Summit, Nordan, HyCrest and CD-II crested wheatgrass varieties were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Parkway had the best emergence and stand density at Hettinger. Stand ratings and plant height all were comparable at both sites. Nordan and HyCrest were generally the tallest entries. They had no disease problems. Seed production was slightly better for Nordan, HyCrest and NU-ARS AC2. Ephraim was rated lower than the other entries for vigor and seed production.

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated crested wheatgrass as high for salt tolerance. The electroconductivity (EC) was 6 to 16 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates crested wheatgrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

Crested wheatgrass, irrelevant of variety, will provide excellent grazing in May and June. When comparing growth patterns and nutritional value, livestock grazing from early May through late June will optimize forage use and nutrient content. Nordan and HyCrest provided 27 percent to 34 percent more forage than Ephraim during the high-moisture year, while Nordan provided 35 percent more forage than either Ephraim or HyCrest during the dry year. During the average-moisture year, Nordan produced greater forage, with Ephraim ranked second and HyCrest third.

Although TDN for crested wheatgrass will be adequate throughout much of the growing season (Ephraim will become deficient by mid-August if vegetative plants are limited), crude protein will become deficient by mid-July. To optimize forage quality with growth, terminate livestock grazing by late June or early July.

Recommended Grazing Season:
early May to mid-June.

Hay Value

Crested wheatgrass will make good hay because of its high palatability and quality when harvested at the proper time. Nordan and HyCrest, based on the findings from this study, would be recommended over Ephraim because of the more productive, taller plants. Crested wheatgrass should be cut by the third week in June to maintain good CP (9.5 percent to 11 percent) and TDN (> 59 percent) for winter feed and early July to maintain highest quantity and provide the minimum CP levels for nonlactating animals.

Harvest efficiency was different among the three varieties studies. When optimizing quality with production (lb + CP), all varieties should be harvested by late June to optimize harvest efficiency. Nordan was 8 percent and 16 percent more efficient than Ephraim and HyCrest, respectively, in capturing CP and production (lb of CP/acre) in this study.

Recommended Haying Time: late June or early July for a nonlactating ration and optimum quality and production; mid to third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Crested wheatgrass was moderately to highly productive in normal to wet years, depending on variety, compared with other cool-season grasses, and good producing in dry years. All three varieties will provide good cover in the spring due to its vigorous spring growth; however, Nordan and Ephraim will provide better cover in the fall, with only a 25 percent loss from peak standing crop, compared with 50 percent for HyCrest. Nordan and HyCrest produce taller, dense clumps that will maintain height and structure during the winter months. Its use for grassland nesting birds is relatively limited since it often exists in a monoculture, thus lacking structural diversity. The inability to maintain forbs and legumes in a mix with crested wheatgrass limits the production of insects important for brooding habitat.

Crested wheatgrass does remain rigid into winter; however, its short stature and monoculture tendencies limit its winter cover use for many wildlife species. Crested wheatgrass is a very palatable grass that provides good growth in the spring and lush regrowth in the fall. This growth provides a high feed value for some foraging animals, especially deer in the spring and fall, and occasionally in summer months when moisture is sufficient for regrowth. It has limited use for native pollinators. Seeds are of limited use.

Cover Value

Spring:	Fair
Summer:	Fair
Fall:	Fair
Winter:	Poor

Forage Value

Spring:	Excellent
Summer:	Fair
Fall:	Good
Winter:	Poor
Regrowth:	Fair

Intermediate Wheatgrass

Intermediate wheatgrass was introduced into the United States in the mid-1900s from Russia. It has proven to be well-adapted to the Central Great Plains and Pacific Northwest regions. It is less hardy and drought resistant than crested wheatgrass; however, it is more productive when moisture is average to high. It is slower to grow in the spring, producing most of its growth in June and July.

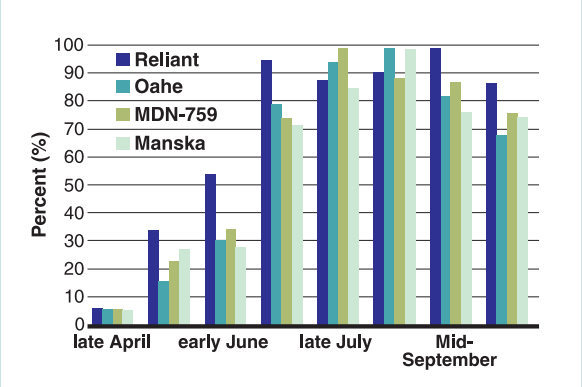
Intermediate wheatgrass is a vigorous, fast-growing, moderately long-lived, sod-forming grass used extensively for hay, pastureland and soil conservation. The pubescent wheatgrass varieties are reported to be more drought tolerant and form a sod more rapidly than the intermediate varieties. Intermediate and pubescent wheatgrass are considered the same species. They have excellent seedling vigor and ease of establishment, and are fast growing. Intermediate wheatgrass was and continues to be common grass used in Conservation Reserve Program plantings in the Northern Great Plains region.

Intermediate wheatgrass

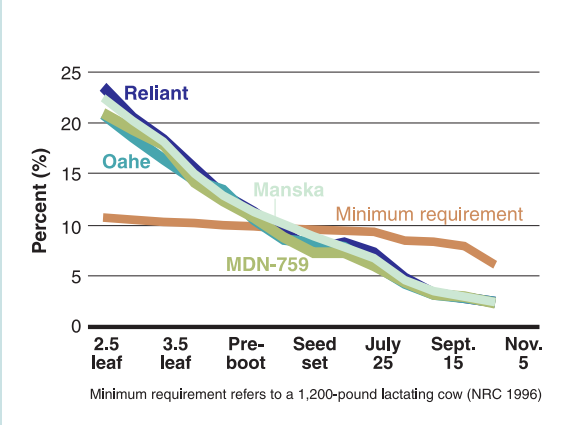
Type	Species	Release	Date Released	Released by	Statement of Use
Intermediate	*Thinopyrum intermedium*	**Manifest**	2007	ARS, Mandan, N.D.	Excellent stand establishment with improved forage yields and improved persistence because of higher tiller densities.
Intermediate	*Thinopyrum intermedium*	**Haymaker**	2003	ARS, Lincoln, Neb.	High forage yields. Forage quality less than Beefmaker but similar to that of other varieties. Taller than most other intermediate wheatgrass varieties.
Intermediate	*Thinopyrum intermedium*	**Beefmaker**	2003	ARS, Lincoln, Neb.	Forage yields less than Haymaker but similar to yields of other released varieties. Good forage quality.
Intermediate	*Thinopyrum intermedium*	**Rush**	1994	Idaho AES and USDA-SCS, Aberdeen, Idaho	Superior seedling emergence and vigor. Good rate of spread by rhizomes. High forage and seed production. Largest seed of the intermediate wheatgrasses. Not adapted to hay land mixes with alfalfa. Did not perform well in trials at Bismarck, N.D.
Intermediate	*Thinopyrum intermedium*	**Reliant**	1991	ARS, Mandan, N.D.	Improved forage production, seed production, forage quality and winter survival. Improved seedling vigor and resistant to leaf spot. Late maturing. Recommended for hay land containing alfalfa as part of the mix.
Intermediate	*Thinopyrum intermedium*	**Clarke**	1980	Ag. Canada, Swift Current, Saskatchewan	Drought-tolerant, winter-hardy variety. High seed yields.
Intermediate	*Thinopyrum intermedium*	**Slate**	1969	Nebraska AES	Strong rhizomatous spread, broad flat leaves, erect form, slate green.
Intermediate	*Thinopyrum intermedium*	**Chief**	1961	Ag. Canada, Saskatoon, Saskatchewan	High seed yields. High forage quality recommended for hay land in mixes with alfalfa. Short-term pasture. Remains productive for 5 years under heavy grazing pressure.
Intermediate	*Thinopyrum intermedium*	**Oahe**	1961	South Dakota AES	Bluish green. Good seedling vigor. Drought tolerant. High seed yields. Rhizomatous traits.
Intermediate	*Thinopyrum intermedium*	**Tegmar**	1968	USDA-SCS, Aberdeen, Idaho	Dwarf growth form (half the height of other varieties). Long lived, late maturing, vigorous seedlings. Rapidly developing rhizomes. Drought tolerant.

Type	Species	Release	Date Released	Released by	Statement of Use
Intermediate	*Thinopyrum intermedium*	**Amur**	1952	New Mexico AES	Leafy, vigorous growth, strong seedling vigor. Good seed production. Slow sod former. Replaced by other varieties that are more widely adapted and have better forage production.
Intermediate	*Thinopyrum intermedium*	**Greenar**	1945	Washington, Idaho, Oregon, AESs	Leafy, broadleafed variety. Late maturing and high forage production. Moderate sod yields.
Pubescent	*Thinopyrum intermedium spp. trichophorum*	**Manska**	1992	ARS, Mandan, N.D.	Improved vigor, high forage and seed production. High nutritional quality is the primary advantage over other varieties. Resistant to leaf spot. Recommended for hay land containing alfalfa in mix and pasture.
Pubescent	*Thinopyrum intermedium spp. trichophorum*	**Greenleaf**	1966	Canada Dept. of Ag., Lethbridge, Alberta	Higher forage yields than Topar. Improved seedling vigor over Mandan 759. Winter hardy. Stands will not maintain high productivity under continuous heavy grazing.
Pubescent	*Thinopyrum intermedium spp. trichophorum*	**Luna**	1963	USDA-SCS, Los Lunas, N.M.	Excellent seedling vigor, fast establishment. Good forage production. One of the most broadly adapted pubescent wheatgrasses available and performs well from the central to northern Great Plains to the northern Rockies and Sierra Nevada region.
Pubescent	*Thinopyrum intermedium spp. trichophorum*	**Topar**	1953	USDA-SCS, Aberdeen, Idaho	Very good seedling vigor, very rhizomatous. Seed production is moderate and seed does not shatter easily.
Pubescent	*Thinopyrum intermedium spp. trichophorum*	**Mandan 759**	Never officially released	ARS, Mandan, N.D.	Replaced with the variety Manska.

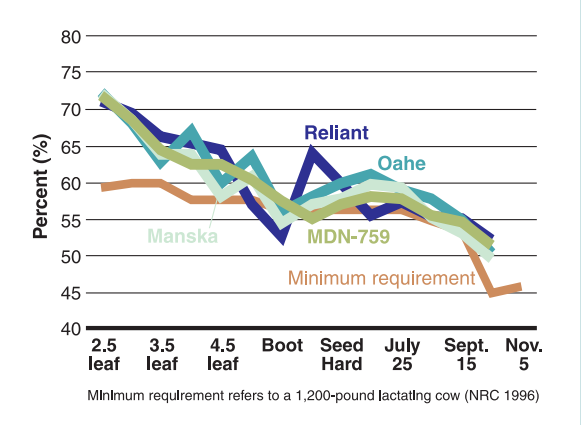
Intermediate wheatgrass



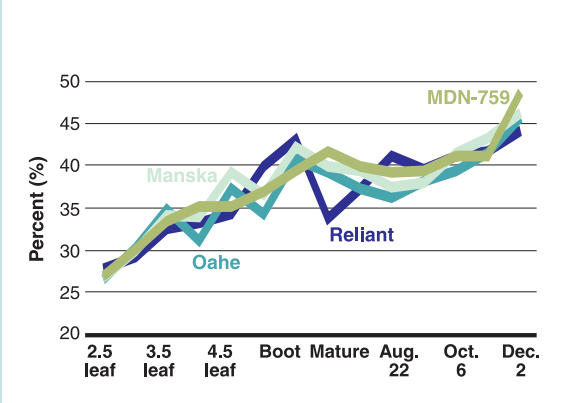
Percent of average peak standing biomass for intermediate wheatgrass Reliant (3,928 lb/ac) and Oahe (3,613 lb/ac) and pubescent wheatgrass Manska (4,244 lb/ac) and MDN-759 (3,787 lb/ac)



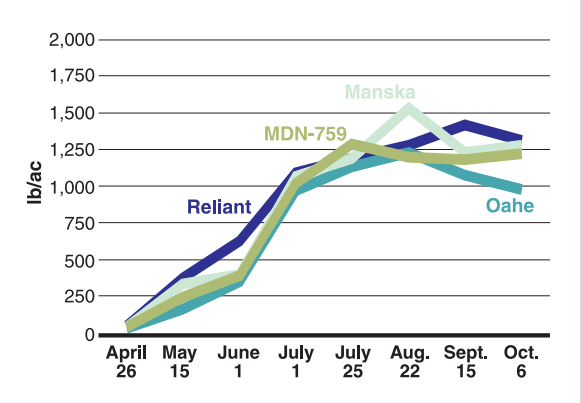
Crude protein content of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Total digestible nutrient content for intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Acid detergent fiber content of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)



Pounds of acid detergent fiber produced per acre for each period of intermediate (Reliant and Oahe) and pubescent wheatgrass (Manska and MDN-759)

Herbage Production

Intermediate wheatgrass is a widely adapted grass that makes good hay and fair to good pasture in areas where moisture is fair to high and on many soils types. Similar yields were recorded in the original study among the intermediate (Chief, Clarke, Reliant, Oahe, Slate, Haymaker) and pubescent (Greenleaf, MDN-759, Manska) varieties on field trials from Hettinger, N.D., and Fort Pierre, S.D., except 1994 at Fort Pierre. Oahe produced more herbage than Chief and Greenleaf in 1994. A five-year mean production was 2,764, 2,715, 2,629, 2,530, 2,527, 2,337, 2,276, 2,276 and 2,103 lb/ac for Haymaker, Manska, Clarke, Chief, Reliant, Greenleaf, Oahe, MDN-759 and Slate, respectively, at Hettinger. A five-year mean production was 2,424, 2,201, 2,049, 1,950, 1,916, 1,816, 1,747, 1,679 and 1,576 lb/ac for Oahe, Haymaker, Slate, MDN-759, Manska, Reliant, Clarke, Chief and Greenleaf, respectively, at Fort Pierre.

In the GPNS, no differences were noted among all four varieties when comparing herbage production during the wet or dry year. During a nearly normal precipitation year, both pubescent wheatgrass varieties MND-759 and Manska produced greater production than the intermediate wheatgrass varieties Oahe and Reliant. When growing season precipitation was greater than 16 inches, cumulative production was 6,132 lb/ac for Reliant, 5,840 lb/ac for Manska, 5,452 lb/ac for Oahe and 5,320 lb/ac for MDN-759. In a dry year when growing season moisture was less than 11 inches, cumulative herbage production was very similar among the varieties (2,320 to 2,812 lb/ac). During the nearly normal precipitation year and with growing season moisture of about 14 inches, cumulative production was greatest with Manska at 9 percent, 26 percent and 30 percent greater than MDN-759, Reliant and Oahe, respectively.

All four varieties appear to be somewhat drought tolerant or water efficient. Development of pasture or hay land with intermediate wheatgrass would be recommended in areas with fair to good moisture conditions, with growing season precipitation 12 inches or more. When growing season precipitation is less than 12 inches, other cool-season grasses will provide greater production with similar or higher quality.

Growth Patterns

Intermediate wheatgrass is not a vigorously growing grass in the spring; however, varietal differences did occur. Reliant was the most aggressive spring growing grass, with 35 percent of total growth occurring by mid-May and 54 percent of growth by early June. Oahe was the slowest spring growing grass, with only 16 percent of total growth occurring by mid-May and 30 percent of growth by early June. The pubescent wheatgrass varieties were moderate in spring growth vigor and very similar among varieties, with 25 percent of total growth occurring by mid-May and about 30 percent to 35 percent of growth by early June. All four varieties reached peak standing crop by late July to mid-August. Reliant and Manska retained much of their production through mid-September, with Reliant maintaining 88 percent of the peak production through early October. Oahe and MDN-759 were least effective in retaining their growth into October, with a 32 percent loss from peak standing crop by early October. Oahe appears to be less vigorous and Reliant more vigorous in May and June. Oahe would be least desirable, compared with the other varieties, for late spring or early summer pastures or hay, based on the findings from this study.

Nutritional Quality

All four varieties were very similar in crude protein content (CP) in early vegetative growth through maturation. Reliant and MDN-759 were 1.5 percent to 2 percent higher in CP than Manska or Oahe in the boot stage through seed hardening (mid-June to mid-July). All four varieties were at or above the 10 percent CP through the boot stage, dropping below 5 percent CP by the third week in July in maturing plants. All four varieties had a CP of 4 percent or less from late August through early October.

Total digestible nutrients (TDN) were variable among all varieties throughout the growing season. All four varieties were at or above 55 percent TDN until mid-September, remaining at or near 50 percent in early October. All varieties met the minimum requirements of a lactating cow until mid-September and a dry cow until early October.

Fiber

Intermediate and pubescent wheatgrass were similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) was similar for all varieties (Reliant, Oahe, Manska and MDN-759) during all growth stages. ADF increased dramatically from the 2.5-leaf stage through seed set, ranging from 26 percent to 28 percent in the 2.5-leaf stage to 39 percent to 43 percent by the seed-set stage. ADF did not change from seed set (~ mid-July) through mid-September, peaking at 44 percent to 49 percent in early October.

Manska ranked third, Reliant fifth, Oahe seventh and MDN-759 eighth out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period of this study. When selecting a grass to produce maximum levels of fiber per acre, intermediate and pubescent wheatgrass would rank high when compared with other cool-season grasses, particularly Manska and Reliant, with only basin wildrye (Magnar) and tall wheatgrass (Alkar) superior to Manska. Harvesting maximum levels of fiber occurs in mid-August for Manska and Oahe and into mid-September for Reliant. The average peak production was 1,527, 1,419, 1,288 and 1,230 pounds of ADF per acre for Manska, Reliant, Oahe and MDN-759, respectively. Intermediate wheatgrass (Oahe) and pubescent wheatgrass (Manska, MDN-759) would be considered low to moderately efficient cool-season grasses, reaching peak herbage and fiber production from late July through mid-September when TDN is at or above and CP well below the minimum levels of a lactating cow. Intermediate wheatgrass (Reliant) would be considered a highly efficient cool-season grass, with aggressive spring growth when nutritional quality was high, and retaining peak production through mid-September when fiber content was greatest.

Performance Characteristics

Chief, Clarke, Reliant, Oahe, Slate, Greenleaf, MDN-759 and Manska were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence and stand densities were similar at both sites. Slate was rated the highest for stand emergence and had the highest stand density the year of establishment at Hettinger. Reliant had the highest stand density the second growing season at Hettinger. All entries had good stand ratings. Haymaker, Reliant and Chief were among the taller entries. They had no disease problems except in 1994 at Fort Pierre. Seed production was rated as excellent for all entries in 1993, and reduced to poor to fair yields in 1994 and 1996 at Hettinger.

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated intermediate wheatgrass as moderate for salt tolerance. The electroconductivity (EC) was 6 to 12 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates intermediate wheatgrass as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

Intermediate and pubescent wheatgrass will provide good grazing from mid-May through early July for Reliant and late May through early July for Manska, Oahe and MDN-759. When comparing growth patterns and nutritional value, livestock grazing from mid to late May through late June will optimize forage use and nutrient content; however, with a rotational grazing system, the potential to extend the nutritional quality through late September may be achieved by maintaining immature plants.

Although TDN for intermediate wheatgrass, irrelevant of variety, will be adequate throughout much of the growing season, crude protein will become deficient by mid to late July, depending on the number of plants in the vegetative growth stage. To optimize forage quality with growth, begin grazing in mid to late May and terminate grazing by mid-July. Manska and Reliant appeared to be superior varieties over Oahe and MDN-759.

Recommended Grazing Season:
mid to late May to mid-July.

Hay Value

Intermediate and pubescent wheatgrass will make good hay because of their good palatability and quality when harvested at the proper time. The Manska and Reliant varieties would be recommended over Oahe due to higher productivity, with Reliant producing more of its potential growth in June and early July, when forage quality is highest. Intermediate wheatgrass should be cut by the third week in June to maintain good CP (9.5 percent to 11 percent) and TDN (> 55 percent) for winter feed; however, less than 70 percent of the total growth is achieved by this time period. Only Reliant had produced more than 90 percent of the total growth by the third week in June. Harvest Manska, MDN-759 and Oahe in mid-July to optimize quantity of growth and quality that maintains a minimum CP level for nonlactating animals. Reliant can be harvested in early July to optimize quantity of growth and quality that maintains a minimum CP level for nonlactating animals.

Harvest efficiency was different among the four varieties studies. When optimizing quality with production (lb + CP), all varieties should be harvested in late June or early July to optimize harvest efficiency. Reliant was 7 percent, 9 percent and 16 percent more efficient than Oahe, MDN-759 and Manska, respectively, in capturing CP and production (lb of CP/acre) in this study.

Recommended Haying Time: Reliant:
early July for a nonlactating ration and optimum quality and production; the third week in June for a lactating ration, optimum quality and good production;
Manska, MDN-759, Oahe: mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Intermediate wheatgrass is highly productive in normal to wet years, compared with other cool-season grasses, and good producing in dry years. All four varieties will provide good cover in late spring due to their moderate spring growth and high carry-over of standing residue. Reliant, Manska and MDN-759 will provide better cover in the fall due to only a 10 percent to 20 percent loss of herbage, compared with 30 percent loss with Oahe. All varieties will provide tall, dense clumps that will maintain height and structure during the winter months, providing good winter cover for many bird, and small and midsized mammals. When used in conjunction with forbs and legumes (e.g., alfalfa), it can provide excellent grassland nesting bird habitat. This combination also provides diversity in structure and insect population for brood habitat.

Intermediate wheatgrass is a palatable grass that provides good growth in the spring and regrowth in the fall. This growth provides a high feed value for foraging animals in the spring and fall, and summer months when moisture is good. Intermediate wheatgrass has poor quality and palatability during the winter months; however, it does provide winter cover for resident wildlife species due to its rigidity. This tendency to

remain upright during the winter makes it very attractive in the spring for grassland nesting birds. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value

Spring:	Good
Summer:	Excellent
Fall:	Excellent
Winter:	Excellent

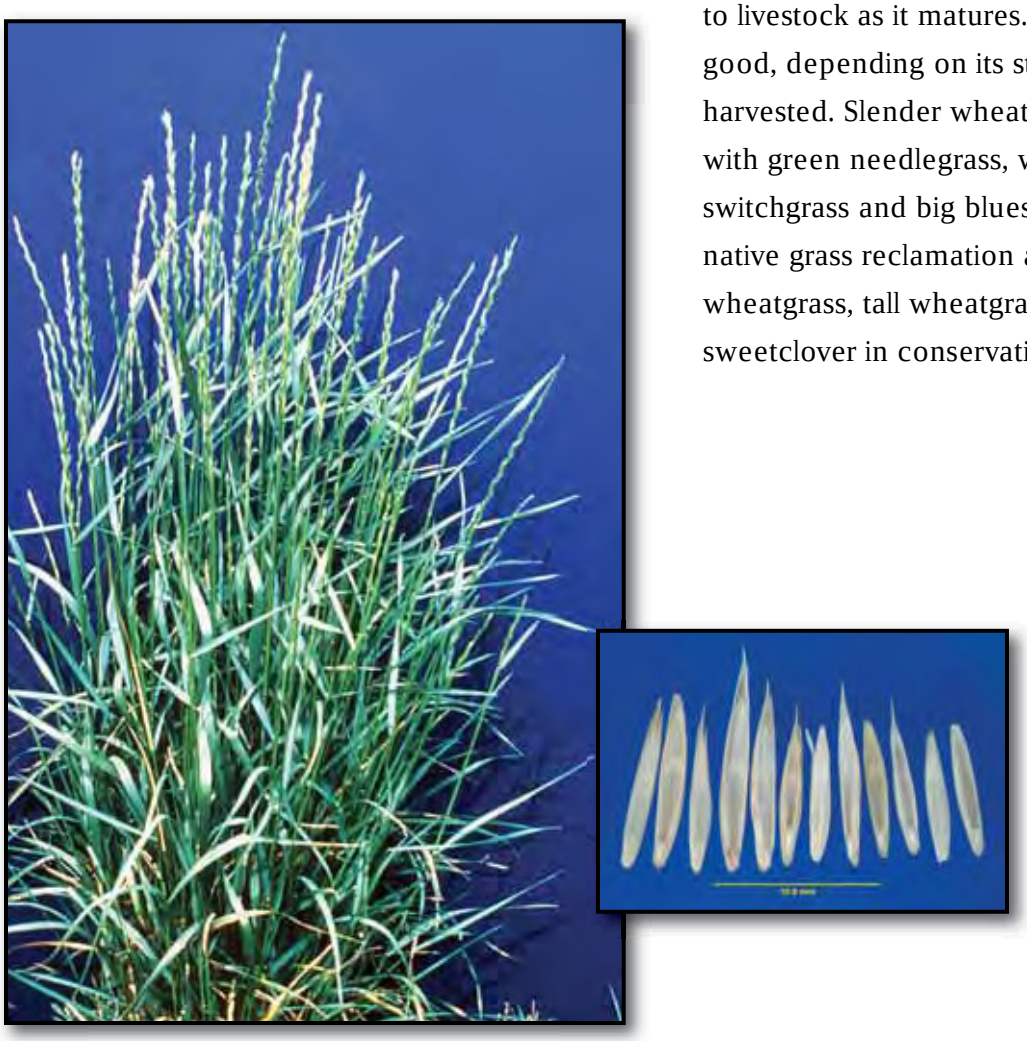
Forage Value

Spring:	Excellent
Summer:	Fair
Fall:	Good
Winter:	Poor
Regrowth:	Good

Slender Wheatgrass

Slender wheatgrass is native to North America and found on clay, loamy, wet meadow and saline lowland ecological sites. It is adapted to grow on wet, alkaline soils that experience spring flooding. It is a cool-season grass that grows to 12 to 24 inches tall, depending on soil type, with good yields when sufficient moisture is present. It is considered a palatable wheatgrass, used primarily for pasture and rangeland. It often is used in seed mixtures for native and conservation program plantings to achieve quick establishment and cover.

Slender wheatgrass is a perennial, sod-forming grass used for revegetating clay to loamy soils, saline and alkali soils, and conservation plantings, and in a mixture for hay. It has good seedling vigor and is easy to establish. The plant becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending on its stage of maturity when harvested. Slender wheatgrass often is seeded with green needlegrass, western wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation and with intermediate wheatgrass, tall wheatgrass, alfalfa and/or sweetclover in conservation plantings.



Herbage Production

Slender wheatgrass makes fair to good hay and good pasture in areas where moisture is fair to excellent. Similar yields in the original study were recorded among all slender wheatgrass varieties (Adanac, Pryor and Primar) in field trials from Fort Pierre, S.D., in all five years. Revenue did not establish successfully near Fort Pierre. No differences were found among the four varieties at the Hettinger, N.D., site in two of five years. Revenue had greater yields than the other three varieties in the other three years. The five-year mean production was 2,042, 1,383, 1,241 and 1,154 lb/ac for Revenue, Primar, Adanac and Pryor, respectively, near Hettinger. The five-year mean production was 1,777, 1,701 and

Slender wheatgrass

Releases	Date Released	Origin	Statement of Use
FirstStrike	2007	Colorado, Wyoming	Improved seedling vigor equal to or greater than current cultivars. Taller than San Luis, but shorter than Pryor. Flag leaves wider and longer than San Luis. Germinates five days earlier than Pryor.
AC Pintail Ecovar (awned wheatgrass)	2002	Manitoba, Saskatchewan, Alberta, Canada	Establishes quickly. Longer lived than slender wheatgrass.
AC Sprig Ecovar (awned wheatgrass)	2002	Alberta, Saskatchewan, Canada	Establishes quickly. Longer lived than slender wheatgrass.
AEC Hillcrest	1994	Alberta, Canada	Similar forage production as Revenue at elevations of 6,000 feet. Seed ripens two weeks earlier than Revenue.
Adanac	1990	Saskatchewan, Canada	Taller with less leaf-to-stem ratio than Revenue. Superior in establishment, persistence and productivity under saline conditions compared with Revenue. Higher forage yields, but forage quality less than Revenue.
Pryor	1988	Montana	Superior to other slender wheatgrass varieties in drought tolerance, saline tolerance and seedling vigor. Earlier to mature and has a larger seed compared with other varieties.
San Luis	1984	Colorado	Rapid establishment and longevity. Performs best at elevations above 6,000 feet in areas receiving more than 14 inches of annual precipitation.
Elbee	1980	Alberta, Saskatchewan, Canada	High seedling vigor, excellent germination. Aggressive root system, good forage and seed yields.
Revenue	1970	Saskatchewan, Canada	Superior to Primar in establishment, salinity tolerance, forage and seed yield. Higher leaf to stem ratio, dry matter digestibility and greater smut resistance than Primar.
Primar	1946	Montana, Washington	Superior to other varieties in resistance to head smut. Resistant to leaf, stem and stripe rust. Good seed production. Usually 10 days earlier in seed maturity and 5 to 10 inches taller than other varieties. Alkali tolerant.

1,684 lb/ac for Pryor, Primar and Adanac, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Revenue was 4,988 lb/ac and ranked the as the eighth most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 2,680 lb/ac, and it was 2,040 lb/ac when growing season moisture was about 14 inches. Revenue ranked eighth, 17th and sixth among the 20 cool-season grass varieties studied in 1995 through 1997. Revenue was considered slightly above average for productivity among all grasses studied, irrelevant of moisture conditions. Slender wheatgrass will provide an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 10 to 24 inches.

Growth Patterns

Revenue was a slow spring growing cool-season grass, producing slightly more than 20 percent of its total growth by late May or early June. Much of the plant's growth occurs in June and July, with almost 80 percent of its growth occurring during these two months. Peak production occurs by late July, declining with maturation to less than 68 percent of peak standing crop by early October. Slender wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, nutritional quality and palatability. Slender wheatgrass would make fair to good hay land if harvested by early July; however, production was low compared with other exotic grasses.

Nutritional Quality

Revenue was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, by the seed-set stage, CP was below 10 percent, and it dropped below 7 percent by late July when mature. The CP of the mature plant dropped below 5 percent by mid-August, and below 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July when mature. Total digestible nutrients never dropped below 50 percent until early October, when TDN content was 46.1 percent. Although CP was low by mid-July in mature plants, TDN remained adequate until late August.

Fiber

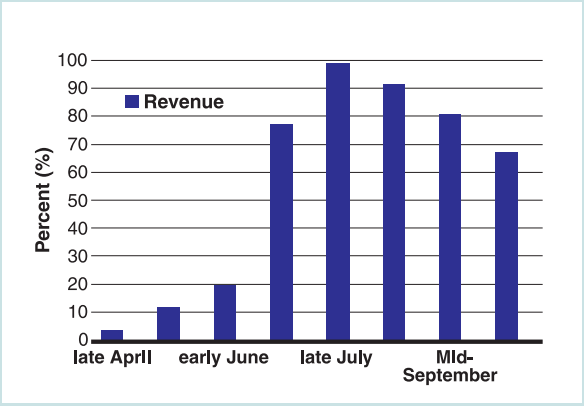
Slender wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5- to four-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season after the fourth-leaf stage, ranging from 29.5 percent in the vegetative stage to 49.5 percent by early October.

Revenue ranked ninth out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Revenue would rank as an average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from Revenue will occur from late July to late August, averaging peak production of 1,185 to 1,139 pounds of ADF per acre, respectively. Slender wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, and maintaining TDN content at or slightly below the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

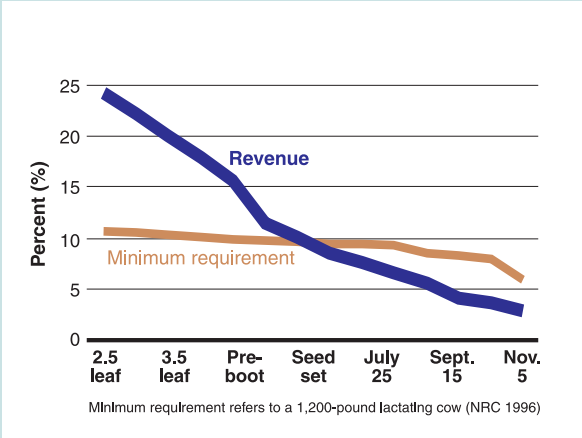
Performance Characteristics

Revenue, Adanac, Pryor and Primar were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Adanac and Primar had the best emergence at Hettinger. Revenue and Adanac had the highest rated stand density at Hettinger. Revenue failed to establish at Pierre due to low germination of the seed lot. Stand ratings were all comparable at both sites. Revenue was the tallest entry at Hettinger. Stem and leaf rust was rated moderate for all entries. Seed production was higher at Hettinger.

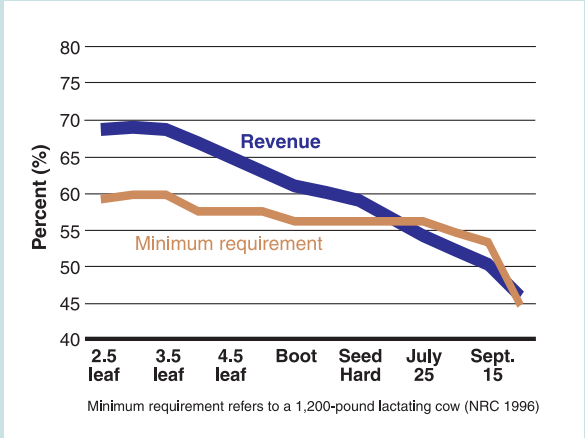
Slender wheatgrass



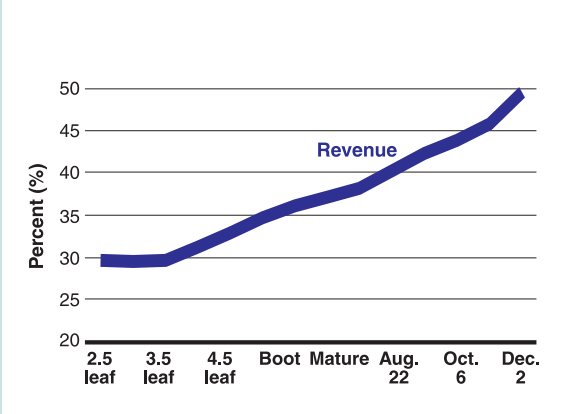
Percent of average peak standing biomass (3,236 lb/ac) for slender wheatgrass



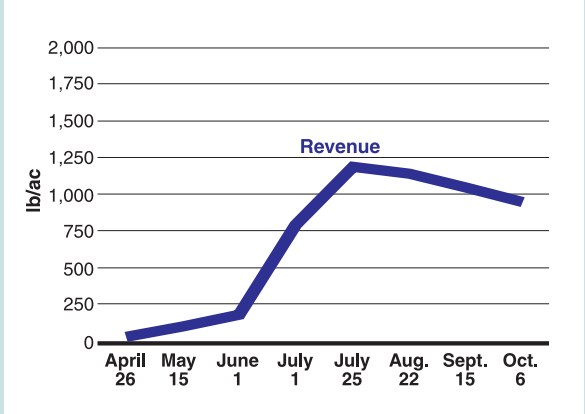
Crude protein content of slender wheatgrass



Total digestible nutrient content for slender wheatgrass



Acid detergent fiber content of slender wheatgrass



Pounds of acid detergent fiber produced per acre for each period of slender wheatgrass

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated slender wheatgrass as very high for salt tolerance. The electroconductivity (EC) was 10 to 22 millimhos per centimeter (mhos/cm). For comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass also were rated very high and measured at 13 to 26 mmhos/cm. Alfalfa is rated low and had an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates slender wheatgrass as having good salt tolerance, based on sodium adsorption ratio (SAR) values.

Grazing Value

Slender wheatgrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 20 percent of the potential plant growth of Revenue occurs by early June, with peak herbage production occurring in late July. Revenue grows most vigorously in June, with more than 58 percent of peak production occurring in this month. Revenue retains only 68 percent of peak biomass into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If young tillers are maintained throughout the growing season, CP and TDN will be adequate until early October for a lactating 1,200-pound cow, depending on regrowth.

Recommended Grazing Season: early June through early October.

Hay Value

Slender wheatgrass will make fair to good hay if harvested before the seed-set stage; however, only 60 percent to 80 percent of its growth will occur by this growth stage. Slender wheatgrass is classified as a midstature plant, with much of the foliage production occurring close to the ground surface, leaving a higher than desired level of unharvestable forage. Slender wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Slender wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), slender wheatgrass should be harvested by late June to optimize harvest efficiency.

Recommended Haying Time: early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Slender wheatgrass was an average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. Slender wheatgrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with forbs and legumes, it provides structural diversity and insect populations for brood habitat.

Slender wheatgrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals

in the spring and early summer, moderate in midsummer and fair into the winter months. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value

Spring:	Good
Summer:	Excellent
Fall:	Good
Winter:	Fair

Forage Value

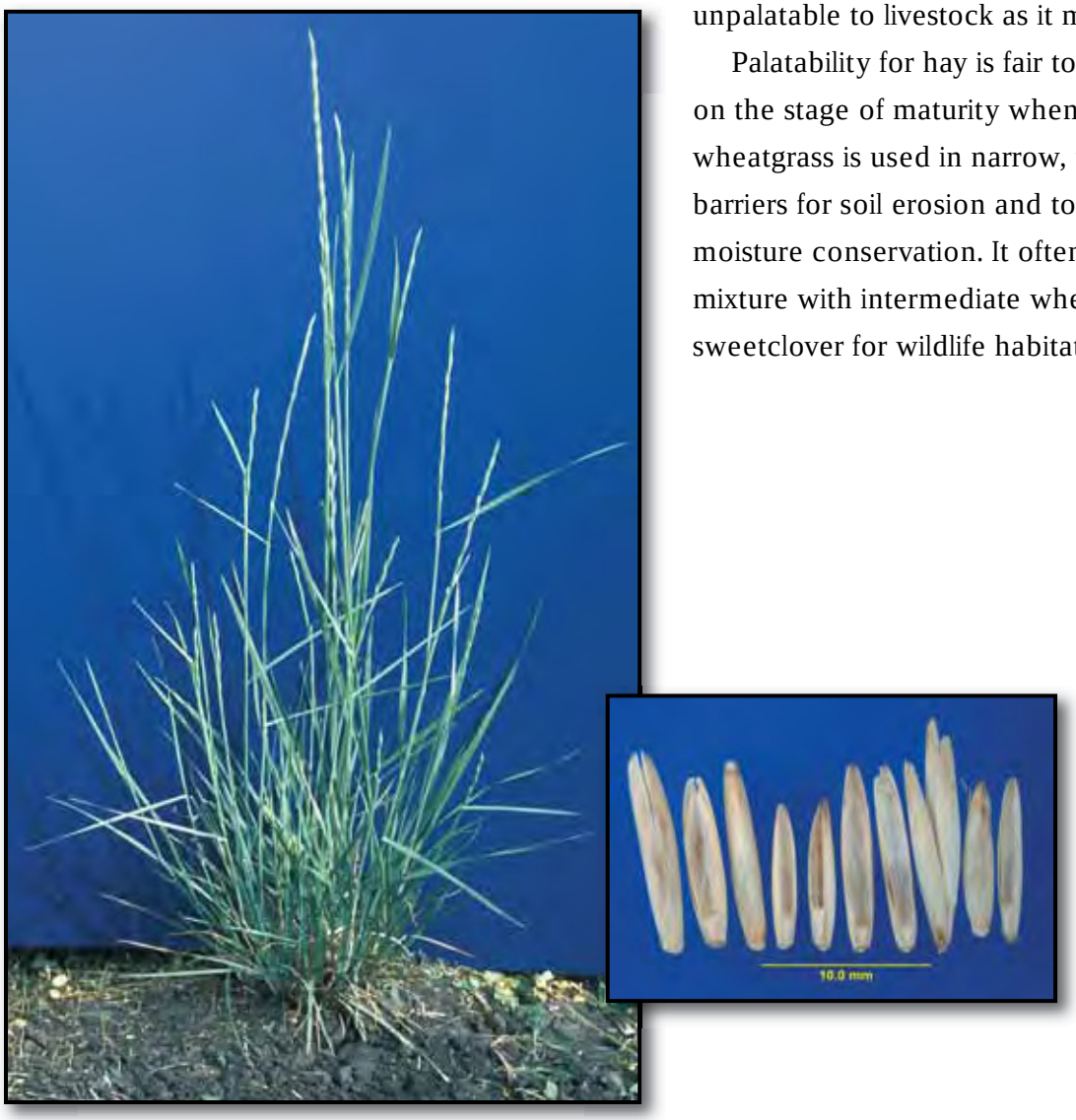
Spring:	Good
Summer:	Good
Fall:	Good
Winter:	Fair
Regrowth:	Good

Tall Wheatgrass

Tall wheatgrass was introduced into the United States in 1932 from Russia. It is adapted to grow on wet, alkaline soils. Plants grow to 6 feet tall and yield heavily with sufficient available moisture. It is less palatable than most all other wheatgrasses, but is useful for both hay and pasturage on soils not suitable for other wheatgrasses.

Tall wheatgrass is a perennial bunch grass used for revegetating saline-alkali soils, conservation plantings and, to a limited degree, hay land. It has good seedling vigor and is easy to establish. The plant becomes coarse and unpalatable to livestock as it matures.

Palatability for hay is fair to good, depending on the stage of maturity when harvested. Tall wheatgrass is used in narrow, uniformly spaced barriers for soil erosion and to manage snow for moisture conservation. It often is seeded in a mixture with intermediate wheatgrass, alfalfa and sweetclover for wildlife habitat.



Herbage Production

Tall wheatgrass makes fair to good hay and fair to poor pasture in areas where moisture is good to excellent. Similar yields were recorded in the original study among Orbit, Alkar and Platte tall wheatgrass varieties on field trials from Fort Pierre, S.D., in three of five years. However, Platte produced greater yields than Orbit in the other years. No differences were found among the three varieties at the Hettinger, N.D., site in all five years The five-year mean production was 2,382, 2,167 and 1,957 lb/ac for Alkar, Orbit and Platte, respectively, near Hettinger. The five-year mean production was 1,940, 1,756 and 1,404 lb/ac for Alkar, Platte and Orbit, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Alkar was 7,748 lb/ac, making it the most productive grass in this study. In a dry year when growing season moisture was less than 11 inches, the Alkar cumulative production was 2,892 lb/ac. When the growing season precipitation was about 14 inches, cumulative production was 3,108 lb/ac. Alkar was very productive when moisture was high and capable of producing high production levels. When growing season moisture was 14 inches or less, production was reduced by 60 percent to 63 percent, indicating tall wheatgrass is not a water use-efficient plant. Although tall wheatgrass is not very water use efficient , Alkar still ranked seventh out of 20 in terms of overall cumulative herbage production in the normal precipitation year (14-inch growing season); however, it ranked only 13th out of 20 in the dry year. Tall wheatgrass will provide a good grass for conservation practices in areas with annual precipitation greater than 12 inches; however, growing season precipitation should be greater than 14 inches when planning hay land development.

Growth Patterns

Alkar was the least vigorous spring growing cool-season grass in this trial, producing only 20 percent of its total growth by early June, with 78 percent of its production occurring in June and July. Once mature, tall wheatgrass retains standing crop biomass and maintains 85 percent of the standing crop through early October. Tall wheatgrass would make fair pasturage for spring and early summer grazing (early May to mid-July) based on lack of production, and fair summer grazing (July and August) if moisture is good to retain quality and palatability. However, tall wheatgrass is unpalatable and nutritional quality is poor when mature. Alkar would make fair to good hay if harvested in June; however, only 64 percent of its growth is achieved by late June.

Tall wheatgrass

Releases	Date Released	Origin	Statement of Use
Platte	1972	ARS, Lincoln, Neb.	Winter hardy.
Orbit	1966	Canada Dept. of Ag., Swift Current, Saskatchewan	Superior to Alkar and other varieties for winter hardiness. Similar in seed and forage yield to other varieties.
Jose	1965	USDA- SCS, Los Lunas, N.M.	Not as coarse (finer leafed) as other tall wheatgrass varieties. Seed production is lower and forage production is similar to other varieties. Earlier maturing than other varieties.
Largo	1961	USDA- SCS, Los Lunas, N.M.	High forage and seed yields. Limited availability due to this variety being replaced with the variety Jose.
Alkar	1951	USDA-SCS, Pullman, Wash.	Good seedling vigor and later maturing.

Nutritional Quality

Alkar was high in crude protein (CP) content during the vegetative growth stages in May and early June; however, by the pre-boot stage, CP dropped below 10 percent, and it dropped below 7 percent by late July during seed set. CP content of the primary growth dropped below 5 percent by mid-August. Tall wheatgrass does not cure well on the stem, losing 2 percent to 3 percent CP when fully mature.

Total digestible nutrients (TDN) were above 55 percent until late July when fully mature. TDN never dropped below 50 percent until early October, when TDN content was 49.6 percent. Although CP was low by mid-July, TDN remained adequate until mid-September.

Fiber

Tall wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) in Alkar increased dramatically from the 2.5-leaf stage through the pre-boot stage, ranging from 23 percent in the 2.5-leaf stage to 44 percent by the pre-boot stage. ADF did not change from pre-boot (mid-June) through late July, peaking at 46 percent in early October.

Alkar ranked second out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, tall wheatgrass would rank superior when compared with other cool-season grasses, with only basin wildrye (Magnar) greater in fiber production. Harvesting maximum levels of fiber occurs in mid-August, averaging a peak production of 1,731 pounds of ADF per acre. Tall wheatgrass would be considered a low-efficient cool-season grass, reaching peak herbage and fiber production in mid-August, when TDN is at or below and CP well below the minimum levels of a lactating cow.

Performance Characteristics

Orbit, Alkar and Platte were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. All three varieties established readily and were very similar in most performance characteristics. They had no disease problems. Seed production and plant height were quite variable each year at both sites.

Salinity Tolerance

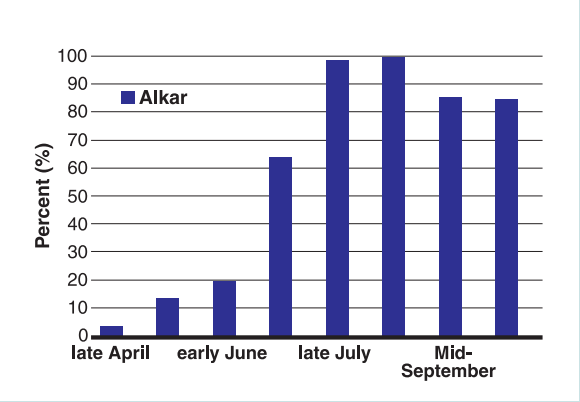
The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated tall wheatgrass as very high for salt tolerance. The electroconductivity (EC) was 13 to 26 millimhos per centimeter (mmhos/cm), which was the same rating as for beardless wildrye and NewHy hybrid wheatgrass. For comparison, alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates tall wheatgrass as having a good salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

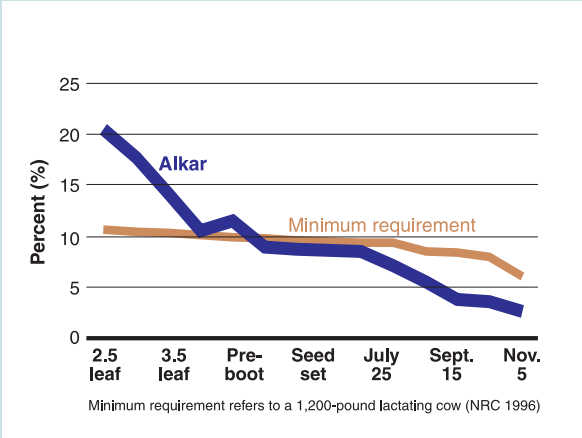
Tall wheatgrass would provide good grazing in May and June; however, plant growth did not achieve 60 percent until late June. Alkar appears to grow most vigorously in June and July, when quality is fair and palatability fair to poor. When comparing growth patterns and nutritional value, livestock grazing from late May through early July will optimize quality and production. Total digestible nutrients will be adequate until mid-September, depending on regrowth.

Recommended Grazing Season: not recommended for pasturage, but if intent is to graze, utilize from early June through early July.

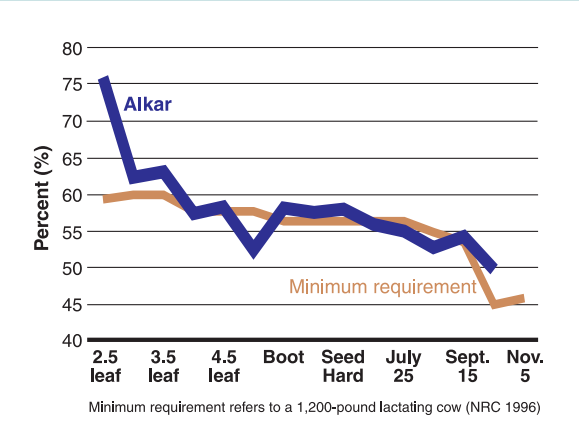
Tall wheatgrass



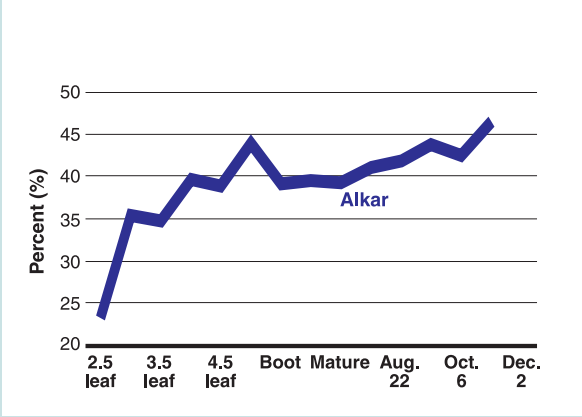
Percent of average peak standing biomass (4,583 lb/ac) for tall wheatgrass



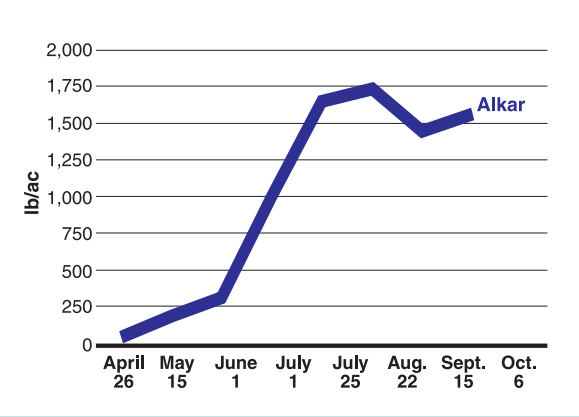
Crude protein content of tall wheatgrass



Total digestible nutrient content for tall wheatgrass



Acid detergent fiber content of tall wheatgrass



Pounds of acid detergent fiber produced per acre for each period of tall wheatgrass

Hay Value

Tall wheatgrass will make fair to good hay if harvested before the boot stage; however, only 40 percent to 60 percent of its growth will occur by this stage. Tall wheatgrass would not be recommended for hay as a monoculture; however, it could be used in a seed mixture, especially in good moisture areas. Tall wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (>55 percent) for winter feed and early July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), tall wheatgrass should be harvested by early to mid-July to optimize harvest efficiency.

Recommended Haying Time: early July for a nonlactating ration and optimum quality and production; mid-June for a lactating ration, optimum quality and and lower production.

Wildlife Value

Tall wheatgrass was extremely productive in normal to wet years, compared with other cool-season grasses, and moderately productive in dry years. This grass will provide good to excellent cover all year due to its high growth and standing residue. When analyzing the level of herbage production and high maintenance of plant tissue late in the season, 2,892 to 4,623 lb/ac of Alkar herbage remained in mid-October, depending on yearly production. Tall wheatgrass provides tall, dense clumps that retain height and structure during winter months, providing good winter cover for many birds, and small and midsized mammals. When used in conjunction with forbs and legumes (e.g., alfalfa), it can provide excellent grassland nesting bird habitat since it maintains its structure during the winter. Used in combination with forbs and legumes, it provides structural diversity and insect populations for brood habitat.

Tall wheatgrass is a palatable grass in the spring, becoming unpalatable as it matures. This grass will provide good feed value for foraging animals in the spring, fair in early summer and poor from midsummer through the dormant season. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value

Spring:	Excellent
Summer:	Excellent
Fall:	Excellent
Winter:	Excellent

Forage Value

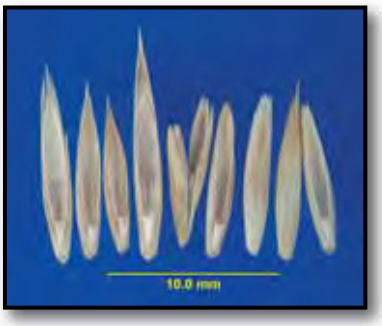
Spring:	Good
Summer:	Fair
Fall:	Poor
Winter:	Poor
Regrowth:	Fair

Western Wheatgrass

Western wheatgrass is native to North America and abundant on heavy clay, clay and loamy ecological sites. It is adapted to grow on most upland ecological sites, including wet, alkaline soils that experience spring flooding. It is a cool-season grass that grows 12 to 24 inches tall, depending on soil type, with good yields when sufficient moisture is available. Western wheatgrass spreads aggressively from rhizomes and tolerates salt-affected soils. It is considered a very palatable wheatgrass, used primarily for grazing as pasture and rangeland.

Western wheatgrass is a perennial, sod-forming grass used for revegetating clay to loamy soils, conservation plantings and, to a limited degree, hay land.

It becomes somewhat coarse and less palatable to livestock as it matures. Palatability for hay is good, depending on the stage of maturity when it's harvested. Western wheatgrass often is seeded with green needlegrass, slender wheatgrass, switchgrass and big bluestem in a mixture for native grass reclamation.



Herbage Production

Western wheatgrass makes fair to good hay and good to excellent pasture in areas where moisture is fair to excellent. Similar yields at the original study were recorded among Walsh, Rodan and Flintlock varieties on field trials from Fort Pierre, S.D., in two of five years. However, Flintlock had greater yields than Walsh and Rodan in the two years, and Walsh was the lowest producer in the fifth year. No differences were found among the three varieties at the Hettinger, N.D., site in three of five years. Flintlock had greater yields than Walsh and Rodan in one year, and Walsh was the lowest producer in the fifth year. The five-year mean production was 2,697, 2,267 and 1,323 lb/ac for Flintlock, Rodan and Walsh, respectively, near Hettinger. The five-year mean production was 1,954, 1,523 and 1,275 lb/ac for Flintlock, Rodan and Walsh, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Rodan was 4,360 lb/ac and it was ranked the 12th most productive grass in the study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 2,292 lb/ac, and it was 2,572 lb/ac when growing season moisture was about 14 inches. Rodan ranked 12th, 12th and 10th among the 20 cool-season grass varieties studied in 1995 through 1997. Rodan was considered average for productivity among all grasses studied, irrelevant of moisture conditions. Western wheatgrass will provide an excellent grass for native plant reclamation areas and re-established pasture and rangeland with annual precipitation of 10 to 24 inches.

Western wheatgrass

Releases	Date Released	Origin	Statement of Use
SERDP (experimental line name)	Projected 2008	Colordao, Wyoming	Greater seed production compared to current cultivars. Improved seedling vigor equal to or greater than current cultivars. Less rhizomatous than Rosana and Rodan.
Rodan	1982	North Dakota	Leafy with good vigor. Leaves are thinner and less heavily veined than other varieties. Moderately rhizomatous. Rust resistant.
Walsh	1982	Alberta, Saskatchewan, Canada	Improved forage and seed yields. Noted for its tolerance to salinity. Aggressive rhizome spread.
Flintlock	1975	Nebraska, Kansas	Diverse collections from Kansas and Nebraska. Coarse culms and soft leaves compared with other varieties. Aggressive rhizome spread.
Arriba	1973	Colorado	Seed germinates rapidly with good seedling establishment. Superior seed production. Aggressive rhizome spread.
Rosana	1972	Montana	Good seedling vigor and ease of establishment. Good forage and seed production. Very aggressive rhizome spread, resulting in a very tight sod.
Barton	1970	Kansas	Leafy, high seed and forage producer. Strongly rhizomatous.

Growth Patterns

Rodan is a slow, spring-growing cool-season grass, producing less than 36 percent of its total growth by late May or early June. Much of the plant's growth occurs in June, with more than 54 percent of growth occurring in this month. Peak production occurs by late July, with much of the standing biomass maintained through early October. Western wheatgrass would make good pasturage for late spring and summer grazing (early June to early October), based on plant growth, quality and palatability. Western wheatgrass would make fair to good hay land if harvested by early July; however, production was low, compared with other exotic grasses.

Nutritional Quality

Rodan was high in crude protein content (CP) during the vegetative growth stages in May and early June. However, CP was below 10 percent at the seed-set stage, and below 7 percent by late July when the plant was mature. The CP of the mature plant dropped below 5 percent by mid-August, and below 3 percent when fully mature.

Total digestible nutrients (TDN) were above 55 percent until mid-August when fully mature. Total digestible nutrients never dropped below 50 percent until early October, when TDN content was 44.6 percent. Although CP was low by mid-July, TDN remained adequate until early October or later.

Fiber

Western wheatgrass was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased linearly throughout the growing season, ranging from 28 percent at the 2.5-leaf stage to 46 percent by early October when mature.

Rodan ranked 10th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, western wheatgrass would rank as an average fiber producer when compared with other cool-season grasses. Harvesting maximum levels of fiber from western wheatgrass will occur from late July to early October, averaging peak production of 1,037 to 1,062 pounds of ADF per acre, respectively. Western wheatgrass was one of the few grasses to maintain a peak in fiber production from late July through October. Western wheatgrass would be considered a moderately efficient cool-season grass, reaching peak herbage and fiber production in late July, and maintaining TDN content at or above the minimum levels of a lactating cow through early October and CP above the minimum levels of a lactating cow through mid-August, depending on maturation.

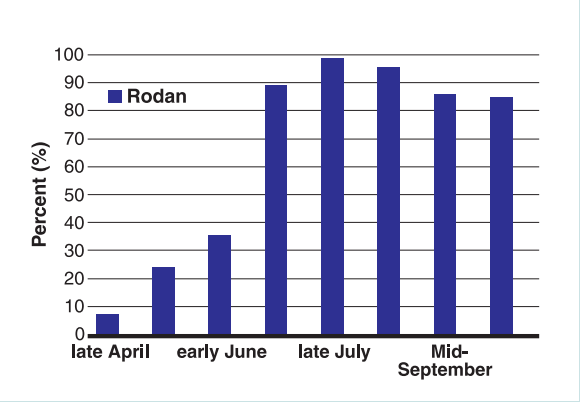
Performance Characteristics

Walsh, Rodan and Flintlock were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence was similar for all varieties. Walsh and Rodan had higher stand densities the first year at both locations. Stand ratings were comparable. Flintlock was measured as being taller each of the three years height was documented at both sites. Seed production was comparatively low for all three varieties. Vigor was rated lowest for Walsh. No disease problems were found at either of the sites.

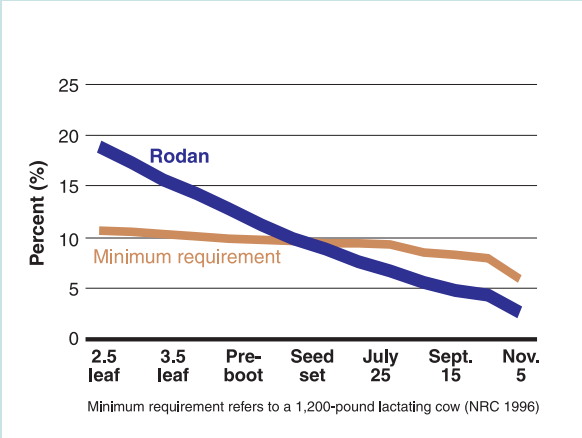
Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated western wheatgrass as high for salt tolerance. The electroconductivity (EC) was 6 to 16 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates western wheatgrass as having a good salt tolerance, based on the sodium adsorption ratio (SAR) values.

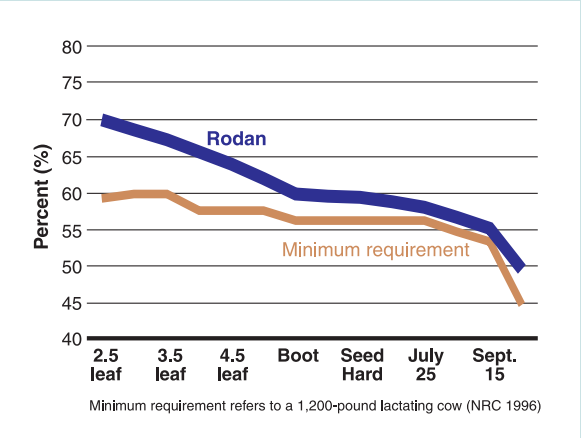
Western wheatgrass



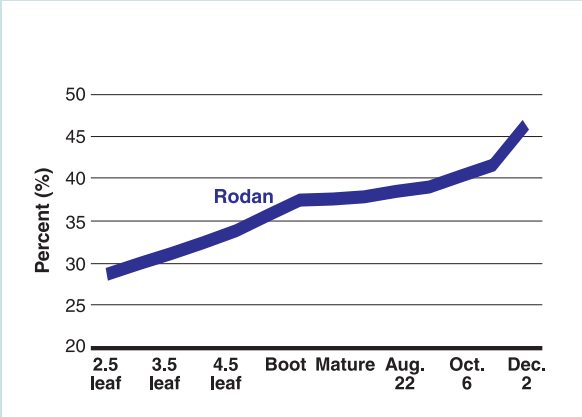
Percent of average peak standing biomass (3,075 lb/ac) for western wheatgrass



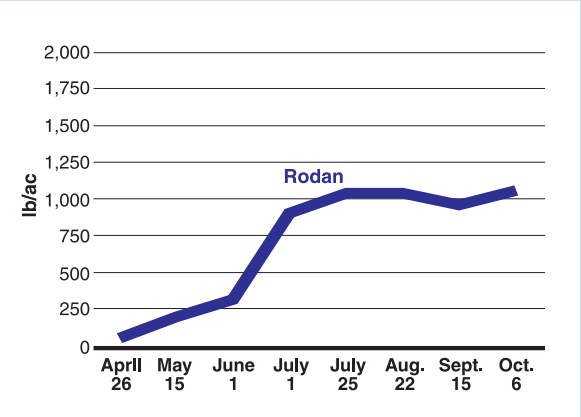
Crude protein content of western wheatgrass



Total digestible nutrient content for western wheatgrass



Acid detergent fiber content of western wheatgrass



Pounds of acid detergent fiber produced per acre for each period of western wheatgrass

Grazing Value

Western wheatgrass would provide good grazing from early June through early October without damaging the vigor or stand quality under proper grazing management strategies. Only 36 percent of the potential plant growth of Rodan occurs by early June, with peak herbage production occurring in late July. Rodan grows most vigorously in June, with more than 54 percent of the growth occurring in this month. Rodan retained more than 86 percent of standing biomass into early October. When comparing growth patterns and nutritional value, livestock grazing from early June through mid-August will optimize quality and production if plants are allowed to mature. If immature tillers are maintained throughout the growing season, crude protein and total digestible nutrients will be adequate until early October for a lactating 1,200–pound cow, depending on regrowth.

Recommended Grazing Season:
early June through early October.

Hay Value

Western wheatgrass will make fair to good hay if harvested before the seed-set stage; however, only 70 percent to 85 percent of its growth will occur by this growth stage. Western wheatgrass is classified as a midstature plant, with much of the plant's growth occurring close to the ground surface, leaving a higher than desired level of unharvestable forage. Western wheatgrass is generally not recommended for hay as a monoculture; however, it could be used in a seed mixture. Western wheatgrass should be cut by the third week in June to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and early to mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), western wheatgrass should be harvested by late June to optimize harvest efficiency.

Recommended Haying Time: not highly recommended, early to mid-July for a nonlactating ration and optimum quality and production; third week in June for a lactating ration, optimum quality and lower production.

Wildlife Value

Western wheatgrass was an average producing grass in dry and wet years, compared with other cool-season grasses. This grass will provide good cover all year due to its upright structure and standing residue. When analyzing the level of herbage production and high maintenance of Rodan plant tissue late in the season, 1,970 to 3,750 lb/ac of standing crop remained in mid-October, depending on yearly production. Western wheatgrass provides medium-sized structure that is retained into the winter months, providing some winter cover for many birds, and small and midsized mammals. Used in combination with native forbs, it provides structural diversity and insect populations for brood habitat.

Western wheatgrass is a palatable grass in the spring and summer, becoming less palatable as it matures. This grass will provide a high feed value for foraging animals in the spring and early summer, moderate in midsummer and fair to good into the dormant season. It has limited use for native pollinators. Many birds and small mammals use the seeds.

Cover Value

Spring:	Good
Summer:	Excellent
Fall:	Good
Winter:	Fair

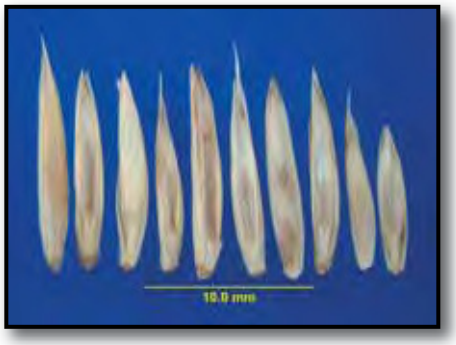
Forage Value

Spring:	Good
Summer:	Good
Fall:	Good
Winter:	Fair
Regrowth:	Fair

Altai Wildrye

Altai wildrye was introduced into the United States from Siberia as a forage option for fall pasture. Altai wildrye is a long-lived bunch grass used as a special-purpose grass to extend the grazing season into the late fall and winter. It is a very winter-hardy grass that may be difficult to establish. The plant has coarse, erect leaves that retain leaf stature after snowfall, permitting late fall or early winter grazing. It is especially adapted to loam and clay soils, with an extensive root system penetrating to a depth of 10 feet. It possesses a high tolerance to saline-alkali soils, but it has less tolerance than tall wheatgrass.

Due to a moderate palatability, compared with other cool-season grasses, it is recommended as a single-species stand for grazing. Palatability for hay is questionable due to limited feeding trials.



Herbage Production

Altai wildrye makes poor to fair hay and good pasture in areas where moisture is fair to excellent. Similar yields in the original study were recorded among all Altai wildrye varieties (Prairieland, Pearl and Eejay) on field trials from Fort Pierre, S.D., in three out of five years. Prairieland produced greater yields than Eejay in one year and Eejay greater yields than Pearl in one year. No differences were found among the three varieties at the Hettinger, N.D., site in three of five years. Prairieland produced greater yields than Pearl in one year and Eejay greater yields than Prairieland and Pearl in one year. The five-year mean production was 2,088, 1,928 and 1,469 lb/ac for Eejay, Prairieland and Pearl, respectively, near Hettinger. The five-year mean production was 1,080, 976 and 920 lb/ac for Prairieland, Eejay and Pearl, respectively, near Fort Pierre.

When growing season precipitation was greater than 16 inches, cumulative herbage production in the GPNS for Prairieland was 5,172 lb/ac and it was one of the top 10 most productive grasses in this study. In a dry year when growing season moisture was less than 11 inches, cumulative production was 3,280 lb/ac. When growing season precipitation was about 14 inches, cumulative production was 3,548 lb/ac. Prairieland was very productive when moisture was high and capable of producing high production levels. When growing season moisture was 14 inches or less, production was still high, compared with other cool-season grasses, and was reduced by only 31 percent to 37 percent, indicating Altai wildrye is a fairly good water use-efficient plant. Prairieland ranked third out of 20 in terms of overall cumulative growth in the normal precipitation year (14-inch growing season) and second out of 20 in the dry year. Altai wildrye will provide a good grass for conservation practices in areas with annual precipitation greater than 8 inches; however, growing season precipitation should be greater than 10 inches when developing pastureland.

Growth Patterns

Prairieland had moderate vigor during the spring growing season in the trial, producing 22 percent of its total growth by mid-May and 30 percent by early June, reaching peak production in late July. Once mature,

Altai wildrye

Releases	Date Released	Released by	Statement of Use
Mustang	2004	ARS, Logan, Utah	Significantly taller than Prairieland, Eejay and Pearl. Higher forage production than Prairieland or Pearl. Superior seedling establishment compared with Pearl and Prairieland. Seedling emergence was better than Prairieland and similar to Pearl. Seed weight was comparable to Prairieland and Eejay but significantly lighter than Pearl.
Eejay	1989	Ag. Canada, Swift Current, Saskatchewan	Higher forage yield and seed production than Prairieland. Good seed quality. Resistant to leaf spot diseases.
Pearl	1989	Ag. Canada, Swift Current, Saskatchewan	Lower forage production and higher seed production than the variety Prairieland. Resistant to leaf spot diseases.
Prairieland	1976	Ag. Canada, Swift Current, Saskatchewan	First known variety of Altai wildrye. High seed yields, high forage yields, high yields of good quality seed. Resistant to leaf spot diseases.

standing biomass remained high, losing on average of only 5 percent of the total herbage produced in early October. Altai wildrye would make good pasturage for spring and early summer grazing (early June to mid-July), based on growth patterns; however, it would provide even better fall pasturage (September and October), assuming quality and palatability are good. Altai wildrye is ranked as fair to good in palatability when mature and quality is good. Altai wildrye could make fair to good hay if harvested by late June; however, only 55 percent to 75 percent of its growth is achieved by late June.

Nutritional Quality

Prairieland was high in crude protein content (CP) in May, June and July in the vegetative to boot growth stage, dropping below 7 percent CP by mid-August when mature. The CP of the primary growth did not drop below 6 percent until early October.

Total digestible nutrients (TDN) were at or above 55 percent until the third week in July when the plant was in the seed-hardening growth stage. TDN never dropped below 50 percent until early November, when TDN content was 49.6 percent. The TDN remained adequate for a lactating cow until early October and a dry cow until early November.

Fiber

Prairieland was similar to all other cool-season grasses, with fiber content lowest at the 2.5- and 3.5-leaf stages, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) increased dramatically from the 3.5-leaf stage through boot stage, ranging from 34 percent in the 2.5-leaf stage to 43 percent by the boot stage. ADF content declined after the boot stage, remaining stable until late July and then increasing from midsummer through early November, peaking at 46 percent.

Prairieland ranked third out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Altai wildrye ranked very high when compared with other cool-season grasses, with only basin wildrye (Magnar) and tall wheatgrass (Alkar) greater in fiber production. Prairieland achieved and retained high fiber content later than all other cool-season grasses, with maximum levels of fiber harvested in early October, averaging peak production of 1,501 pounds of ADF per acre. Altai wildrye would be considered a highly efficient cool-season grass, reaching peak herbage production in late July when nutrient content is high, retaining more than 90 percent of the standing biomass through early October and achieving peak fiber production late in the growing season (early October), while maintaining TDN at or slightly below and CP at or slightly below the minimum levels of a lactating cow.

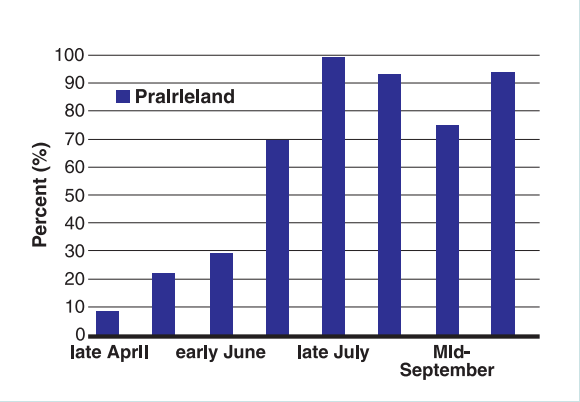
Performance Characteristics

Prairieland, Pearl and Eejay were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. All three varieties established readily. Prairieland had the highest initial stand rating and stand density at Hettinger. Pearl had declined in stand rating by 1997, while Prairieland and Eejay still were rated good at Hettinger. Eejay had the poorest stand density at Fort Pierre. Neither site had disease problems. Seed production was rated as poor for all three entries except for 1993 at Fort Pierre.

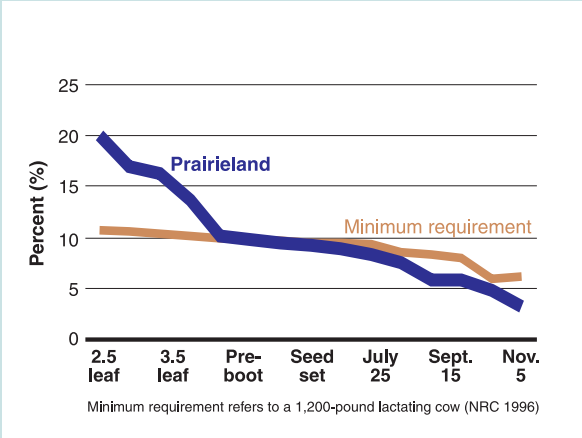
Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated Altai wildrye as very high for salt tolerance. The electroconductivity (EC) was 10 to 22 millimhos per centimeter (mmhos/cm). In comparison, beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass are rated very high also and have an EC rating of 13 to 26 mmhos/cm. Alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates Altai wildrye as having a fair salt tolerance based on the sodium adsorption ratio (SAR) values.

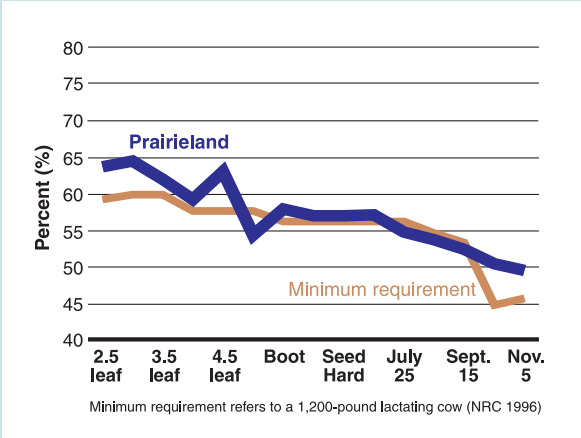
Altai wildrye



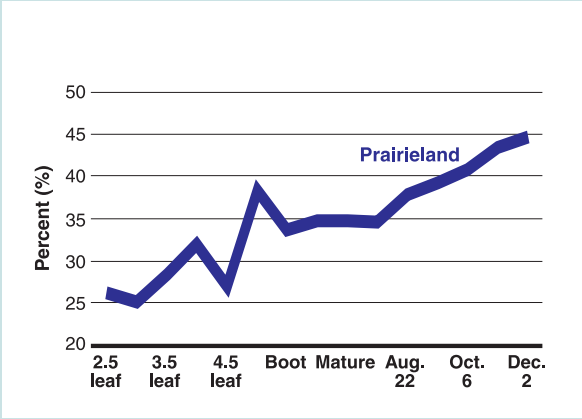
Percent of average peak standing biomass (4,000 lb/ac) for altai wildrye



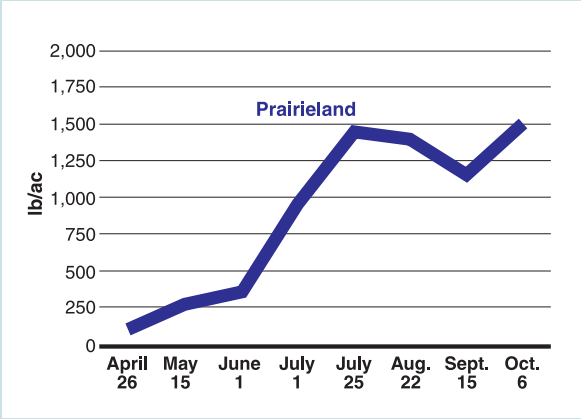
Crude protein content of altai wildrye



Total digestible nutrient content for altai wildrye



Acid detergent fiber content of altai wildrye



Pounds of acid detergent fiber produced per acre for each period of altai wildrye

Grazing Value

Altai wildrye would provide good grazing in May and June; however, its potential use for late summer and fall pasture is much greater than spring use. Prairieland plant growth was only 30 percent by early June and 70 percent by early July. This grass grows most vigorously in June and July, maintaining standing biomass in September and October. Although forage nutritional quality is very good in May, June and July, Prairieland maintained good quality in September and October. When comparing growth pattern and nutritional value, livestock grazing could be recommended from early June through early August; however, early September through early November would provide a better choice for this grass. Weaning of offspring should be conducted by early October to maintain performance on the dam. Total digestible nutrients will be adequate throughout most of the growing season and into the early dormant season.

Recommended Grazing Season: early September through early November.

Hay Value

Altai wildrye is recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, Altai wildrye should make a good hay if harvested before the seed-hardening stage of plant development; however, only 60 percent to 70 percent of its growth will occur by this growth stage. Altai wildrye should be cut by early July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), Altai wildrye should be harvested by early July to optimize harvest efficiency.

Recommended Haying Time: not recommended; mid-July for a nonlactating ration and optimum quality and production; late June or early July for a lactating ration, optimum quality and low production.

Wildlife Value

Altai wildrye was extremely productive in normal to wet years, compared with other cool-season grasses, and good producing in dry years. This grass will provide good cover all year due to its high growth and standing residue. However, in most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat. It provides good winter cover due its bunch grass growth structure.

Altai wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. Even though this grass provides high feed value, its use by foraging wildlife is limited. It has limited use for native pollinators and as a wildlife food seed source.

Cover Value

Spring:	Good
Summer:	Good
Fall:	Good
Winter:	Good

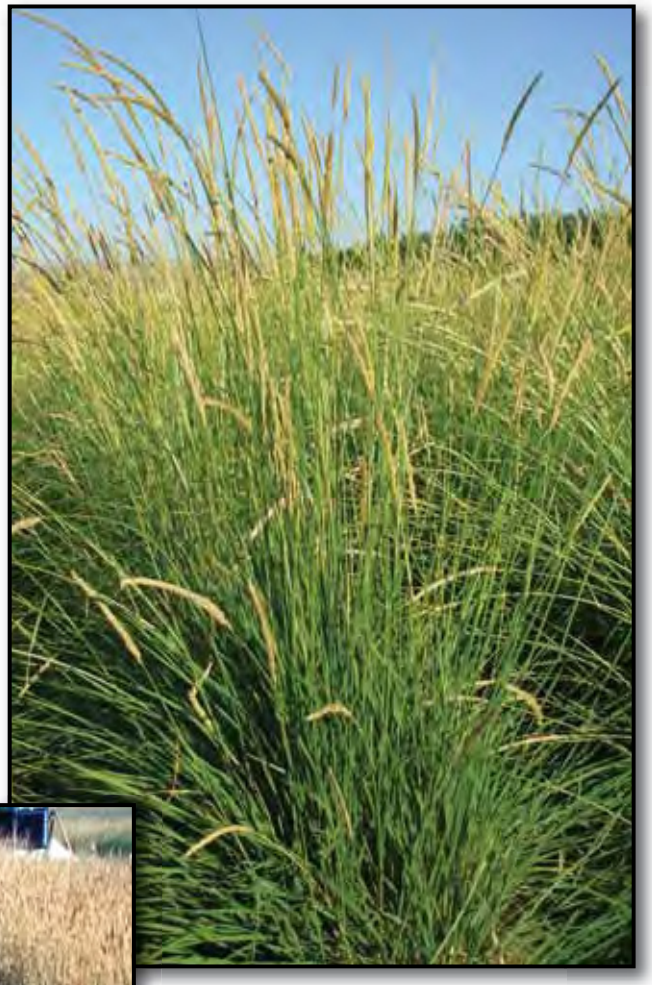
Forage Value

Spring:	Fair
Summer:	Fair
Fall:	Fair
Winter:	Fair
Regrowth:	Fair

Basin Wildrye

Basin wildrye is native to the western part of the northern Great Plains region; however, it is more abundant in the valleys of the northern Rocky Mountain region and the northern part of the intermountain area.

Basin wildrye is a long-lived bunch grass used as standing grazing forage for livestock, nesting cover and escape cover. It is a very winter-hardy grass with coarse, erect leaves that retain leaf stature after snowfall, permitting late fall or early winter grazing. Due to a moderate palatability, compared with other cool-season grasses, it is recommended as a single-species stand for grazing. Palatability for hay is questionable because feeding trials have been limited. Establishment and persistence have been variable in field trials in North and South Dakota.



Herbage Production

Basin wildrye is native grass from the Basin Desert region of North America and a grass grazed on rangeland with limited information on hay value. Similar yields were recorded in the original study between the basin wildrye varieties (Magnar and Trailhead) on field trials from Fort Pierre, S.D., in all five years. No differences were found between varieties at the Hettinger, N.D., site in four of five years. Magnar produced greater yields than Trailhead in one year. The five-year mean production was 2,146 and 1,496 lb/ac for Magnar and Trailhead, respectively, near Hettinger. The five-year mean production was 932 and 923 lb/ac for Magnar and Trailhead, respectively, near Fort Pierre.

Basin wildrye (Magnar) was one of the most productive grasses in the GPNS, ranking first, second and fourth during the three years of study. When growing season precipitation was greater than 16 inches, cumulative herbage production was 7,332 lb/ac and second only to tall wheatgrass (Alkar). In a dry year when growing season moisture was less than 11 inches, cumulative production was 4,932 lb/ac and it was the top producing grass in the trial. When growing season moisture was about 14 inches, cumulative production was 3,480 lb/ac and it ranked fourth, behind both pubescent wheatgrass varieties and Altai wildrye.

Magnar was very productive when moisture was high and low, and always capable of producing high yields. When growing season moisture was 14 inches or less, production was still high, compared with other cool-season grasses, indicating basin wildrye is a fairly good to moderate water use-efficient plant. Basin wildrye will provide a good grass for conservation practices in areas with annual precipitation greater than 8 inches; however, growing season precipitation should be greater than 10 inches when developing it for pastureland or hay.

Growth Patterns

Magnar's growth patterns were quite variable among the years and dependant on moisture. During the dry year, basin wildrye had excellent vigor during the spring growing season in the trial, producing 33 percent of its total growth by mid-May, 52 percent by early June and 100 percent by the first week in July. However, during the wet year, Magnar produced only 18 percent of its total growth by mid-May and 29 percent by early June, with 100 percent by late July. Peak production always will occur in July; however, moisture will dictate aggressiveness of spring growth.

Once mature, standing crop, on average, was reduced by 45 percent to 55 percent by mid-September, rebounding to 55 percent to 95 percent of potential standing crop in early October. Basin wildrye would make good pasturage for spring and early summer grazing (mid-May to mid-July), based on growth patterns. However, it would provide even better fall pasturage (September and October), assuming quality and palatability is good. Basin wildrye is ranked as having fair to good palatability when mature and quality is good.

Basin wildrye

Releases	Date Released	Origin	Statement of Use
Washoe Germplasm	2002	USDA-SCS, Bridger, Mont.	Increased overall height, vigor and survival compared with Trailhead and Magnar when tested in moderately acidic and heavy metal-contaminated sites. Very drought tolerant.
Trailhead	1991	USDA-SCS, Bridger, Mont.	Seed production fair. Good seedling vigor. Excellent spring forage production. Adapted to moderately saline-alkaline to acid soils. Dark green. More drought tolerant than Magnar.
Magnar	1979	Saskatchewan, Canada	Tall, leafy with large stems and seedheads. Good seed production. Good seedling vigor. Grows well on saline soils. Blue.

Basin wildrye would make good quality hay if harvested by late June, allowing for maximum quantity since 80 percent to 100 percent of its growth is achieved by late June or early July.

Nutritional Quality

Magnar was high in crude protein content (CP) in May, June and July prior to the seed-set stage, dropping below 10 percent CP by early July and below 7 percent CP by mid-August when in the mature growth stage. The CP of primary growth did not drop below 6 percent until late August or early September.

Total digestible nutrients (TDN) were at or above 55 percent until mid-August and when mature. Total digestible nutrients never dropped below 50 percent until early October, when TDN content was 45.1 percent. The TDN remained adequate for lactating cows until late September or early October and dry cows until early December.

Fiber

Basin wildrye was similar to all other cool-season grasses, with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. Acid detergent fiber (ADF) of Magnar was 23 percent at the 3.5-leaf stage, peaking at 53 percent in early December.

Magnar ranked first among the 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Magnar was superior to all other grass species and varieties studied in this trial. Basin wildrye achieved high fiber content early and reached peak levels of fiber harvested in early July, declining rapidly through mid-September. Average peak production was 1,873 pounds of ADF per acre in early July, declining to 1,094 in mid-September and 1,494 in early October. Magnar would be considered a highly efficient cool-season grass, reaching peak herbage production in early July when nutrient content is high; however, it retained only 65 percent of the standing crop through early October. Peak fiber production also occurred in early July as a function of peak herbage production, maintaining TDN at or slightly below the minimum levels of a lactating cow throughout the growing season; however, CP became deficient by late July.

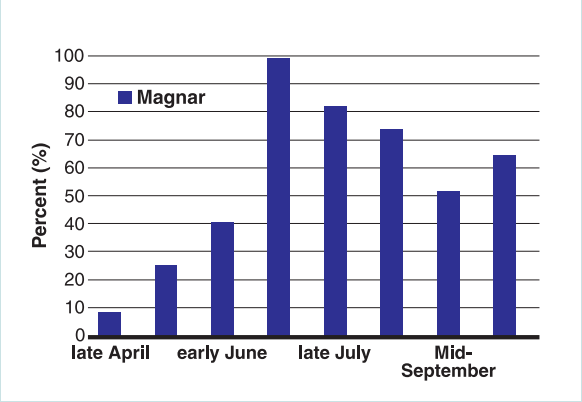
Performance Characteristics

Magnar and Trailhead were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence and establishment were slower than in most other species in the trial. Trailhead had higher stand densities the first two years at both locations. Stand densities and ratings were lower for both entries at the Fort Pierre site. Trailhead had higher disease ratings (stem and leaf rust). Seed production was rated as poor, except in 1993 at the Fort Pierre site.

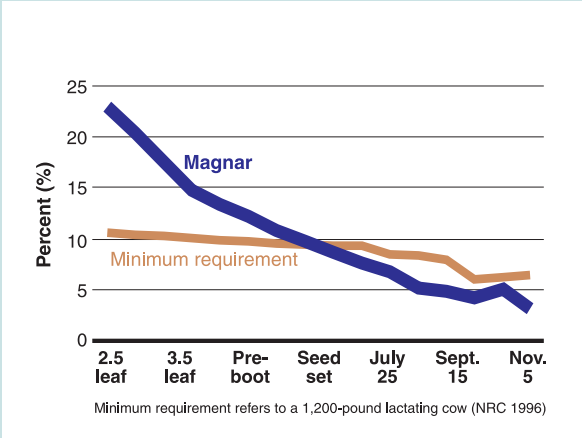
Salinity Tolerance

Basin wildrye is tolerant of low to moderate levels (< 10 millimhos per centimeter) of saline and (sodium adsorption ratio < 15) sodic conditions (USDA NRCS PLANTS database, 2003). For comparison, a study conducted at the Plant Materials Center, Bridger, Mont., (USDA NRCS 1996) showed an electroconductivity (EC) of 13 to 26 mmhos/cm for beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass. Alfalfa was rated low and had an EC rating of 4 to 8 mmhos/cm. Section IV of the North Dakota NRCS Field Office Technical Guide (USDA NRCS 2003) rates basin wildrye as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

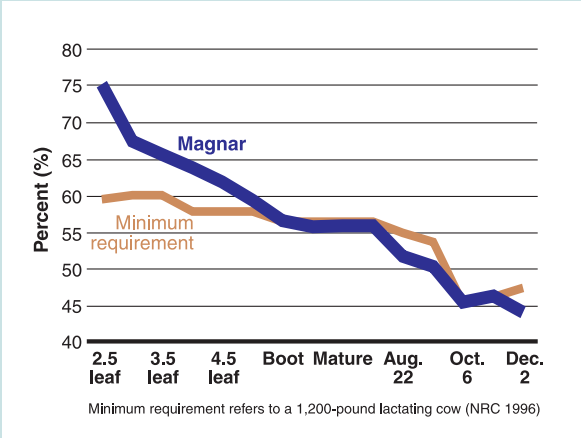
Basin wildrye



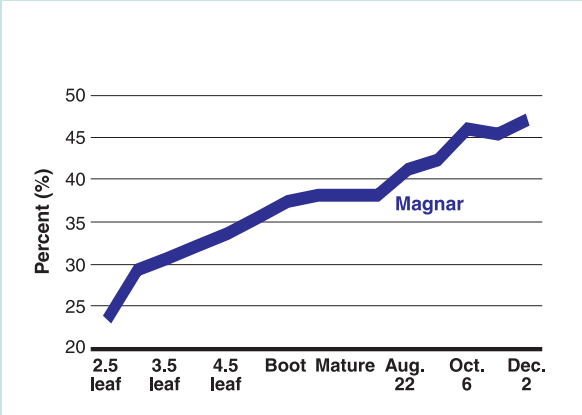
Percent of average peak standing biomass (5,248 lb/ac) for basin wildrye



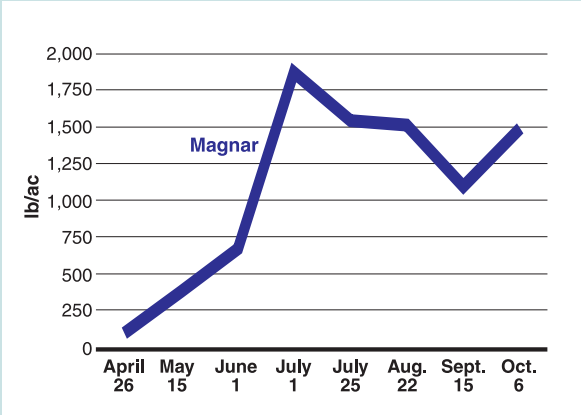
Crude protein content of basin wildrye



Total digestible nutrient content for basin wildrye



Acid detergent fiber content of basin wildrye



Pounds of acid detergent fiber produced per acre for each period of basin wildrye

Grazing Value

Basin wildrye would provide good grazing in May and June and also potential use for late summer and fall pasturage. Magnar plant growth was 18 percent to 32 percent in mid-May and 100 percent in early to late July. This grass grows most vigorously in June, losing standing biomass in late July, August and September. Although forage nutritional quality is very good in May, June and July, basin wildrye maintains fair to good quality in September and October. When comparing growth patterns and nutritional value, livestock grazing could be recommended from mid-May through mid-July or early September through early November. Weaning of offspring should be conducted by mid to late October to maintain performance on the dam. Total digestible nutrients will be adequate through late September for a lactating cow and early December for a dry cow.

Recommended Grazing Season:
mid-May through mid-July or early September through early December.

Hay Value

Basin wildrye typically has been recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, basin wildrye should make a good hay-type grass if harvested before the seed-hardening stage of plant development. At this stage of growth, hay quality and quantity will be maximized since 80 percent to 100 percent of its growth will occur by this growth stage. Basin wildrye should be cut by late June or early July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-July to maintain minimum CP levels for nonlactating animals. When optimizing quality with production (lb + CP), basin wildrye should be harvested by late June to optimize harvest efficiency.

Recommended Haying Time: not highly recommended; early July for a nonlactating ration and optimum quality and production; late June for a lactating ration, optimum quality and low production.

Wildlife Value

Basin wildrye was extremely productive in normal to wet years, compared with other cool-season grasses, and highly productive in dry years. This grass will provide good to excellent cover all year due to its high growth and standing residue. However, it most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat in the spring and summer.

Basin wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. This grass will provide a high feed value for foraging animals in the spring, good in early summer and fair from midsummer into the dormant season. It has limited use for native pollinators and as a seed food source.

Cover Value

Spring:	Good
Summer:	Good
Fall:	Good
Winter:	Good

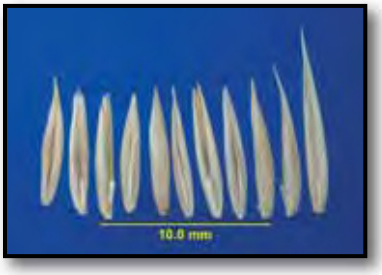
Forage Value

Spring:	Good
Summer:	Good
Fall:	Fair
Winter:	Fair to Poor
Regrowth:	Good

Russian Wildrye

Russian wildrye was introduced from Siberia as a forage crop, brought to North Dakota in 1907 and first grown at the USDA-ARS at Mandan, N.D., in 1927. Seed from the Mandan source was released to the public in 1941 and 1942.

Russian wildrye is a early spring-growing, long-lived, drought-tolerant bunch grass used as a special-purpose grass to extend the grazing season into the late fall and early winter. It is a very winter-hardy grass classified as somewhat difficult to establish. The plant has fine basal leaves that retain nutritional quality after maturation, permitting late fall or early winter grazing. It is especially adapted to many types of soils and has moderately high tolerance to saline-alkali soils. It is highly competitive with other plant species; however, it is recommended for a single-grass seeding pasture. Palatability for hay is questionable since feeding trials have been limited.



Herbage Production

Russian wildrye makes poor to fair hay and good pasture in areas where moisture is fair to excellent. Similar yields from the original study were recorded among all Russian wildrye varieties (Bozoisky Select, Mankota, Mayak, Swift and Cabree) on field trials from Fort Pierre, S.D., in all five years. No differences were found among the five varieties at the Hettinger, N.D., site in four of five years. Bozoisky Select produced greater yields than Mayak and Cabree in one year. The five-year mean production was 1,021, 912, 870, 727 and 648 lb/ac for Bozoisky Select, Swift, Mankota, Cabree and Mayak, respectively, near Hettinger. The five-year mean production was 1,008, 943, 919, 840 and 555 lb/ac for Bozoisky Select, Mankota, Swift, Cabree and Mayak, respectively, near Fort Pierre.

Cumulative herbage production from the GPNS for Russian wildrye was low compared with all other cool-season grasses in this study. When growing season precipitation was greater than 16 inches, cumulative production was 3,560 lb/ac for Mankota and 2,680 lb/ac for Bozoisky Select. Mankota ranked 18th and Bozoisky Select 20th out of 20 grass varieties in the trial during the wet year. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,480 lb/ac for Mankota and 2,228 lb/ac for Bozoisky Select. Mankota ranked last among the 20 grasses in overall cumulative herbage production in the dry year. When growing season precipitation was about 14 inches, cumulative production was 1,560 and 2,228 lb/ac for Mankota and Bozoisky Select, respectively.

Both varieties were low herbage-producing grasses when moisture was high and low. No statistical

Russian wildrye

Releases	Date Released	Released by	Statement of Use
Bozoisky II	2004	ARS, Logan, Utah	Good seedling vigor. High forage and seed yields.
Mankota	1991	ARS, Mandan, N.D.	Heading date is 2 weeks later than other varieties. Moderate to good resistance to leaf spot disease.
Tetracan	1988	Ag. Canada, Swift Current, Saskatchewan	Excellent seedling vigor and establishment. Larger seed than other varieties.
Bozoisky Select	1984	ARS, Logan, Utah	Significantly more vigorous and productive than Vinall. Stand establishment is equal or superior to Vinall. Better seedling vigor and larger seed than Vinall or Swift.
Swift	1978	Ag. Canada, Swift Current, Saskatchewan	Good seedling emergence and resistance to leaf spot. Improved seedling vigor.
Cabree	1976	Ag. Canada, Lethbridge, Alberta	Resistant to powdery mildew, leaf rust and spot blotch. Improved seed retention is Cabree's main attribute.
Mayak	1971	Canada Dept. of Ag., Swift Current, Saskatchewan	High forage and seed yields. Resistant to leaf spot. Similar to other varieties in other characteristics.
Vinall	1960	ARS, Mandan, N.D.	First released variety of Russian wildrye. It no longer is recommended and has been replaced by Mankota.

difference was found in herbage production between the two varieties for any year of the study. Both varieties appear to be drought tolerant, with Bozoisky Select producing the same level of herbage production in the normal and dry years and Mankota producing only 5 percent less forage in the dry year. Mankota appears to be more productive in a wet year than Bozoisky Select. Russian wildrye will provide a good grass for conservation practices in areas with low annual precipitation; however, other grasses would be rated higher than Russian wildrye when growing season precipitation is greater than 10 inches.

Growth Patterns

Russian wildrye was a very vigorous spring-growing grass in this trial, especially the Mankota variety. Both varieties achieved almost 40 percent growth by mid-May. Mankota achieved 59 percent of its growth by late May or early June and more than 90 percent by early July. Bozoisky Select growth was vigorous through mid-May, slowing in comparison with Mankota. Bozoisky Select achieved slightly less than 50 percent of its growth by late May or early June. Both Mankota and Bozoisky Select were superior in retaining their standing herbage, with 80 percent to 100 percent of their biomass produced standing in early October. Russian wildrye would make good pasturage for spring and early summer grazing (early May to early July), based on growth patterns; however, it would provide even better fall pasturage (September and October), based on herbage retention, good quality and palatability. Russian wildrye is ranked as having fair to good palatability when mature and forage quality is good. Russian wildrye would make fair hay if harvested by late June; however, production potential will be less than most other cool-season grass species.

Nutritional Quality

Both Russian wildrye varieties were high in crude protein content (CP) in May, June and July during the vegetative growth stage, dropping below 10 percent CP by the third week in July when seed was hardening. The CP never dropped below 7 percent until November. Russian wildrye was the only grass to maintain minimum requirements of a lactating cow throughout the growing season and minimum requirements of a dry cow in October and November. This data could be skewed low for August, September and October since we did not look specifically at regrowth quality in this study, with hand clippings collected as a swath (mature and young tissue combined).

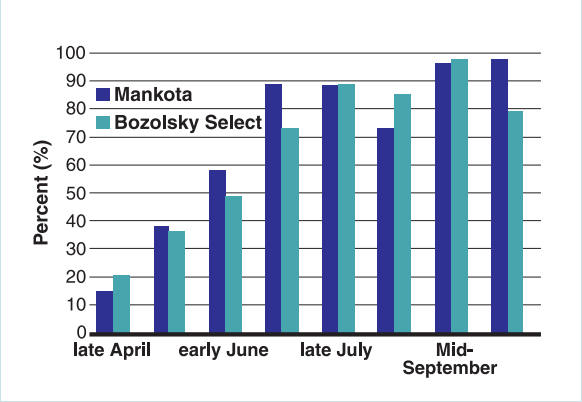
Total digestible nutrients (TDN) were at or above 55 percent until early July for Mankota and mid-August for Bozoisky Select. Total digestible nutrients never dropped below 50 percent for either variety until early November. The TDN remained adequate for a lactating cow until early October and a dry cow until early December for Bozoisky Select and Mankota.

Fiber

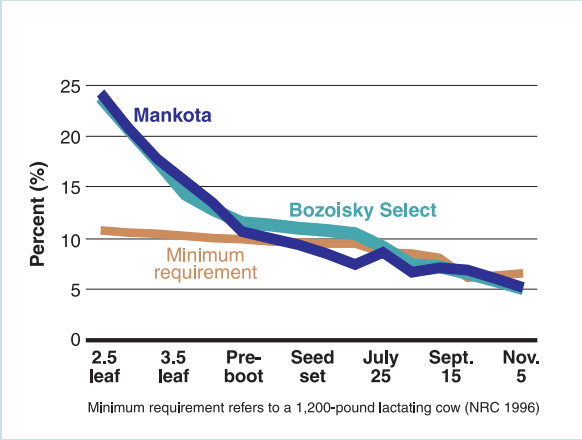
Both Mankota and Bozoisky Select were similar to all other cool-season grasses with fiber content lowest at the 2.5-leaf stage, increasing through maturation and peaking at the end of the growing season. No difference was found in acid detergent fiber (ADF) content between varieties at any time of the growing season. Unlike most of the cool-season grass varieties in this study, the Russian wildrye varieties did not have a lag in ADF levels, increasing during each collection period throughout the growing season. ADF increased from 27 percent to 29 percent in the 2.5-leaf stage to 48 percent in early December.

Mankota ranked 17th out of 20 cool-season grasses and Bozoisky Select ranked 19th out of 20 cool-season grasses studied in terms of average pounds of ADF produced per acre during the three-year period. When selecting a grass to produce maximum levels of fiber per acre, Russian wildrye ranked low when compared with other cool-season grasses. Similar to Altai wildrye, Russian wildrye achieved and retained higher fiber

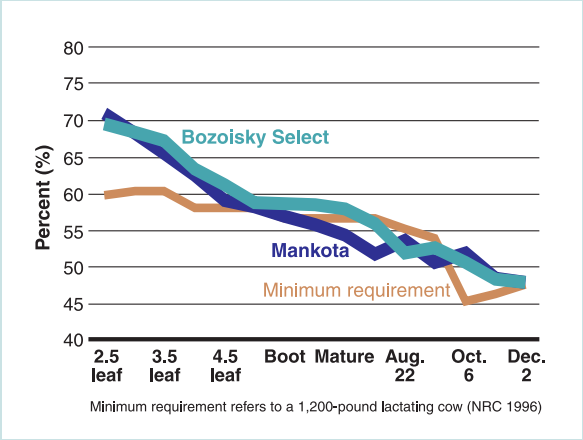
Russian wildrye



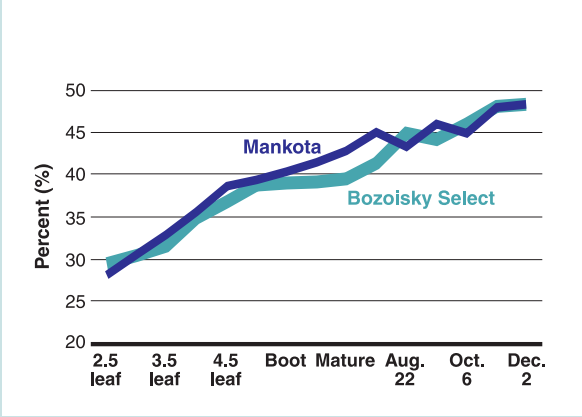
Percent of average peak standing biomass for Russian wildrye Mankota (2,200 lb/ac) and Bozoisky Select (2,379 lb/ac)



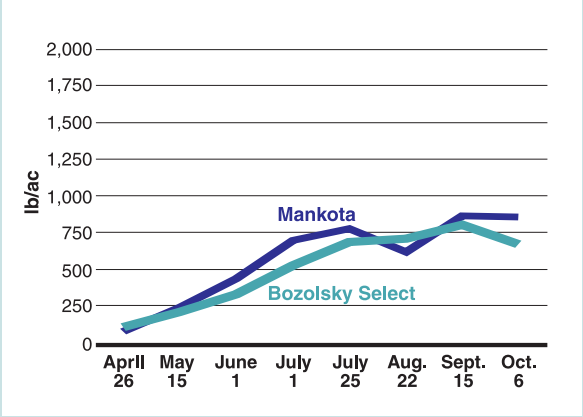
Crude protein content of Russian wildrye



Total digestible nutrient content for Russian wildrye



Acid detergent fiber content of Russian wildrye



Pounds of acid detergent fiber produced per acre for each period of Russian wildrye

content later than all other cool-season grasses, with maximum levels of fiber harvested in mid-September to early October, averaging peak production of 858 and 799 pounds of ADF per acre for Mankota and Bozoisky Select, respectively. Russian wildrye would be considered a highly efficient cool-season grass, reaching peak herbage production in mid-September while maintaining high nutrient content throughout the growing season, retaining more than 80 percent to 100 percent of the standing crop through early October and achieving peak fiber production late in the growing season (early October), while maintaining TDN at or slightly below and CP at or slightly above the minimum levels of a lactating cow.

Performance Characteristics

Mayak, Swift, Cabree, Mankota and Bozoisky Select were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence for all entries was slower than for most other species in the trial. Stand densities were comparable, except for Swift, which had less at both locations. Disease was not a problem. Seed production was similar for all entries and greatly variable by years. The best year for seed production was the second growing season at Hettinger.

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated Russian wildrye as very high for salt tolerance. The electroconductivity (EC) is 13 to 24 millimhos per centimeter (mmhos/cm), which is similar to beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass. For comparison, alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the NRCS Field Office Technical Guide (USDA NRCS 2003) rates Russian wildrye as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

Russian wildrye would provide good grazing in early May through June and from late summer through late fall (September through December). Russian wildrye plant growth was 35 percent to 40 percent by mid-May for both varieties. Mankota reached 59 percent of its growth by early June and 90 percent growth by early July, and retained 100 percent of its growth through early October. Bozoisky Select reached 49 percent of its growth by early June, reaching peak herbage production in mid-September and retaining 80 percent of its production through early October. Mankota's growth pattern was more vigorous than Bozoisky Select in late May and June and also retained greater standing forage in October.

Although forage nutritional quality is very good in May, June and July, Russian wildrye maintains good quality in September, October and November. When comparing growth patterns and nutritional value, livestock grazing could be recommended from early May through early July; however, early September through early December would provide a better choice for this grass. Weaning of offspring should be conducted by early October to maintain performance on the dam. Total digestible nutrients will be adequate throughout most of the growing and early winter months for Bozoisky Select and Mankota.

Recommended Grazing Season: late September through early December, or early May through early July.

Hay Value

Russian wildrye is recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, Russian wildrye should make good hay if harvested before the seed-hardening stage of plant development. Russian wildrye should be cut by mid-July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-September to maintain minimum CP levels for nonlactating animals. When optimizing

Herbage Production

Russian wildrye makes poor to fair hay and good pasture in areas where moisture is fair to excellent. Similar yields from the original study were recorded among all Russian wildrye varieties (Bozoisky Select, Mankota, Mayak, Swift and Cabree) on field trials from Fort Pierre, S.D., in all five years. No differences were found among the five varieties at the Hettinger, N.D., site in four of five years. Bozoisky Select produced greater yields than Mayak and Cabree in one year. The five-year mean production was 1,021, 912, 870, 727 and 648 lb/ac for Bozoisky Select, Swift, Mankota, Cabree and Mayak, respectively, near Hettinger. The five-year mean production was 1,008, 943, 919, 840 and 555 lb/ac for Bozoisky Select, Mankota, Swift, Cabree and Mayak, respectively, near Fort Pierre.

Cumulative herbage production from the GPNS for Russian wildrye was low compared with all other cool-season grasses in this study. When growing season precipitation was greater than 16 inches, cumulative production was 3,560 lb/ac for Mankota and 2,680 lb/ac for Bozoisky Select. Mankota ranked 18th and Bozoisky Select 20th out of 20 grass varieties in the trial during the wet year. In a dry year when growing season moisture was less than 11 inches, cumulative production was 1,480 lb/ac for Mankota and 2,228 lb/ac for Bozoisky Select. Mankota ranked last among the 20 grasses in overall cumulative herbage production in the dry year. When growing season precipitation was about 14 inches, cumulative production was 1,560 and 2,228 lb/ac for Mankota and Bozoisky Select, respectively.

Both varieties were low herbage-producing grasses when moisture was high and low. No statistical

Russian wildrye

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Growth Patterns

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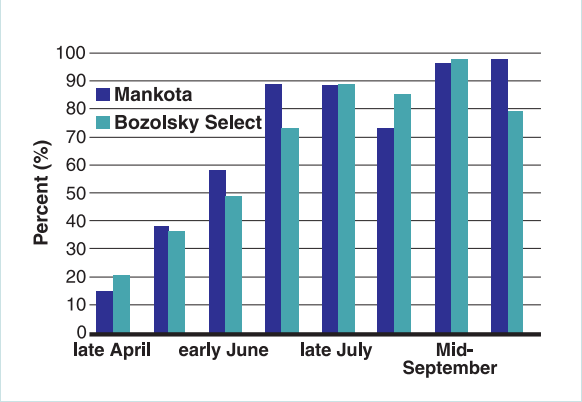
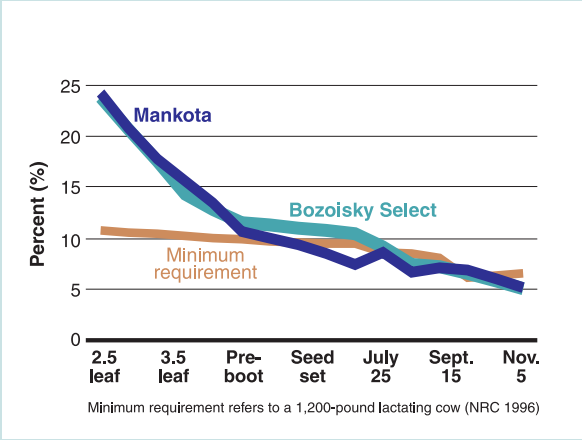
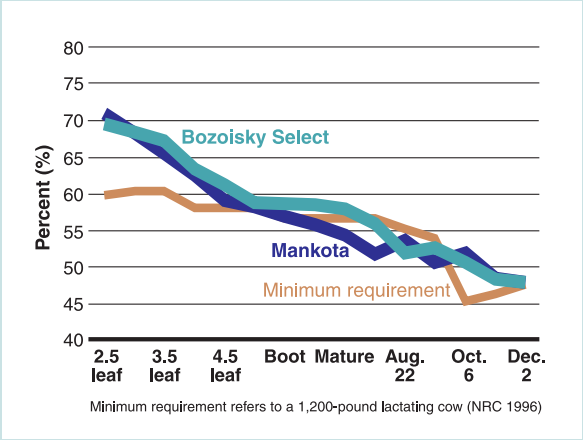
Russian wildrye



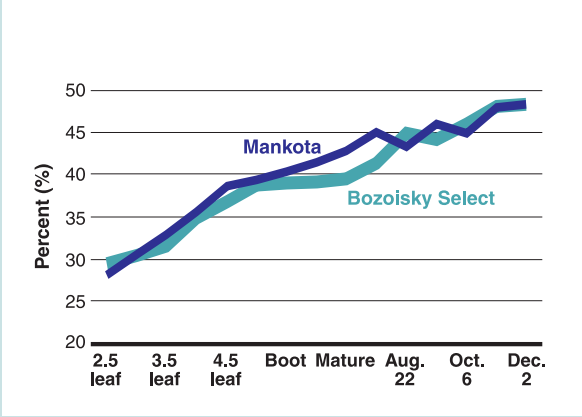
Percent of average peak standing biomass for Russian wildrye Mankota (2,200 lb/ac) and Bozoisky Select (2,379 lb/ac)



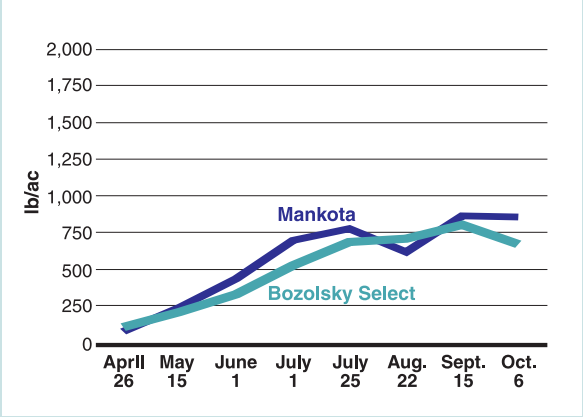
Crude protein content of Russian wildrye



Total digestible nutrient content for Russian wildrye



Acid detergent fiber content of Russian wildrye



Pounds of acid detergent fiber produced per acre for each period of Russian wildrye

content later than all other cool-season grasses, with maximum levels of fiber harvested in mid-September to early October, averaging peak production of 858 and 799 pounds of ADF per acre for Mankota and Bozoisky Select, respectively. Russian wildrye would be considered a highly efficient cool-season grass, reaching peak herbage production in mid-September while maintaining high nutrient content throughout the growing season, retaining more than 80 percent to 100 percent of the standing crop through early October and achieving peak fiber production late in the growing season (early October), while maintaining TDN at or slightly below and CP at or slightly above the minimum levels of a lactating cow.

Performance Characteristics

Mayak, Swift, Cabree, Mankota and Bozoisky Select were studied in replicated trials (USDA NRCS 1997) for emergence and stand uniformity seven weeks after seeding and evaluated for weed competition, stand density, stand rating, plant height, disease, seed production and vigor. Emergence for all entries was slower than for most other species in the trial. Stand densities were comparable, except for Swift, which had less at both locations. Disease was not a problem. Seed production was similar for all entries and greatly variable by years. The best year for seed production was the second growing season at Hettinger.

Salinity Tolerance

The Plant Materials Center at Bridger, Mont., (USDA NRCS 1996) rated Russian wildrye as very high for salt tolerance. The electroconductivity (EC) is 13 to 24 millimhos per centimeter (mmhos/cm), which is similar to beardless wildrye, tall wheatgrass and NewHy hybrid wheatgrass. For comparison, alfalfa is rated low and has an EC rating of 4 to 8 mmhos/cm. Section IV of the NRCS Field Office Technical Guide (USDA NRCS 2003) rates Russian wildrye as having a fair salt tolerance, based on the sodium adsorption ratio (SAR) values.

Grazing Value

Russian wildrye would provide good grazing in early May through June and from late summer through late fall (September through December). Russian wildrye plant growth was 35 percent to 40 percent by mid-May for both varieties. Mankota reached 59 percent of its growth by early June and 90 percent growth by early July, and retained 100 percent of its growth through early October. Bozoisky Select reached 49 percent of its growth by early June, reaching peak herbage production in mid-September and retaining 80 percent of its production through early October. Mankota's growth pattern was more vigorous than Bozoisky Select in late May and June and also retained greater standing forage in October.

Although forage nutritional quality is very good in May, June and July, Russian wildrye maintains good quality in September, October and November. When comparing growth patterns and nutritional value, livestock grazing could be recommended from early May through early July; however, early September through early December would provide a better choice for this grass. Weaning of offspring should be conducted by early October to maintain performance on the dam. Total digestible nutrients will be adequate throughout most of the growing and early winter months for Bozoisky Select and Mankota.

Recommended Grazing Season: late September through early December, or early May through early July.

Hay Value

Russian wildrye is recommended as a pasture grass, with limited information available on value for hay. Based on growth patterns and nutritional quality levels, Russian wildrye should make good hay if harvested before the seed-hardening stage of plant development. Russian wildrye should be cut by mid-July to maintain good CP (9 percent to 10 percent) and TDN (> 55 percent) for winter feed and mid-September to maintain minimum CP levels for nonlactating animals. When optimizing

quality with production (lb + CP), Russian wildrye should be harvested by mid to late July to optimize harvest efficiency.

Recommended Haying Time: not recommended; mid-July for a nonlactating ration and optimum quality and production; early July for a lactating ration, optimum quality and low production.

Wildlife Value

Russian wildrye was low to moderate in productivity, compared with all other cool-season grasses. This grass will provide adequate cover in the fall and winter months due to its high level of standing residue. However, in most cases, it is planted as a monoculture without an understory of legumes or forbs. As a monoculture, it will lack structural diversity and insect populations, making it less attractive to grassland nesting birds and brood habitat in the spring and summer.

Russian wildrye is a palatable grass in the spring, becoming moderately palatable as it matures. This grass will provide a high feed value for foraging animals in the spring, good in early summer and good from midsummer through the fall months. It has limited use for native pollinators and as a seed food source.

Cover Value

Spring:	Fair
Summer:	Fair
Fall:	Good
Winter:	Good

Forage Value

Spring:	Excellent
Summer:	Good
Fall:	Good
Winter:	Good
Regrowth:	Good

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