Plant Science Pamphlet 29
Annual Progress Report

Progress Report 2006

Central Crops and Soils Research Station
Highmore, South Dakota

South Dakota State University • Plant Science Department • Brookings, South Dakota 57007

SDSU

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Welcome

Robin Bortnem, Manager

2006 was definitely a stress year at the station with low rainfall and high temperatures. The month of July had 15 days with temperatures in the 90s and 7 that reached 100°F or higher. Field Day on June 28 was an afternoon tour (3 pm) that featured weed control in a variety of different crops. This was followed by a meal and the traditional twilight tour. The annual field tour typically takes place near the end of June and is an event I strongly encourage you to attend. It's a great opportunity to observe active research being conducted at the station and also to interact with specialists in several diverse areas such as weed and insect control, crop breeding, and production.

A significant amount of time and hard work went into making our tour a success. I'd like to take this time to thank all that were involved: Mike Volek and crew, several Plant Science personnel, and all the speakers, Dixie Volek and daughter Sherise who prepared the desserts and helped serve the meal, and the SDSU Weed Extension project for hauling trailers from Brookings to the station to be used for the tour.

The research conducted each year and included in this report involves long hours by staff from many disciplines at SDSU and the Highmore Research Farm. Their efforts in contributing to this publication each year are greatly appreciated. Support and input from area producers, ranchers, Advisory Board members, and county Extension educators are also greatly appreciated.

A special thanks to Nancy Kleinjan for her assistance in preparing this report.

Greetings

It is a pleasure to welcome you to the 2006 edition of the Highmore Research Station Summary. Agronomy is in the midst of perhaps the greatest paradigm shift since the transition from Horse Power to Tractor Power. We are in the process of moving from being the nation's provider of food, feed, and fiber to being the provider of food, feed, fiber, and energy. This is a time when agronomic research in general is being elevated in its importance as a national resource. Simultaneously, the Highmore Station has been and will continue to play a most significant part in the research effort of South Dakota agronomy.

I want to thank Mike Volek and Robin Bortnem for their efforts in ensuring efficient and effective day-to-day operation and management of the station.

Last of all I want to thank you, the readers of this report, for continuing to support agronomic research and Extension in South Dakota. Please feel welcome to provide us with feedback to our work and this report as we move forward into 2007.

Gregg Carlson
Interim Head, Plant Science Department

2006 Central Substation Advisory Board

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Growing season temperature and precipitation data for the research station during 2006.

Month	Temperature (°F)		No. days	Precipitation
	Maximum	Minimum	Max ≥ 90°	(inches)
	Average			
April	64	38	0	2.45
May	73	44	2	0.95
June	84	56	4	2.02
July	95	65	22	0.98
August	87	60	12	4.58
September	68	45	0	3.45

Evaluation of Native and Naturalized Grasses for Reduced-Input Turf in the Northern Plains

L.C. Schleicher and **S.M. Andersen**
South Dakota State University

Introduction

Buffalograss and blue grama grass are warm-season, sod-forming grasses that require less water, fertilizer, pesticides, and culture than more commonly used cool-season turfgrasses. These two native grasses perform well in the semi-arid climate common to most of South Dakota, and the demand for reduced-input turf has steadily increased in recent years.

Objectives

The objectives of this research are to:

1. collect and preserve grass samples obtained from native grasslands and other high potential sites in the Northern Plains,
2. establish replicated plots to evaluate turfgrass characteristics, response to environmental stress, and sustainability as reduced-input turfgrasses,
3. investigate environmental stress resistance mechanisms that are important to Northern Plains adaptation, and
4. work collaboratively with interdisciplinary and multi-state scientists to enhance the value of the project.

Materials and Methods

To date, 73 blue grama and 127 buffalograss samples have been collected from sites across South Dakota and propagated in the Department of Horticulture, Forestry, Landscape & Parks greenhouses on the SDSU campus in Brookings. Of these, 52 blue grama and 92 buffalograss accessions were established in three replicates at the Central Crops and Soils Research Station in Highmore in previous years, and were rated for genetic color and turfgrass quality in 2006. Leaf texture (width) of blue grama accessions was calculated using spatial calibration software from digitized images obtained with an optical scanner. Un-mowed buffalograss canopy height measurements were also taken.

Plots received no supplemental irrigation, fertilizer, or mowing. Pendimethalin or oxadiazon was applied preemergence for weed control, while spot applications of glyphosate were foliar-applied postemergence for emerged weeds.

Blue Grama Results and Discussion

Four of 52 accessions (7.7%) have shown acceptable color (≥ 5.0) for reduced-input turf. Although a bluish-gray color is typical of blue grama as a species, samples collected in

South Dakota have shown considerable variability in color. A dark green color is highly desirable for turfgrasses commonly used in the U.S.

Fifteen accessions (28.8%) demonstrated potential for acceptable turfgrass quality (≥ 5.0) as a reduced-input turfgrass.

Turfgrass leaf texture is primarily a function of leaf width. Fine-textured turfgrasses are generally preferred over grasses with a coarser texture. All accessions were finely textured (1 to 2 mm), except for four medium textured (2 to 3 mm) grasses.

Accession 507-04 rated as high as or higher than other accessions in all three categories presented in Table 1.

Table 1. Leaf texture, genetic color, and turfgrass quality of 52 blue grama accessions at Highmore, S.D. in 2006.

Accession	Width[†] (mm)	Color[‡] (1-9)	Quality[§] (1-9)
507-04	1.254	5.0	6.3
502-04	1.872	4.0	6.0
533-04	3.176	3.3	6.0
504-04	1.677	5.0	5.7
510-04	1.607	3.7	5.7
522-04	1.433	3.5	5.5
551-04	2.365	3.3	5.3
553-04	1.588	3.0	5.3
501-04	1.371	4.0	5.0
506-04	1.461	4.0	5.0
520-04	1.504	4.5	5.0
523-04	1.407	3.5	5.0
526-04	1.836	5.0	5.0
531-04	1.349	4.0	5.0
550-04	1.816	4.3	5.0
508-04	NA	3.7	4.7
515-04	1.560	5.0	4.7
541-04	1.530	3.0	4.7
552-04	1.350	2.0	4.7
556-04	1.542	4.5	4.7
505-04	1.685	3.0	4.5
509-04	1.365	3.5	4.5
530-04	1.526	3.5	4.5
547-04	1.960	2.5	4.5

Accession	Width[†] (mm)	Color[‡] (1-9)	Quality[§] (1-9)
511-04	2.216	2.7	4.3
512-04	2.074	2.3	4.3
513-04	1.777	3.0	4.3
521-04	1.905	3.3	4.3
529-04	1.483	2.7	4.3
532-04	1.655	3.7	4.3
539-04	1.927	3.3	4.3
543-04	1.563	3.7	4.3
545-04	1.698	4.0	4.3
503-04	1.764	3.0	4.0
517-04	1.677	3.7	4.0
542-04	1.354	2.5	4.0
548-04	1.628	2.5	4.0
549-04	1.729	3.3	4.0
514-04	1.534	4.0	3.7
534-04	1.624	3.7	3.7
535-04	1.660	2.7	3.7
524-04	1.500	3.0	3.5
554-04	1.676	2.0	3.5
555-04	1.577	2.5	3.5
527-04	NA	3.0	3.3
538-04	1.799	3.0	3.3
546-04	1.668	3.0	3.3
516-04	1.470	2.7	3.0
518-04	1.921	3.0	3.0
536-04	1.820	2.5	3.0
537-04	1.607	3.5	3.0
540-04	1.647	2.0	3.0
Mean	1.650	3.4	4.4
LSD (0.05)	0.081	1.4	1.6

[†] leaf width calculated from measurements taken from second-oldest, fully developed leaf blade of individual tillers at 25.4 mm apical to the leaf collar using an optical scanner and spatial calibration software

[‡] genetic color, 1 to 9, where 5=acceptable, 9=excellent

[§] turfgrass quality, 1 to 9, where 5=acceptable, 9=excellent

Buffalograss Results and Discussion

Eight of 92 (< 1%) accessions rated higher than the minimum acceptable value (5.0) for genetic color, but color was unacceptable for eight accessions. Accessions 011-04 and 029-04 rated as high as or higher than all other accessions. The typical grayish-green color of buffalograss has historically been an unfavorable characteristic of the species. Like blue grama, cultivars with a darker green color would be more widely acceptable.

Un-mowed canopy height varied considerably from 4.5 to 24.8 cm (1.8 to 9.8 in.) with an average height of 9.3 cm (3.8 in.). Sixty-six accessions were ≤ 10.2 cm (4 in.) in height, which suggests that nearly three-quarters of the accessions would not require mowing in a reduced-input turf site except to even the top of the canopy, if desired.

Nearly one-half (49%) of the accessions provided acceptable turfgrass quality (≥ 5.0). Although the mean quality value of 008-04 was highest among accessions (7.3), it was not statistically different than 20 others.

Overall, 011-04 ranked highest when averaged over the three rating categories of color, low canopy height, and turfgrass quality.

Table 2. Genetic color, canopy height, and un-mowed turfgrass quality ratings of 92 buffalograss accessions at the Central Crops and Soils Research Station, Highmore, S.D. in 2006.

Accession	Color†	Height (cm)	Quality‡
008-04	5.0	12.0	7.3
006-04	5.0	10.7	6.6
042-04	6.0	10.3	6.6
009-04	5.0	13.0	6.5
024-04	5.0	9.8	6.3
041-04	5.0	24.8	6.3
011-04	7.5	7.0	6.0
021-04	5.0	10.0	6.0
026-04	5.0	9.6	6.0
030-04	5.0	11.0	6.0
046-04	5.0	7.3	6.0
081-04	5.0	10.5	6.0
088-04	5.0	11.1	6.0
005-04	5.0	8.4	5.6
013-04	5.0	11.7	5.6
018-04	5.0	10.7	5.6
023-04	5.0	11.5	5.6
036-04	5.0	10.5	5.6
045-04	5.0	7.8	5.6
054-04	5.0	7.3	5.6
022-04	5.0	11.0	5.5

Accession	Color†	Height (cm)	Quality‡
019-04	5.0	13.5	5.3
034-04	5.0	9.8	5.3
039-04	5.0	7.8	5.3
058-04	4.0	9.7	5.3
087-04	5.0	10.2	5.3
012-04	5.0	12.5	5.0
016-04	5.0	9.6	5.0
020-04	5.0	10.0	5.0
031-04	5.0	10.8	5.0
037-04	5.0	7.8	5.0
044-04	4.0	7.0	5.0
048-04	5.0	8.5	5.0
051-04	5.0	9.5	5.0
057-04	5.0	6.0	5.0
060-04	7.0	9.5	5.0
066-04	4.7	9.9	5.0
070-04	5.0	9.5	5.0
071-04	4.0	6.5	5.0
078-04	5.0	10.5	5.0
082-04	5.0	9.2	5.0
083-04	5.0	8.3	5.0
084-04	6.7	7.4	5.0
097-04	7.0	9.2	5.0
002-04	5.0	10.3	4.6
032-04	5.0	9.2	4.6
035-04	5.0	8.2	4.6
052-04	5.0	7.7	4.6
059-04	4.7	6.9	4.6
079-04	5.0	9.4	4.6
090-04	4.0	7.3	4.5
001-04	7.0	8.9	4.3
010-04	5.0	9.2	4.3
015-04	5.0	9.5	4.3
025-04	5.0	10.7	4.3
029-04	7.3	8.5	4.3
033-04	5.0	12.4	4.3
047-04	5.0	6.8	4.3
049-04	5.0	15.2	4.3
050-01	5.0	8.3	4.3
061-04	5.0	7.3	4.3
076-04	5.0	9.3	4.3
077-04	5.0	9.6	4.3
086-04	6.7	10.3	4.3
093-04	5.0	8.1	4.3
003-04	5.0	11.7	4.0

Accession	Color†	Height (cm)	Quality‡
027-04	5.0	9.3	4.0
028-04	5.0	8.7	4.0
038-04	5.0	9.8	4.0
055-04	4.3	10.1	4.0
056-04	5.0	6.5	4.0
063-04	5.0	7.7	4.0
065-04	5.0	4.5	4.0
067-04	5.0	7.4	4.0
069-04	5.0	7.1	4.0
089-04	5.0	11.3	4.0
073-04	5.0	7.5	3.6
075-04	5.0	7.5	3.6
092-04	5.0	7.0	3.6
040-04	5.0	6.9	3.5
064-04	5.0	7.0	3.5
091-04	5.0	7.8	3.5
007-04	5.0	10.1	3.3
068-04	5.0	6.1	3.3
074-04	4.0	9.7	3.3
004-04	5.0	5.2	3.0
043-04	5.0	5.6	3.0
053-04	5.0	5.0	3.0
062-04	5.0	6.6	3.0
098-04	5.0	7.6	3.0
017-04	5.0	NA	NA
085-04	5.0	NA	NA
Mean	5.1	9.3	4.8
LSD (0.05)	0.4	3.7	1.9

† genetic color, 1 to 9, where 5=acceptable, 9=excellent
‡ turfgrass quality, 1 to 9, where 5=acceptable, 9=excellent

Acknowledgements
This research is sponsored and funded by the SDSU Agricultural Experiment Station, and the Department of Horticulture, Forestry, Landscape & Parks. The authors also acknowledge the support of the Plant Science Department and the Central Crops and Soils Research Station.

2006 NTEP Tall Fescue Ancillary Trial for Drought Tolerance

L.C. Schleicher and **S.M. Andersen**
South Dakota State University

South Dakota State University has participated as an official test site for the National Turfgrass Evaluation Program (NTEP) since 1998. During this period, nearly 85,000 individual plot ratings have been performed on hundreds of commercial turfgrass cultivars and experimental germplasm at the N.E. Hansen Research Center in Brookings, S.D.

In 2006, the Department of Horticulture, Forestry, Landscape & Parks was awarded an ancillary trial to specifically evaluate tall fescue entries under drought stress. Tall fescue traditionally has the greatest drought tolerance among commonly used turfgrass species in the U.S. due primarily to its deep, extensive root system. The Central Crops and Soils Research Station was selected over Brookings as the site for this test due to the likelihood of more extreme high temperatures and drought conditions (Figs 1 and 2).

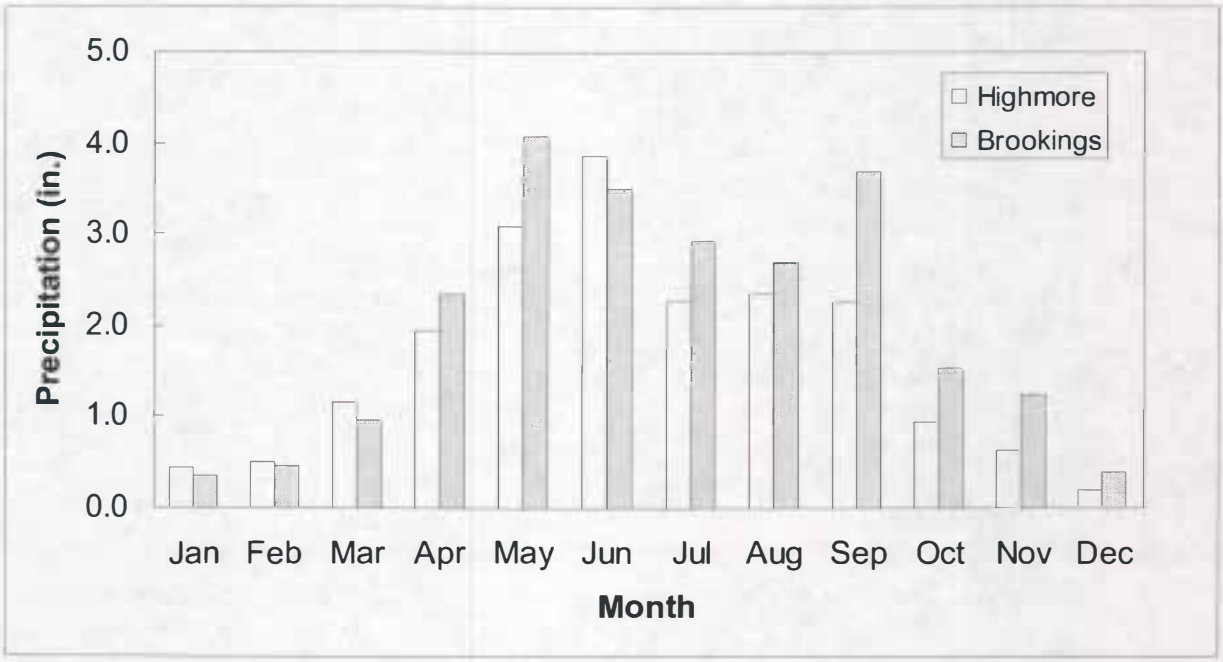

Fig 1. Mean monthly precipitation comparison between Highmore and Brookings, 2000-2005.

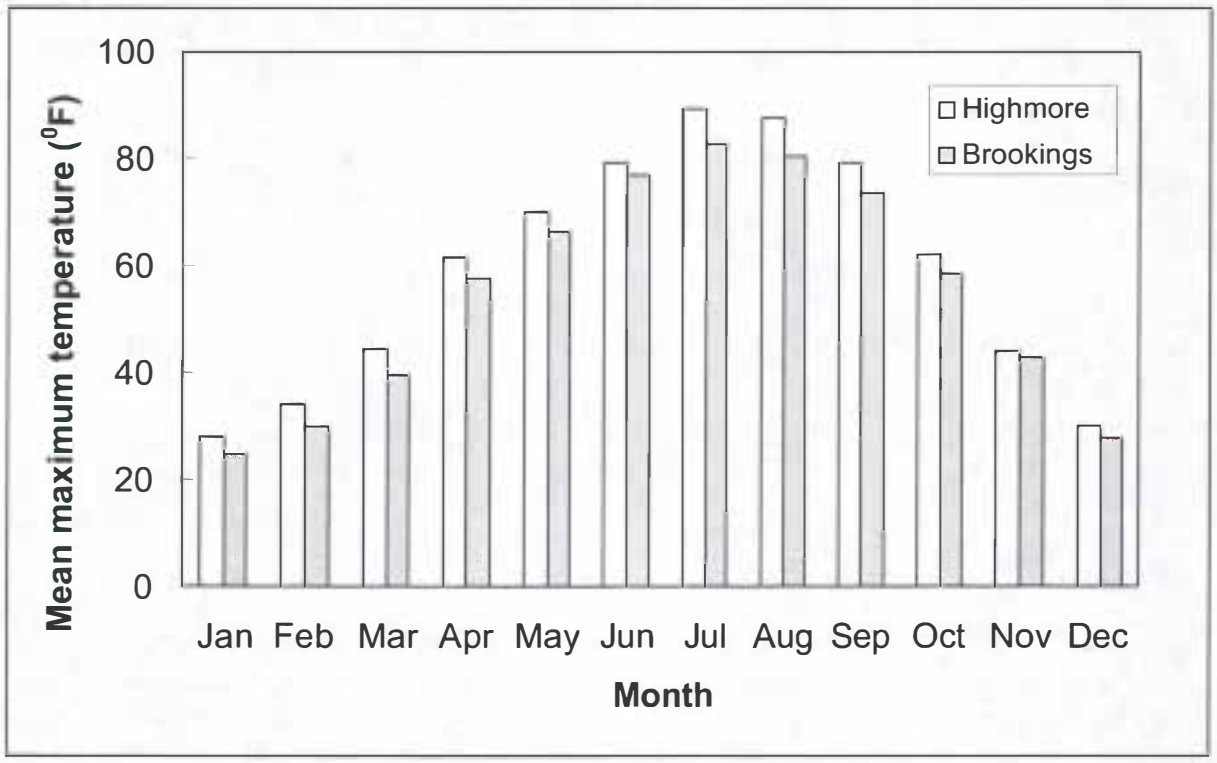

Fig 2. Mean monthly maximum temperature comparison between Highmore and Brookings, 2000-2005.

Materials and Methods

On 7 September, 2006 three replicates each of 113 entries were seeded into individual 5 ft. x 5 ft. field plots arranged in a randomized complete block design. A 20-27-5 starter fertilizer was incorporated into the seedbed immediately prior to seeding at the rate of 1.0 lb. N/1000 ft^2. Entries were rated 21 days after planting for establishment rate (% ground cover) on 28 September (Table 1).

Management protocol beginning 2007 through 2011 includes the following:

Mowing height	3.0 in.
Mowing frequency	2 to 3 wks
Irrigation	50% Et_P or less
Fertilization	None
Fungicides, insecticides	None
Weed control	Minimal; only to prevent stand loss

Potential evapotranspiration (Et_P) will be calculated using lysimeters and soil moisture sensors.

Entries will be evaluated over a 5-year period for monthly turfgrass quality, percent living ground cover each spring and fall, fall/winter color retention, winter injury, percent weed infestation, and drought recovery. Data will be submitted annually to NTEP for analysis and results will be published on the NTEP website (www.ntep.org).

2006 Results

Table 1. Establishment rate 21 days after planting of tall fescue entries seeded 7 September in the 2006 National Tall Fescue Test sponsored by the National Turfgrass Evaluation Program (NTEP).

Entry name	Sponsor	Establishment (%)
Millennium SRP	Turf Merchants, Inc.	71.7
Magellan	LESCO, Inc.	70.0
SH 3	ProSeeds Marketing	70.0
TG 50-9460	DLF Trifolium A/S	68.3
RK 4	Pennington Seed Company	68.3
Lindbergh	Olsen Seed Company	66.7
Silverado	Standard Entry	66.7
3IS-TF-128	DLF International Seeds	66.7
PST-5HP	Pure-Seed Testing, Inc.	66.7
Einstein	Olsen Seed Company	65.0
LTP-610 CL	Lebanon Seaboard Corp.	65.0
RK 5	Pennington Seed Company	65.0
SC-1	Lewis Seed Company	65.0
RK 6	Pro Seeds Marketing	65.0
Aristotle	Olsen Seed Company	63.3
ATF 1247	Ampac Seed Company	63.3
GE-l	Pennington Seed Company	63.3
MVS-341	Mountain View Seeds	63.3
ATM	ProSeeds Marketing	63.3
BAR Fa 6363	Barenbrug USA	63.3
BAR Fa 6253	Barenbrug USA	63.3
RP 3	Columbia Seeds	63.3
Tahoe II	Columbia Seeds	63.3
K06-WA	The Scotts Company	63.3
Rembrandt	Standard Entry	63.3
PST-5WMD	Pure-Seed Testing, Inc.	63.3
Rebel IV	Standard Entry	63.3
DP 50-9407	DLF Trifolium A/S	61.7
IS-TF-154	DLF International Seeds	61.7
RP 2	Pro Seeds Marketing	61.7
Escalade	Oregro Seeds	61.7
PSG-TTRH	Smith Seed Services	61.7
Ky-31	Standard Entry	60.0
DP 50-9411	DLF Trifolium A/S	60.0
Plato	Olsen Seed Company	60.0
RKCL	Ampac Seed Company	60.0
Burl-TF8	Burlingham Seeds	60.0
Biltmore	LESCO, Inc.	60.0
NA-BT-l	LESCO, Inc.	60.0

Entry name	Sponsor	Establishment(%)
BGR-TF2	Berger Seed Company	60.0
J-140	Pickseed West, Inc.	60.0
Justice	Standard Entry	60.0
Skyline	Burlingham Seeds	58.3
Turbo	Burlingham Seeds	58.3
Padre	LESCO, Inc.	58.3
NA-SS	LESCO, Inc.	58.3
GO-IBFD	Grassland Oregon	58.3
Firenza	Integra Seeds	58.3
J-130	Pickseed West, Inc.	57.5
Z-2000	Z-Seeds	56.7
LTP-RK2	Lebanon Seaboard Corp.	56.7
IS-TF-147	DLF International Seeds	56.7
MVS-MST	Mountain View Seeds	56.7
Col-J	Pickseed West, Inc.	56.7
06-DUST	Oregro Seeds	56.7
STR-8LMM	Seed Research of Oregon	56.7
STR-aBB5	Seed Research of Oregon	56.7
STR-8BPDX	Seed Research of Oregon	56.7
JT-45	Jacklin Seed by Simplot	56.7
AST 7002	Allied Seed LLC	56.7
AST-3	Allied Seed LLC	56.7
AST 7003	Allied Seed LLC	56.7
LTP-CRL	Lebanon Seaboard Corp.	55.0
Hemi	Burlingham Seeds	55.0
Bullseye	Burlingham Seeds	55.0
IS-TF-151	Columbia Seeds	55.0
MVS-TF-158	Mountain View Seeds	55.0
IS-TF-161	DLF International Seeds	55.0
MVS-1107	Mountain View Seeds	55.0
M4	Pickseed West, Inc.	55.0
06-WALK	Oregro Seeds	55.0
RAD-TF17	Radix Research	55.0
STR-8GRQR	Seed Research of Oregon	55.0
Tulsa III	Seed Research of Oregon	55.0
JT-41	Jacklin Seed by Simplot	55.0
AST 7001	Allied Seed LLC	55.0
KZ-1	KZ Seeds	55.0
DKS	Smith Seed Services	55.0
AST-2	Allied Seed LLC	55.0
AST-1	Allied Seed LLC	55.0
Falcon IV	Standard Entry	55.0
IS-TF-135	DLF International Seeds	53.3
IS-TF-153	DLF International Seeds	53.3
MVS-BB-1	Mountain View Seeds	53.3

Entry name	Sponsor	Establishment(%)
CE 1	Pro Seeds Marketing	53.3
JT-42	Jacklin Seed by Simplot	53.3
JT-33	Jacklin Seed by Simplot	53.3
CS-TF1	Columbia Seeds	53.3
LS-11	LESCO, Inc.	53.3
LS-03	LESCO, Inc.	53.3
GWTF	Grassland Oregon	53.3
IS-TF-152	Ampac Seed Company	51.7
PSG-TTST	Smith Seed Services	51.7
Col-M	Pickseed West, Inc.	51.7
Hunter	LESCO, Inc.	51.7
PSG-85QR	Pickseed Genetics	51.7
PSG-82BR	Pickseed Genetics	51.7
JT-36	Jacklin Seed by Simplot	51.7
Rhambler	Turf Merchants, Inc.	51.7
ATF 1328	Lewis Seed Company	50.0
IS-TF-159	Grassland Oregon	50.0
LS-06	LESCO, Inc.	50.0
KZ-2	KZ Seeds	50.0
ATF-1199	Pennington Seed Company	50.0
RK-1	Turf Merchants, Inc.	50.0
DP 50-9440	DLF Trifolium A/S	48.3
IS-TF-138	Ampac Seed Company	48.3
0312	Pickseed West, Inc.	48.3
BGR-TF1	Berger Seed Company	48.3
AST-4	Allied Seed LLC	48.3
RNP	Pennington Seed Company	47.5
Col-1	Pickseed West, Inc.	46.7
PSG-RNDR	Smith Seed Services	46.7
Mean		57.5
LSD (0.05)		13.3

Acknowledgements

This research is sponsored and funded by the National Turfgrass Evaluation Program, the SDSU Agricultural Experiment Station, and the Department of Horticulture, Forestry, Landscape & Parks. The authors also acknowledge the support of the Plant Science Department and the Central Crops and Soils Research Station.

2006 Highmore Report

Field Evaluation of Woody Plant Materials Highmore, South Dakota

Dwight Tober
Plant Materials Specialist, USDA/NRCS, Bismarck, ND

Objectives

1. Assemble and evaluate the adaptation and performance of selected woody plant material for field and farmstead windbreaks, wildlife habitat, and streambank and lakeshore plantings in the Northern Great Plains.
2. Select and cooperatively release superior woody conservation plants for increase by commercial nurseries.

Activities in 2006

Approximately 140 accessions of 87 different species are currently being evaluated. The latest new entries were planted on May 17, 2004, and included black currant (*Ribes americanum*), Missouri gooseberry (*Ribes missouriense*), aspen (*Populus tremuloides*), Amur linden (*Tilia amurensis*), and black cherry (*Prunus serotina*). These entries were planted between tree stumps of several accessions of apricot which were removed in 2002. No new entries were planted in 2005 or 2006 because of shading and lack of room. Significant information can still be documented from existing entries, and data collection will continue on a scheduled annual basis. The first entries were planted at the Highmore site on April 11, 1978. Data is summarized annually and documented in the Annual Technical Report. Anyone who desires a copy of the latest technical report from Highmore can contact me at (701)530-2075 or at Dwight.Tober@nd.usda.gov. The report is about 40 pages in length. Also Mike Knudson has compiled a report titled "Twenty-five Years of Tree Planting Trials at the Highmore Field Evaluation Planting" which contains complete data summary information inclusive to all species tested at this site. This 53-page report can be requested through me or the Bismarck Plant Materials Center (701) 250-4330.

Weed control and maintenance have been consistently good. A major renovation effort in 2000 included removal of broken branches and limbs resulting from snow damage, removal and pruning of natural die-back of some species (primarily shrubs), and cutting and removal of contaminant species (primarily Siberian elm and mulberry). All of the apricot (8 entries) and some entries of crabapple, poplar, Russian olive, and other species have been removed at various times by staff at the station. Staff at the Highmore NRCS

Field Office helped collect data on selected entries on September 6, 2006. Measurements and notes were taken on crown spread and plant height, disease and insect damage, drought and cold tolerance, fruit production, survival, vigor, and snow and animal damage. Many of the mature entries continued to perform well. There are also numerous species declining in health and overall vigor because of disease and natural die-back as they approach the end of their life span. Some of the species noted as showing disease symptoms or die-back include tamarack, white cedar, forsythia, chokeberry (rust), river birch, and seaberry. Many of the green ash accessions were showing ash borer damage. Drought stress was obvious on numerous entries. The Homestead hawthorn had wilted/brown leaves. There were additional blow-down trees on the chokecherry accessions resulting from stem cankers.

New releases

Data collected from this site were used to support the formal release of two new shrubs last year cooperatively with SDSU and the Agricultural Experiment Station. 'Silver Sands' sandbar willow, planted in 1990, and 'Survivor' false indigo, planted in 1987, were officially released in January 2005. They both had 100% survival and superior performance for at least the first 5 years, even though both species are subject to natural die-back due to winter or drought conditions. A release brochure was completed in 2006 and is available on the Bismarck PMC homepage (http://Plant-Materials.nrcs.usda.gov) for these two new releases, or it can be ordered from the Bismarck PMC.

Summary of accomplishments

Selected accessions/cultivars that have performed well at the Highmore site and show promise for additional testing and/or promotion for conservation use include the following:

'Cardan' green ash
'Centennial' cotoneaster
'Sakakawea' silver buffaloberry
'Indigo' silky dogwood
ND-1134 hybrid plum
'Silver Sands' sandbar willow
ND-1879 honeylocust
'Legacy' late lilac
9058862 tamarack
ND-170 cotoneaster
'Bighorn' skunkbush sumac
14272 hybrid poplar
9069081 littleleaf linden
9063130 river birch
9016318 Siberian elm
Arnold's Red honeysuckle
9057409 American hazel
'Oahe' hackberry
'Scarlet' Mongolian cherry
'McDermand' Ussurian pear
'Regal' Russian almond
ND-21 nannyberry
9047238 seaberry
'Survivor' false indigo
ND-1863 honeylocust
'Meadowlark' forsythia
'Midwest' Manchurian crabapple
323957 chokeberry
ND-2103 highbush cranberry
hybrid poplar 9069086 (Theves)
9047228 pygmy caragana
ND-46 Timm's juneberry
ND-3744 Korean barberry
Siberian larch (SL–383, ND-1765)

ponderosa pine (ND-1763, 9067413)
Scot's pine (9063156, 9063154)
9063148 corktree
9057411 lodgepole pine
9057410 hackberry
9063116 black ash

Data from this planting has been used to document the cooperative release of the cultivars listed below. These cultivars are generally available from local conservation nurseries and are used in conservation plantings throughout the Northern Great Plains. Several more releases are anticipated in the near future. Information gathered concerning plant performance assists cooperating nurseryman and plant researchers in determining the range of adaptation of many other accessions/cultivars also included in the test planting.

Formal Releases with Supporting Documentation from the Highmore Site

'Cardan' green ash (1979)
'Oahe' hackberry (1982)
'Sakakawea' silver buffaloberry (1984)
'Scarlet' Mongolian cherry (1984)
'Centennial' cotoneaster (1987)
'McDermand' Ussurian pear (1990)
'Homestead' Arnold hawthorn (1993)
'CanAm' hybrid poplar (1995)
'Regal' Russian almond (1997)
'Legacy' late lilac (1999)
'Silver Sands' sandbar willow (2005)
'Survivor' false indigo (2005)

Acknowledgments

This research was sponsored and financial support was provided by the SDSU Agricultural Experiment Station, the SDSU Plant Science Department, the Hyde County Soil Conservation District, and the USDA Natural Resources Conservation Service.

2006 Alfalfa Production
Central Crops and Soils Research Station

Vance Owens, Peter Jeranyama, and **Chris Lee**

Alfalfa cultivars are tested at several South Dakota research stations. Our objective is to provide producers with yield data from currently available alfalfa cultivars to aid them in cultivar selection. Even though our yield trials do not contain all available cultivars, they should be a helpful tool in identifying cultivars suitable for specific needs. Table 1 provides forage production data from 18 cultivars planted at Highmore in 2003 and harvested through 2006. Table 2 includes 11 cultivars planted in a new trial at Highmore in 2005. Due to drought conditions only one cutting was harvested from both trials in 2006.

Cultivars are ranked from highest to lowest based on total yield. The least significant difference (LSD) listed at the bottom of the table is used to identify significant differences between the cultivars. If the difference in yield between two cultivars exceeds the given LSD, then they are significantly different.

Alfalfa was planted at both trials at a seeding rate of 18 lbs pure live seed (PLS)/acre. Experimental design consists of six replications in a randomized complete block. Fifty pounds of super phosphate (P_2O_5) was applied preplant, as was Treflan for weed control.

Plots were harvested once in the establishment year with a sickle-type harvester equipped with a weigh bin for obtaining fresh plot weights. Random subsamples from the fresh herbage were taken to determine percent dry matter. Alfalfa cultivars were evaluated for maturity prior to harvest. Yield differences among cultivars were tested using the LSD at the 0.10 level of probability when significant F-tests were detected by analysis of variance (Tables 1 and 2).

Table 1. Yield of 18 alfalfa cultivars entered in the South Dakota State University alfalfa testing program at the Central Research Station. Plots were planted 28 April 2003.

Entry	2006 31 May	2005 Total	2004 Total	2003 Total	4-year Total
	---------- Tons DM/acre ----------				
Released cultivars					
A 30-06	2.08	2.96	4.75	1.03	10.82
DKA 42-15	1.91	3.07	4.18	1.07	10.23
WL 319 HQ	1.81	2.98	4.24	0.86	9.89
Hybriforce 400	1.69	2.98	4.04	1.17	9.87
Hybriforce 420 Wet	1.90	2.91	3.83	1.23	9.87
Vernal	1.73	2.97	4.19	0.93	9.82
Journey Brand 204 Hyb.	1.78	2.95	4.03	1.04	9.79
Notice II	1.68	2.85	3.99	1.04	9.56
Somerset	1.54	2.97	3.82	1.22	9.54
Husky Supreme	1.71	2.79	3.89	1.13	9.53
54V54	1.70	2.90	3.92	0.98	9.49
WL 357 HQ	1.44	3.03	3.77	1.15	9.39
Maverick	1.40	2.96	3.87	1.05	9.28
Setter	1.46	2.64	3.58	1.21	8.89
Alfastar II	1.24	2.45	3.93	1.18	8.80
Gold Rush 747	1.17	2.67	3.71	1.11	8.66
Multiplier 3	1.65	2.38	3.43	1.13	8.59
FK 421	1.16	2.46	3.40	1.15	8.17
Average	1.61	2.83	3.92	1.09	9.46
Maturity (Kalu & Fick)	4.4				
LSD (P=0.10)	NS	0.20	NS	NS	NS
CV (%)	39.9	14.7	19.9	19.7	15.5
P-value	0.506	0.075	0.499	0.194	0.312

NS = not significant at 0.10 level of probability

Treflan applied pre-planting 50 lbs P2O5/Acre - preplant

Table 2. Yield of eleven alfalfa cultivars entered in the South Dakota State University alfalfa testing program at the Central Research Station. Plots were planted 3 May 2005.

Entry	2006 31-May	2005 Total	2-year Total
361 HY	2.26	1.56	3.81
Mountaineer 2.0	1.99	1.68	3.67
6400 HT	2.02	1.61	3.64
Vernal	2.05	1.57	3.62
Labrador	1.97	1.64	3.61
4A421	2.02	1.57	3.59
Rebound 5.0	1.83	1.55	3.38
54V46	1.96	1.32	3.28
LegenDairy 5.0	1.79	1.43	3.21
Integrity	1.83	1.22	3.05
WL 335HQ	1.80	1.23	3.03
Average	1.94	1.51	3.44
Maturity (Kalu & Fick)	4.2		
LSD (P=0.05)	NS	NS	NS
CV (%)	17.7	27.9	16.9
P-value	0.356	0.466	0.348

NS = not significant at 0.10 level of probability
Treflan applied before planting
50 lbs P2O5/Acre - preplant

Acknowledgements

This research was sponsored by various alfalfa seed companies, the SDSU Agricultural Experiment Station, and the SDSU Plant Science Department.

2006 Highmore Report

Optimal Management of Drought-Tolerant Legumes and Warm Season Annual Grasses

Peter Jeranyama, Vance Owens and **Chris Lee**

Summer annual forages, since they are quick to establish, can supply emergency forage under conditions of drought or after a winter where there has been considerable mortality of perennial species such as alfalfa. Although cool-season perennial grasses make up the bulk of forage consumed by livestock in the Northern Great Plains, annual species are being used more frequently as emergency forage sources. In some operations, annuals fit better into crop rotations than perennial forages.

Many acres of perennial forage have been lost in recent years due to the drought in north-central and western South Dakota. Producers are looking for viable annual forage alternatives to replenish forage supplies for livestock operations. This trial is evaluating the potential to mix annual warm season grasses and annual legumes as emergency forages. The objective of the study was to evaluate forage dry matter yield and quality of annual warm season grass and legume species either alone or in two-way legume/grass mixtures.

Materials and Methods

Pigeonpea, cowpea, pearl millet, and foxtail millet were planted alone and in all possible two-way legume/grass mixtures (total of eight) in plots 3 x 20 ft at the Central Crops and Soil Research Station, Highmore, on 31 May 2006. Five rows with 6-inch spacings were planted with a cone seeder (Carter Man. Brookston, Ind.). Plots were fertilized with 100 lb/acre of 18-46-0 at planting, and no additional fertilizer was used. Seeding rates were as follows: pigeonpea at 36 lb/acre in pure seeding and 18 lb/acre in mixtures, cowpea at 48 lb/acre in pure seeding and 24 lb/acre in mixtures, pearl millet and golden foxtail at 20 lb/acre and 10 lb/acre in their associated mixtures. Experimental design consisted of an 8 x 2 factorial replicated 4 times in a randomized complete block, becoming repeated measures with respect to harvest time. Plots were harvested at the soft- to hard-dough to evaluate yield.

Results

Table 1 shows the forage dry matter yield on 2 October 2006. Highmore experienced a prolonged drought after the forages had been planted, and germination of some species was delayed by more than 3 weeks. Those species that germinated remained stunted until a single significant rainfall event that occurred 3 months after planting.

Acknowledgments: We appreciate CES for funding this research.

Table 1. Forage dry matter yield of several warm-season annual species at Highmore Central Research Station on 2 October 2006.

Forage	Dry matter yield (tons/acre)
Cowpea	0.8
Pigeonpea	1.4
Golden foxtail millet	1.1
Pearl millet	1.8
Golden foxtail millet + Cowpea	1.3
Golden foxtail millet + Pigeonpea	1.3
Pearl millet + Cowpea	1.1
Pearl millet + Pigeonpea	2.4
LSD 5%	1.4
CV, %	35

Winter Wheat Breeding and Genetics

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Summary of Activities

The Winter Wheat Breeding and Genetics Program utilizes the Central Research Station at Highmore primarily for early-generation testing and evaluation of advanced-generation lines. The breeding program also conducts field trials at several other sites throughout South Dakota.

Central Research Station trials conducted in 2005 by the Winter Wheat Program included:

1. The CPT Variety Trial, under the overall coordination of Dr. Bob Hall. The trial included 30 entries, consisting of 18 released varieties (including new releases from other states), 10 advanced experimental lines from our program, and one experimental line each from the Nebraska public breeding program and AgriPro. This trial was also grown at 13 other sites in South Dakota. Prior to cultivar release, promising elite lines must be grown in the CPT Variety Trial for 3 years to accurately measure the potential performance across a range of environmental conditions.
2. The South Dakota Advanced Yield Trial (AYT), with both hard red and hard white lines. The AYT nursery included 45 entries of 35 advanced experimental lines and 10 checks. Eleven of the experimental lines have the white kernel color. The AYT nurseries were also grown at seven other sites in South Dakota and one each in North Dakota, Nebraska, and Colorado. Each year, three to six superior experimental lines are selected from these nurseries and advanced to the CPT Variety Trial and the Northern Regional Testing Program.

Trial Conditions

The nurseries at Highmore were planted one inch deep into fallow soil with good moisture conditions on September 16, 2005. Plots were sprayed in late April 2006 with 5 quarts Ramrod per acre and in early May 2006 with 1.5 pints Bronate per acre. Yield and test weight data for Highmore and other CPT locations are presented in Table1.

Acknowledgements

Each year, 600-800 new cross combinations are made and 600-800 new experimental lines are developed by the winter wheat breeding program. In addition to the excellent support of our wheat pathology programs (small grains pathology and virology), the solid and consistent financial support from the South Dakota Wheat Commission and the South Dakota Crop Improvement Association are vitally important to ensuring continued availability of improved winter wheat varieties for producers in South Dakota.

Table 1. Yield results of entries in the 2006 Crop Performance Testing (CPT) nursery.

Grain Yield (bu/a)

Entry $	Brookings 06'	Water town 06'	Platte 06'	Highmore 06'	D. Lakes 06'	Winner 1 06'	Winner 2 06'	Martin 06'	Oelrichs 06'	Bison 06'	Sturgis 06'	Wall 06'	State 06' †	State 06' ±	3-yr
Darrell	84	48	53	42	32	37	39	52	55	19	39	43	50	47	52
Hatcher	78	50	55	46	24	38	35	55	62	12	38	41	50	46	
NuDakota	89	52	72	49	27	37	25	50	58	16	31	47	50	48	
SD01058	79	46	61	50	27	40	37	51	55	14	35	44	50	47	
SD98W175-1	77	67	59	44	33	45	39	47	55	13	33	43	49	49	
Harry	77	36	48	45	37	39	36	44	60	19	36	46	49	45	
Alliance	81	51	43	48	23	41	39	42	54	17	33	46	49	44	51
Expedition	85	51	56	40	27	37	36	44	56	17	33	46	48	46	49
Wahoo	78	44	49	44	27	35	33	45	61	16	36	48	48	45	52
Trego	72	47	48	51	27	38	38	53	54	17	36	40	48	45	49
Wesley	81	53	49	52	30	34	31	48	52	17	34	42	48	45	49
Alice	72	47	62	46	29	39	34	47	52	17	37	45	48	46	50
Wendy	80	49	49	34	32	38	39	48	49	19	33	46	48	45	49
Overland	85	52	53	32	31	38	35	44	52	13	28	46	47	45	
Nufrontier	66	40	54	50	25	38	35	46	57	11	35	44	47	43	
SD96240-3-1	86	57	48	46	22	38	38	41	45	20	28	44	47	44	
SD02480	77	43	58	41	22	39	41	42	52	18	26	44	46	43	
Arapahoe	82	50	46	45	28	35	33	45	52	17	30	42	46	43	49
Millennium	79	44	57	42	33	31	37	43	56	19	32	41	46	45	53
Jagalene	65	42	51	44	24	41	36	42	57	16	38	42	46	43	51
SD02279	73	43	55	54	27	36	31	42	51	13	31	47	46	43	
SD01W064	74	51	51	37	35	39	36	46	50	18	30	44	46	44	
Harding	71	45	46	49	24	37	37	40	52	18	33	42	45	42	50
Nekota	76	43	50	54	25	37	34	42	50	21	33	36	45	43	46
Tandem	65	48	47	45	25	36	36	44	51	16	35	45	45	42	49
Jerry	78	44	44	42	22	29	31	43	53	20	30	39	45	41	50
SD97059-2	82	50	42	41	25	31	28	45	47	12	30	45	45	42	52
Overley	81	68	69	26	25	30	27	41	54	17	29	46	44	46	
Crimson	73	42	54	46	23	37	33	42	51	14	33	34	44	41	47
SD01122	63	36	56	52	33	28	33	45	52	18	29	43	44	42	
Mean	77	48	53	45	27	37	35	45	54	16	33	43	47	44	50
CV‡	8.6	23.5	23.4	13.2	35.7	9.0	12.2	12.5	8.2	20.0	12.6	11.2	10.7	16.7	14.9
LSD.05£	9.3	15.8	17.4	12.0	13.8	5.4	5.0	8.0	6.2	6.7	6.8	6.8	2.6	3.1	1.8

‡ The CV (coefficient of variability) is a statistical measure of experimental error. In general, yield trials with a CV of 16% or greater are considered to contain too much experimental error for reliable data interpretation.

† 2006 statewide average grain yield excluding locations that have a CV% of more than 15%.

± 2006 statewide average grain yield including high CV% locations.

$ Entries were sorted by 2006 statewide average excluding locations that have a CV% of more than 15%.

£ The LSD (least significant difference) is the minimum value by which two entries must differ in order for that difference to be meaningful (and not be due to random chance alone). If the difference between two entries is equal to or less than the LSD value, the entries are not statistically different.

2006 Highmore Report

Evaluation of Sunflower Germplasm for Resistance to the Red Sunflower Seed Weevil, Highmore, S.D., 2006

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The red sunflower seed weevil, *Smicronyx fulvus* LeConte, is a serious pest of sunflower in North and South Dakota. Adult females lay eggs in immature seeds and larvae consume a portion of the kernel, causing economic damage in the form of lost yield and oil content of oilseed sunflower and reduced yield and quality of confection sunflower. Mature larvae exit the seeds in late August or September and drop to the soil to overwinter. The goal of this project is to identify sunflower germplasm with genetic resistance to the red sunflower seed weevil. Resistant germplasm, if identified, will be made available to seed companies for incorporation into hybrids.

This was the fifth year of a cooperative trial conducted by the USDA-ARS Sunflower Research Unit, Fargo, N.D., and the South Dakota Experiment Station, South Dakota State University. Sunflower germplasm tested at Highmore and Prosper, N.D., in 2006 included 21 interspecific crosses or accessions obtained from the North Central Plant Introduction Station, Ames, Iowa. These included both new lines and the retesting of lines from earlier trials to confirm their efficacy. Additionally, 60 S_1 lines developed by the USDA-ARS through a recurrent selection breeding procedure that genetically combined lines with quantitatively inherited insect tolerance factors from previous trials were subjected to insect infestation at Colby, Kan., (stem weevil and sunflower moth), Highmore (red sunflower seed weevil), and Prosper (red sunflower seed weevil and banded sunflower moth).

The plots at Highmore were seeded on June 9, 2006. Five heads from each plot were bagged following pollination to protect them from bird damage. The bagged heads were harvested and threshed individually. Seed was sent to the USDA-ARS, Northern Crop Science Laboratory, Fargo, N.D., for evaluation of seed damage. Results are pending.

In 2004, 18 accessions and the check variety USDA Hybrid 894 were planted in single-row plots, four replications. Up to five heads were harvested and threshed from each row and a pooled seed sample sent to Fargo for damage evaluation. The results showed that a high level of red seed weevil infestation occurred at Highmore in 2004. Seed damaged ranged from 6 to 49%. The accession PI 431542 had the lowest amount of damage. Ames 3269 also had a low amount of damage (12.5%) in 2004 and had shown low damage levels in 2003 as well.

The 2005 trial at Highmore consisted of 17 accessions, 2 interspecific crosses, and Hybrid 894 planted in two-row plots with three replications. Eight of the lines were previously tested and 12 were new. Up to 10 heads from each plot were harvested and threshed individually. Seed damage from the red sunflower seed weevil ranged from 2 to 59% damaged seed. Three accessions showed seed damage of less than 18%. Ames 3269 had low levels of damage (18%) for the third year of testing and PI 431542 had the least amount of damage recorded in 2004 (6%) and 2005 (2%). PI 431545, which had not been tested previously, also showed low levels of seed damage in 2005 (13.5%). Results of the 2004 and 2005 screenings are outlined in Table 1.

Acknowledgements

The Highmore, S.D., portion of this research was funded by the National Sunflower Association and the SDSU Agricultural Experiment Station.

Table 1. Mean percentage of seed damaged by red sunflower seed weevil from sunflower lines and accessions evaluated at Highmore, S.D., from 2004 to 2006.

Line or Accession	ID	% Damaged Seed		
		2004	2005	2006
Str 1622-1		27.2 ± 2.7	--	--
PI 170385		37.7 ± 2.9	--	--
PI 253776		33.5 ± 3.0	--	--
PI 267665		30.8 ± 1.7	--	--
PI 291403		34.9 ± 2.5	--	--
PI 386230		19.9 ± 2.1	--	--
PI 431513		13.8 ± 4.1	--	--
PI 494859		31.4 ± 2.6	--	--
PI 494861		26.4 ± 3.0	--	--
PI 505651		21.1 ± 2.7	--	--
HYB 894	Hybrid 894(check)	23.9 ± 1.2	43.3 ± 1.5	*
PI 431506	(Susceptible check)	--	38.5 + 4.1	*
Hir 828-3	(Susceptible check)	49.0 ± 3.7	58.9 + 2.9	*
Str 1622-2	(Susceptible check)	32.4 ± 4.5	34.0 + 2.7	*
Ames 3269	PURPUREUS	12.5 ± 1.6	18.0 + 1.9	*
Ames 3391		23.6 ± 1.9	25.3 +2.1	--
Ames 3454		16.7 ± 5.3	35.4 + 4.1	--
PI 431542		6.0 ± 1.6	2.0 + 0.8	*
PI 497939		12.6 ± 1.8	53.7 + 3.9	--
PI 431516		--	36.3 + 3.7	--
PI 431514		--	37.2 + 3.5	--
PI 431518		--	45.4 + 3.4	--
PI 431520		--	29.5 + 3.9	--

PI 431524		--	39.7 + 4.4	--
PI 431528		--	42.9 + 4.2	--
PI 431529		--	32.5 + 6.5	--
PI 431545		--	13.5 + 5.5	*
PI 431549		--	41.9 + 2.7	--
PI 431563		--	35.8 + 2.4	--
PI 431568		--	25.3 + 3.5	--
PI 431569		--	36.0 + 4.1	--
PI 170391	Low banded moth damage	--	--	*
PI 170401	Low banded moth damage	--	--	*
PI 251902	Low banded moth damage	--	--	*
PI 265503	Low banded moth damage	--	--	*
PI 372259	Low banded moth damage	--	--	*
Par 1673-1	Low sunflower moth damage	--	--	*
Pra Pra 1142	Low sunflower moth damage	--	--	*
Ames 3454	Low sunflower moth damage	--	--	*
PI 162453	Low sunflower moth damage	--	--	*
PI 170405	Low sunflower moth damage	--	--	*
PI 175728	Low sunflower moth damage	--	--	*
PI 193775	Low sunflower moth damage	--	--	*

* Seed damage evaluations from 2006 are in process.

2006 Highmore Report

Weed Control

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Experiment stations make it possible to evaluate experimental treatments and to demonstrate practices. The Highmore Station is a strategic location for several weed control field trials. The location provides performance data and field tour training opportunities for producers and industry in central South Dakota.

2006 Projects

Small grains research focused on downy brome (cheatgrass) control in winter wheat. The Highmore Station has provided an ideal location to study cheatgrass control, which has resulted in information necessary for identifying economically effective control options. New products, such as Olympus Flex and Beyond in new Clearfield varieties, have been evaluated to provide South Dakota wheat growers local efficacy data prior to the release of these products. A new herbicide resistant sunflower variety that is tolerant to Express was evaluated this year. This sunflower variety may be released for sale in 2007. Sunflower research was also conducted in collaboration with a multi-state effort to evaluate the efficacy and crop tolerance of an experimental herbicide, KIH-485. This herbicide was also evaluated in sorghum. Research also continued on the use of alternative herbicide chemistries in pulse crops, such as lentil, chickpea, and field pea or oil seed crops such as safflower and flax. These studies demonstrate the unique opportunities that the Highmore research station provides for conducting research that helps expand weed control options for growers in central and western South Dakota.

2006 Season

There was enough spring precipitation for crop establishment, but soils began to dry in late spring, which greatly suppressed weed emergence. Consequently, many untreated check plots had relatively low weed populations, making herbicide efficacy evaluation difficult. There were also some storms with hail and high winds that caused some crop damage in the summer. Nevertheless, most crops survived until fall. Yields were very low on all crops due to the extreme drought conditions. However, some growers at the field day commented that the crops at the Highmore Station looked better than some crops in the area.

2006 Research

1. Cheatgrass Control in Winter Wheat
2. Split Applications for Cheatgrass Control in Winter Wheat
3. Cheatgrass Control in Clearfield and Conventional Winter Wheat
4. Weed Control in Clearfield Sunflower
5. Weed Control in Sunflower with Pre-Emergence Treatments
6. Pre-Emergence Weed Control in Sunflower
7. Weed Control in Safflower
8. Preemergence Herbicide Pulse Demonstration
9. Postemergence Herbicide Pulse Demonstration
10. No-Till Corn Herbicide Demonstration
11. Weed Control in Grain Sorghum
12. Fall Alfalfa Burndown

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2. National Sunflower Association
3. Consortium for Alternative Crops
4. Crop Protection Industries

NOTE: Data reported in this publication results from field tests that include experimental products, experimental uses, or experimental rates, combinations, or other unlabeled uses for herbicide products. Tradenames of products used are listed; there frequently are other brand products available in the market. Users are responsible for applying herbicide according to label directions. Refer to the appropriate weed control fact sheets available from county Extension offices for herbicide recommendations.

Table 1. Cheatgrass control in winter wheat

RCB; 3 reps
Planting Date: 9/8/05
Variety: Harding
FALL: 10/13/05; W wht 2-3 lf; Dobr 1.5-3 lf, 1-2 in.
SPRING: 4/12/06; W wht 2 lf, 2-3 in; Dobr 2-3 lf, 1-2 in.
Soil: Clay loam; 2.5% OM; 6.2 pH

Precipitation:

FALL:	1st week	0.00 inches
	2nd week	0.00 inches
SPRING:	1st week	Trace
	2nd week	0.85 inches

VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)
Dobr=Downy brome

Comments: Herbicide programs were evaluated for downy brome (cheatgrass) control in winter wheat. Downy brome control was similar between Olympus applied at 0.92 oz/A and 0.6 oz/A. Weed control with Olympus Flex was similar to that with Olympus or Maverick. Downy brome control with Everest was less than the other treatments. For the split applications, downy brome control was greater than 90% with the fall application of Olympus at 0.6 oz/A, making the spring application unnecessary for adequate control.

Treatment	***Rate/A***	***% Dobr 10/27/05***	***% Dobr 4/12/06***	***% VCRR Stunt 4/12/06***	***% Dobr 6/21/06***
Check	----	0	0	0	0
FALL					
Olympus+NIS	.92 oz+.5%	81	98	12	97
Olympus+NIS	.6 oz+.5%	72	96	8	93
Olympus Flex+NIS+28% N	3.5 oz+.5%+2 qt	73	96	2	93
Maverick+NIS	.66 oz+.5%	73	97	5	91
Everest+NIS	.6 oz+.25%	72	89	0	63
FALL & SPRING					
Olympus+NIS&Olympus+NIS	.6 oz+.5%&.6 oz+.5%	72	96	10	98
LSD (.05)		5	3	5	9

Table 2. Split applications for cheatgrass control in winter wheat

RCB; 3 reps
Planting Date: 9/8/05
Variety: Harding
FALL: 10/13/05; W wht 2-3 lf; Dobr 1.5-3 lf, 1-2 in.
SPRING: 4/12/06; W wht 2 lf, 2-3 in; Dobr 2-3 lf, 1-2 in.
Soil: Clay loam; 2.5% OM; 6.2 pH

Precipitation:

FALL:	1st week	0.00 inches
	2nd week	0.00 inches
SPRING:	1st week	Trace
	2nd week	0.85 inches

VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)
Dobr=Downy brome

Comments: Herbicide application timing was evaluated for downy brome (cheatgrass) control. A single fall application of Olympus (0.92 oz/A) resulted in similar downy brome control as split applications of Olympus (0.6 oz/A and 0.6 oz/A). Downy brome control was greater in the Olympus treatments than the Everest treatments. Tank mixtures of Olympus + Everest resulted in 82% downy brome control whereas Olympus alone resulted in 96% control.

			% VCRR		
		% Dobr	*Stunt*	*% Dobr*	*% Dobr*
Treatment	***Rate/A***	***10/27/05***	***4/12/06***	***4/12/06***	***6/21/06***
Check	----	0	0	0	0
FALL					
Olympus+NIS	.92 oz+.5%	83	8	97	96
FALL & SPRING					
Olympus+NIS&Olympus+NIS	.6 oz+.5%&.6 oz+.5%	74	2	97	95
Olympus+NIS&Olympus+NIS	.6 oz+.5%&.3 oz+.5%	70	2	95	93
FALL					
Everest+NIS	.6 oz+.25%	63	10	91	62
Everest+NIS	.3 oz+.25%	65	0	75	43
FALL & SPRING					
Everest+NIS&Olympus+NIS	.3 oz+.25%&.6 oz+.5%	65	0	75	82
LSD (.05)		6	5	5	9

Table 3. Cheatgrass control in Clearfield and conventional winter wheat

RCB; 3 reps
Planting Date: 9/8/05
Variety: CF Wheat
SPRING: 4/12/06; W Wht 2 lf, 2-3 in; Dobr 2-3 lf, 1-2 in.
Soil: Clay loam; 2.5% OM; 6.2 pH

Precipitation:
SPRING: 1st week Trace
2nd week 0.85 inches

Dobr=Downy brome

Comments: Herbicide programs were evaluated for downy brome (cheatgrass) control in winter wheat. Everest resulted in the least downy brome control at the early evaluation, but control was similar to the other programs at the late evaluation. Clearfield wheat was used to enable applications of Beyond.

Treatment	***Rate/A***	***% Dobr 5/24/06***	***% Dobr 6/21/06***
SPRING			
Beyond+Rhonox+Bronate Advanced+ NIS+28% N	4 oz+8 oz+15 oz+ .25%+2.5%	85	82
Maverick+Bronate Advanced+NIS	.66 oz+15 oz+.5%	76	75
Everest+Bronate Advanced+NIS	.6 oz+15 oz+.25%	62	73
Olympus+Bronate Advanced+NIS	.9 oz+15 oz+.5%	80	78
Olympus Flex+Bronate Advanced+NIS	3 oz+15 oz+.5%	75	73
LSD(.05)		9	9

Table 4. Weed control in Clearfield sunflower

RCB; 3 reps
Planting Date: 5/25/06
Variety: Legend 218 NCL
PRE: 5/25/06
POST: 6/21/06; Sunflower 5-7 in; Grft 3-5 in; KOCZ 2-4 in.
Soil: Clay loam; 2.8% OM; 6.3 pH

Precipitation:

PRE:	1st week	0.17 inches
	2nd week	0.17 inches
POST:	1st week	0.03 inches
	2nd week	0.06 inches

Grft=Green foxtail
KOCZ=Kochia

Comments: Beyond herbicide programs were evaluated in Clearfield sunflowers for green foxtail and kochia control. Conditions were extremely dry which inhibited later weed emergence flushes. Beyond (imazamox) alone resulted in more than 95% control of foxtail and kochia, which was similar to the control resulting from programs with pre-emergence applications. Results suggest a low percentage of the kochia population was ALS resistant.

Treatment	***Rate/A***	***% Grft 9/14/06***	***% KOCZ 9/14/06***
Check	----	0	0
POSTEMERGENCE			
Beyond+MSO+28% N	4 oz+1%+1%	95	95
Beyond+MSO+28% N	6 oz+1%+1%	96	97
PREEMERGENCE & POSTEMERGENCE			
Prowl 3.3EC&Beyond+MSO+28% N	3 pt&4 oz+1%+1%	95	97
Spartan 4F&Beyond+MSO+28% N	3 oz&4 oz+1%+1%	97	97
Spartan 4F&Beyond+MSO+28% N	1.5 oz&4 oz+1%+1%	96	98
Spartan 4F+Prowl 3.3EC& Beyond+MSO+28% N	1.5 oz+2 pt& 3 oz+1%+1%	98	98
Dual II Magnum&Beyond+MSO+28% N	1 pt&4 oz+1%+1%	97	98
POSTEMERGENCE			
Select+Beyond+MSO+28% N	6 oz+4 oz+1%+1%	96	97
LSD (.05)		2	3

Table 5. Weed control in sunflower with pre-emergence treatments

RCB; 3 reps
Planting Date: 5/25/06
Variety: XF 3312
PRE: 5/25/06
EPOST: Sunflower 6-8 in; Grft 3-5 in; KOCZ 2-4 in.
Soil: Clay loam; 2.8% OM; 6.3 pH

Precipitation:

PRE:	1st week	0.17 inches
	2nd week	0.17 inches
EPOST:	1st week	0.03 inches
	2nd week	0.06 inches

Grft=Green foxtail
KOCZ=Kochia

Comments: Evaluation of Express (tribenuron) programs for weed control in Express-tolerant sunflowers. Weed control was greater than 95% in all treatments. However, weed pressure was low this year as the dry spring conditions suppressed weed emergence. No significant sunflower injury was noted from these treatments.

Treatment	***Rate/A***	***% Grft 9/14/06***	***% KOCZ 9/14/06***
PREEMERGENCE & EARLY POSTEMERGENCE			
Prowl 3.3EC&Express 50SG+Assure II+COC	2 pt&.25 oz+8 oz+1.5%	94	96
Prowl 3.3EC&Express 50SG+Assure II+COC	2 pt&.5 oz+8 oz+1.5%	97	97
Prowl 3.3EC&Express 50SG+COC	3 pt&.5 oz+1.5%	96	96
Authority&Express 50SG+Assure II+COC	3 oz&.25 oz+8 oz+1.5%	96	99
Authority&Express 50SG+Assure II+COC	3 oz&.5 oz+8 oz+1.5%	98	98
Authority&Express 50SG+Assure II+COC	1.5 oz&.5 oz+8 oz+1.5%	96	94
PREEMERGENCE			
Dual II Magnum+Authority	2 pt+4 oz	95	98
EARLY POSTEMERGENCE			
Express 50SG+Assure II+COC	.25 oz+8 oz+1.5%	96	96
Express 50SG+Assure II+COC	.5 oz+8 oz+1.5%	96	96
Express XP+Assure II+Quad 7	.167 oz+8 oz+1%	95	96
Express XP+Assure II+Quad 7	.33 oz+8 oz+1%	96	95
Check	----	0	0
LSD (.05)		3	5

Table 6. Pre-emergence weed control in sunflower

RCB; 3 reps
Planting Date: 5/25/06
Variety: Legend 218CL
PRE: 5/25/06
POST: 6/21/06; Sunflower 5-7 in; Grft 3-5 in.
Soil: Clay loam; 2.8% OM; 6.3 pH

Precipitation:

PRE:	1st week	0.17 inches
	2nd week	0.17 inches
POST:	1st week	0.03 inches
	2nd week	0.06 inches

VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)
Grft=Green foxtail
KOCZ=Kochia

Comments: This research was conducted as part of a regional study funded by the National Sunflower Association to evaluate alternative herbicide chemistries for weed control in sunflowers. KIH-485 is an experimental herbicide that is applied pre-emergence to control several grass and some broadleaf weed species. Surpass (acetochlor) is another pre-emergence herbicide primarily intended for grass control, but Surpass is not registered for use on sunflowers. Other registered pre-emergence herbicides were evaluated for comparison purposes. Grass control with Prowl (pendimethalin) or Dual (S-metolachlor) and kochia control with Spartan (sulfentrazone) was approximately 90%. Kochia control was about 10% less when Spartan was applied at 2 oz/A rather than 4.5 oz/A. A slight rate response was noted for green foxtail control (85-94%) among the KIH-485 rates (2.8-7 oz/A). Kochia control was approximately 90% among the KIH-485 rates. However, the extremely dry conditions greatly inhibited weed germination and growth, making herbicide efficacy evaluation difficult. Therefore, results from this research may not represent weed control seen with more typical precipitation.

Treatment	*Rate/A*	*% VCRR 6/21/06*	*% Grft 9/14/06*	*% KOCZ 9/14/06*
Check	---	0	0	0
PREEMERGENCE				
Prowl 3.3 EC	3 pt	0	89	87
Prowl 3.3 EC+Spartan 4F	3 pt+4.5 oz	0	93	97
Prowl 3.3 EC+Spartan 4F	3 pt+2 oz	0	94	83
Spartan 4F	4.5 oz	0	87	92
Spartan 4F	2 oz	0	88	82
Dual II Magnum+Spartan 4F	1.25 pt+4.5 oz	0	92	90
Dual II Magnum+Spartan 4F	1 pt+2 oz	0	90	75
PREEMERGENCE & POSTEMERGENCE				
Spartan 4F&Select+COC	4 oz&6 oz+1%	0	98	92
PREEMERGENCE				
Surpass+Spartan 4F	1.25 pt+4.5 oz	0	90	92
KIH-485	2.8 oz	0	85	89
KIH-485	3.5 oz	0	88	88
KIH-485	5.6 oz	0	93	87
KIH-485	7 oz	0	94	93
LSD (.05)		0	7	9

Table 7. Weed control in safflower

RCB; 3 reps
Planting Date: 4/27/06
Variety: Finch
PRE: 4/27/06
POST: 6/6/06; Safflower 6-8 in; KOCZ 4 in.
Soil: Clay loam; 2.1% OM; 6.7 pH

Precipitation:

PRE:	1st week	0.06 inches
	2nd week	0.05 inches
POST:	1st week	0.06 inches
	2nd week	0.10 inches

KOCZ=Kochia

Comments: Weed control programs were evaluated for kochia control in safflower. Among the pre-emergence treatments, Prowl H_2O (pendimethalin) and Spartan (sulfentrazone) resulted in the greatest kochia control. Post-emergence applications of Harmony (thifensulfuron) and Ally (metsulfuron) resulted in similar kochia control as many of the pre-emergence treatments.

Treatment	***Rate/A***	***% KOCZ 9/14/06***
Check	----	0
PREEMERGENCE		
Prowl H_2O	3 pt	75
Define	10 oz	43
Outlook	12 oz	50
Intrro	2 qt	52
Dual II Magnum	1 pt	63
Spartan 4F	2 oz	70
Spartan 4F	4 oz	78
Valor	3 oz	68
POSTEMERGENCE		
Harmony GT 75WG+NIS	.25 oz+.25%	57
Harmony GT 75WG+NIS	.4 oz+.25%	67
Ally XP+NIS	.08 oz+.25%	67
LSD (.05)		19

Table 8. Pre-emergence herbicide pulse demonstration

RCB; 3 reps
Planting Date: 4/27/06
Variety: Lentil - Richlea; Field pea - Salute; Chickpea - Dwelly
PPI/PRE: 4/27/06
Soil: Clay loam; 2.1% OM; 6.5 pH

		Precipitation:
PPI/PRE:	1st week	0.06 inches
	2nd week	0.05 inches

VCRR=Visual Crop Response Rating (0=no injury; 100=complete kill)

Comments: Several pre-plant incorporated and pre-emergence herbicide treatments were evaluated for weed control and crop tolerance in lentil, field pea, and chickpea. However, the extremely dry conditions inhibited weed emergence and growth, resulting in little difference in weed densities among treated plots and the untreated check. None of the herbicide treatments caused visual crop injury symptoms, which is not what is typically observed in years when precipitation is closer to average. The lack of rain may have inhibited the availability of the herbicides in the soil for seedling uptake, which may have decreased their effect on weeds and the crop.

Treatment	***Rate/A***	***% VCRR Lentil 6/6/06***	***% VCRR Field Pea 6/6/06***	***% VCRR Chickpea 6/6/06***
Check	----	0	0	0
PREPLANT INCORPORATED				
Treflan	2 pt	0	0	0
Sonalan	3 pt	0	0	0
Prowl H_2O	2.75 pt	0	0	0
Intrro	3 qt	0	0	0
PREEMERGENCE				
Dual II Magnum	1.67 pt	0	0	0
Stalwart	1.67 pt	0	0	0
Python	1 oz	0	0	0
Outlook	19 oz	0	0	0
Intrro	3 qt	0	0	0
Spartan 4F	6 oz	0	0	0
Spartan 4F	3 oz	0	0	0
Lorox DF	1.5 lb	0	0	0
Direx 4L Diuron	1.4 qt	0	0	0
Aim	1 oz	0	0	0
Degree	4.25 pt	0	0	0
Define SC	15 oz	0	0	0
Sencor DF	.5 lb	0	0	0
Axiom	10 oz	0	0	0
Valor	3 oz	0	0	0
FirstRate	0.6 oz	0	0	0
Balance Pro	1.5 oz	0	0	0
Princep 4L	1 qt	0	0	0
Pursuit 2L	3 oz	0	0	0
Pursuit Plus	2.5 pt	0	0	0
LSD (.05)		0	0	0

Table 9. Post-emergence herbicide pulse demonstration

RCB; 3 reps
Planting Date: 4/27/06
Varieties: Lentil - Richlea; Chickpea - Dwelly; Field pea - Salute
POST: 6/6/06; Lentil 3-5 in; Chickpea 5-8 in; Field pea 4-6 in.
Soil: Clay loam; 2.1% OM; 6.5 pH

Precipitation:
POST: 1st week 0.06 inches
2nd week 0.10 inches

VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)

Comments: Herbicide programs were evaluated for chickpea, lentil, and field pea tolerance. Chickpea injury was greatest after application of Basagran (bentazon), Raptor (imazamox), Sencor (metribuzin), or 2,4-DB applications. Pursuit and Aim resulted in minor chickpea injury. Lentil injury was greatest after applications of Basagran, Raptor, and Resource (flumiclorac). Field pea injury was greater than 10% only after an application of Aim + crop oil concentrate (COC). Injury was greater when Aim was applied with COC than non-ionic surfactant for each crop. Basagran is occasionally mixed with Raptor to reduce crop injury from Raptor in field peas, but no field pea injury was observed in the Raptor treatments in this study.

Treatment	*Rate/A*	*Chickpea % VCRR Stunt 6/21/06*	*Chickpea % VCRR Necrosis 6/21/06*	*Lentil % VCRR Stunt 6/21/06*	*Lentil % VCRR Necrosis 6/21/06*	*Field Pea % VCRR Stunt 6/21/06*	*Field Pea % VCRR Necrosis 6/21/06*
Check	----	0	0	0	0	0	0
POSTEMERGENCE							
Pursuit 2L+NIS	3 oz+.25%	7	2	15	0	0	0
Raptor+NIS	4 oz+.25%	15	5	23	0	0	0
Raptor+Basagran+NIS	4 oz+2 pt+.25%	12	18	40	67	0	0
Basagran+NIS	2 pt+.25%	12	27	50	67	7	8
Resource+COC	4 oz+1 qt	0	5	28	12	3	0
Ultra Blazer+NIS	8 oz+.125%	0	0	5	0	0	2
Outlook	19 oz	0	0	0	0	0	0
Sencor DF	.33 lb	5	25	0	0	0	0
2,4-DB+NIS	1 pt+.5%	28	0	3	0	3	0
Aim+NIS	.5 oz+.25%	0	3	13	0	0	0
Aim+COC	.5 oz+1 qt	8	7	30	17	18	25
LSD (.05)		7	6	14	5	4	3

Table 10. No-till corn herbicide demonstration

RCB; 3 reps
Planting Date: 5/3/06
Variety: RR - DK 46-22; LL - Pio 38H69
PRE: 5/3/06
EPOST: 5/25/06; Corn 2-3 lf; Grft 2-3 lf, 1-2 in.; Wibw 1-3 lf; KOCZ 1-1.5 in.
POST: 6/6/06; Corn V-3, 5 lf, 5-7 in; Grft 2-4in; Wibw 3-5 in; KOCZ 2-4 in.
Soil: Clay loam; 2.8% OM; 6.3 pH

Precipitation:

PRE:	1st week	0.05 inches
	2nd week	0.00 inches
EPOST:	1st week	0.17 inches
	2nd week	0.17 inches
POST:	1st week	0.06 inches
	2nd week	0.10 inches

Grft=Green foxtail
Wibw=Wild buckwheat
KOCZ=Kochia

Comments: Study was established to evaluate weed control programs in no-till corn.

Liberty programs: Grass and broadleaf control was generally good to excellent, but wild buckwheat escapes were noted in the Balance + atrazine treatment.

Roundup programs: Weed control was greater than 95% in all treatments. Pre-emergence herbicide applications were not necessary for achieving nearly complete weed control, as dry conditions suppressed late weed flushes. Tank-mixes with Roundup for post-emergence applications did not improve weed control, as Roundup alone resulted in more than 97% weed control.

Treatment	***Rate/A***	***% Grft 9/14/06***	***% Wibw 9/14/06***	***% KOCZ 9/14/06***
Liberty Link Check	----	0	0	0
EARLY POSTEMERGENCE				
Liberty+AMS	32 oz+3 lb	90	95	88
Liberty+atrazine+AMS	32 oz+1 pt+3 lb	85	97	96
Liberty+Resolve+AMS	32 oz+1 oz+3 lb	92	93	96
Liberty+Resolve+atrazine+AMS	32 oz+1 oz+1.5 pt+3 lb	90	97	95
EARLY POSTEMERGENCE & POSTEMERGENCE				
Liberty+atrazine+AMS& Liberty+AMS	24 oz+1 pt+3 lb& 24 oz+3 lb	95	98	98
PREEMERGENCE				
Bicep Lite II Magnum	2 qt	82	88	92
Harness Xtra 6L	2 qt	92	92	95
Balance Pro+atrazine	2.25 oz+1.5 pt	83	57	90
Lumax	2.5 qt	80	92	97
Roundup Ready Check	----	0	0	0
EARLY POSTEMERGENCE				
Roundup WeatherMax+AMS	22 oz+2.5 lb	96	97	96
Roundup WeatherMax+Lumax+AMS	22 oz+1.5 qt+2.5 lb	97	98	98
Roundup WeatherMax+Resolve+AMS	22 oz+1 oz+2.5 lb	96	98	95

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Treatment	*Rate/A*	*% Grft 9/14/06*	*% Wibw 9/14/06*	*% KOCZ 9/14/06*
EARLY POSTEMERGENCE (Continued . . .)				
Roundup WeatherMax+Resolve+ Atrazine+AMS	22 oz+1 oz+ 1.5 pt+2.5 lb	98	98	98
Roundup WeatherMax+atrazine+AMS	22 oz+1.5 pt+2.5 lb	95	98	98
Roundup WeatherMax+Harness+AMS	22 oz+1 pt+2.5 lb	96	96	97
Roundup WeatherMax+Outlook+AMS	22 oz+.75 pt+2.5 lb	96	98	98
EARLY POSTEMERGENCE & POSTEMERGENCE				
Roundup WeatherMax+AMS& Roundup WeatherMax+AMS	22 oz+2.5 lb& 22 oz+2.5 lb	97	98	98
POSTEMERGENCE				
Roundup WeatherMax+AMS	22 oz+2.5 lb	97	98	97
Roundup WeatherMax+Callisto+AMS	22 oz+1.5 oz+2.5 lb	98	98	97
Roundup WeatherMax+Clarity+AMS	22 oz+8 oz+2.5 lb	98	98	97
Roundup WeatherMax+Aim+AMS	22 oz+.5 oz+2.5 lb	98	98	95
Roundup WeatherMax+Priority+ NIS+AMS	22 oz+1 oz+ .25%+2.5 lb	96	98	96
LSD (.05)		5	3	3

Table 11. Weed control in grain sorghum

RCB; 3 reps
Planting Date: 5/25/06
Variety: Garst 5624
PRE: 5/25/06
POST: 6/21/06; Sorghum V-4, 5-7 in; Grft 3-5 in; KOCZ 2-4 in.
Soil: Clay loam; 2.8% OM; 6.3 pH

Precipitation:

PRE:	1st week	0.17 inches
	2nd week	0.17 inches
POST:	1st week	0.03 inches
	2nd week	0.06 inches

VCRR=Visual Crop Response Rating (0=no injury; 100=complete kill)
Grft=Green foxtail
KOCZ=Kochia

Comments: Herbicide programs in grain sorghum were evaluated for green foxtail and kochia control. Weed pressure was relatively low as the dry conditions suppressed weed emergence. All treatments resulted in more than 87%. Some sorghum lodging was observed in the treatments with 2,4-D or Starane. KIH-485 is an experimental herbicide for controlling several grass and some broadleaf weed species and may be primarily targeted for the corn market. Our results are consistent with those in other states that have demonstrated good sorghum tolerance.

Treatment	*Rate/A*	*% Grft 9/14/06*	*% KOCZ 9/14/06*	*% VCRR Lodging 9/14/06*
Check	----	0	0	----
PREEMERGENCE				
Dual II Magnum	1.67 pt	95	96	----
Outlook	19 oz	93	96	----
G-Max Lite	2 pt	92	93	----
Micro-Tech	2.5 qt	93	89	----
Lumax	1.5 qt	87	96	----
KIH-485	2.8 oz	93	93	----
POSTEMERGENCE				
Paramount+MSO+atrazine	5.33 oz+1 qt+1 pt	94	96	----
PREEMERGENCE & POSTEMERGENCE				
Dual II Magnum&Paramount+MSO	1 pt&4 oz+1 qt	96	93	----
Dual II Magnum&Ally+2,4-D amine	1.5 pt&.05 oz+8 oz	92	96	5
Dual II Magnum&Starane	1.5 pt&.5 pt	92	96	1
Dual II Magnum&2,4-D amine	1.5 pt&8 oz	92	96	2
POSTEMERGENCE				
Starane+atrazine	.67 pt+1 pt	92	98	----
Paramount+MSO	5.33 oz+1 qt	97	91	----
LSD (.05)		7	6	5

Table 12. Fall alfalfa burndown

RCB; 3 reps
FALL: 10/13/05; Alfalfa 4-7 in. (green)

Precipitation:

FALL:	1st week	0.00 inches
	2nd week	0.00 inches

Comments: Herbicide treatments were evaluated for fall control of alfalfa. Herbicides were applied October 13, 2005, and control was evaluated on June 21, 2006. Alfalfa control was similar among many treatments, but least in the Distinct treatment. However, a low rate of Distinct (3 oz/A) plus a low rate of 2,4-D (1 pt/A) resulted in alfalfa control similar to or greater than control from either of these herbicides applied alone at higher rates.

Treatment	***Rate/A***	***% Necrosis 10/27/05***	***% Alfalfa Control 6/21/06***
Check	---	0	0
FALL			
2,4-D amine	2 qt	80	97
2,4-D ester	2 qt	80	97
Roundup UltraMax II+AMS	33 oz+2.5 lb	90	93
Roundup UltraMax II+2,4-D ester	22 oz+1 pt	90	98
Roundup UltraMax II+2,4-D ester	44 oz+1 pt	90	96
Curtail	2 pt	80	98
Clarity	1 pt	80	90
Stinger	.5 pt	70	97
Distinct+NIS+28% N	6 oz+.25%+1 qt	80	30
Distinct+2,4-D ester+NIS+28% N	3 oz+1 pt+.25%+1 qt	80	97
LSD (.05)		0	6

2006 Highmore Report

Fertilizer Influence on Soil Tests and Wheat Yield

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Soil testing research has shown that knowledge of soil test levels can improve the profitability of fertilizer use. Profits increase if more fertilizer is used when soil test levels are low and little or no fertilizer is used when test levels are high. Frequently, however, the major nutrients (N P K) and sometimes zinc and sulfur are applied without a current soil test. This experiment was initiated to demonstrate the long-term effects of applying phosphorus, potassium, zinc, and sulfur regardless of soil test. The intent is to continue the experiment on the same location at the Highmore station for a number of years. The planned rotation is soybean and wheat. The objective is to demonstrate soil testing's ability to predict crop response to fertilizer and fertilizer influence on soil tests.

Materials and Methods

The experiment was established on a Glenham loam soil series on the Highmore Experiment Station in 1997. Glenham soils are deep, well drained soils formed in friable glacial till. Fertilizer treatments (Table 1) consisted of phosphorus only (0-46-0), N only (urea), or phosphorus and nitrogen plus either potassium (0-0-60), sulfur (gypsum), or zinc ($ZnSO_4$-35%). Fertilizer was broadcast on April 26, 2006, on soybean stubble that was no-till planted to spring wheat. Wheat was in the 1 – 2 leaf stage when fertilizer was applied. Fertilizer treatments have been applied on the same plots since 1997. Fertilizer rates were the same each year except nitrogen, which varied according to soil test and crop need. Plot size in this experiment is 25 feet by 50 feet. Harvest is done with a small plot combine.

Results and Discussion

Soil analysis on samples taken on April 18, 2006, is reported in Table 2. The nitrate N soil test was similar whether or not nitrogen had been applied since 1997. No nitrogen, however, was applied to the soybean crop in 2005 and nitrogen uptake by the beans likely removed excess fertilizer applied in the past.

The sulfur soil test was low where no sulfur had been applied in the past and medium where 25 lb S/a has been applied each year. However, previous applications of sulfur increased sulfur soil test by only 6 lb/a. The 25 lbs of phosphorus and 50 lbs of potassium applied each year since 1997 increased phosphorus soil test from 11 ppm in the check to 26 ppm and potassium soil test

from 507 to 633 ppm. The check phosphorus test (11 ppm) was in the medium range, and about 35 lb of phosphorus fertilizer would have been recommended for a 50 bu wheat yield goal. The potassium soil test was very high and none would have been recommended. The zinc soil test was raised from 1.07 ppm to 11.35 ppm by the annual addition of 5 lb of zinc per year since 1997. The check zinc soil test (1.07 ppm) was in the very high soil test range. No zinc would have been recommended regardless of soil test since wheat does not usually respond to zinc fertilization.

The dry hot summer severely stressed wheat and reduced yield which averaged only 23 bu/a (Table 1). The no-nitrogen treatment, however, did reduce yield 6 bu/a. The response to N even with such low yields was likely due to dry conditions reducing mineralization of organic N and slowing root activity, resulting in inefficient N uptake. No response to the other applied fertilizer was measured this year. The P soil test was in the medium range, but responses do not occur every year in this soil test range. The sulfur soil test was low, but a low soil sulfur test does not always result in a yield increase. Potassium and zinc soil tests were high and no response to these nutrients was measured or expected.

This site may be rotated back to soybean in 2007. Similar fertilizer treatments may be applied to the same plots. Yields and soil tests from the previous years of this study can be found in the 1997 – 2005 Highmore annual reports or in the 1997 – 2005 SDSU Plant Science Department Soil/Water Science Research Annual Report, TB No. 99.

Acknowledgements

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Table 1. Fertilizer treatments and spring wheat yield, Highmore, 2006.

Fertilizer treatment	Wheat yield
lb/a	bu/a
0 N + 35 P	18 a
80 N + 0 P	22 a b
80 N + 35 P	23 b c
80 N + 35 P + 50 K	26 b c
80 N + 35 P + 25 S	23 b c
80 N + 35 P + 5 Zn	25 c
Pr > F	0.01
CV	10.2
LSD .05	3.5

Yields followed by the same letter are not statistically different.

Table 2. Soil test levels, Highmore, 2006.

Soil Test[1]	Check	Treated
Nitrate-N, lb/a		
0 – 6 in.	12	12
6 in. – 24 in.	18	24
Sulfate-S, lb/a		
0 – 6 in.	4	2
6 in. – 24 in.	6	18
Phosphorus, ppm	11	26
Potassium, ppm	507	633
Zinc, ppm	1.07	11.35
OM, %	3.0	
pH	6.7	
Salts, mmho/cm	0.4	

[1]Sampled 4/18/06

2006 Highmore Report

Spring-Seeded Small Grains - 2006 Eastern South Dakota Variety Test Results

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Trial Methods

A random complete block design is used in all trials. Plots were 5 feet wide and either 12 or 14 feet long and harvested with a small plot combine. Yield means were generated from four variety replications per location per year. Plots were fertilized with 60 lb per acre of 18-46-0 (10.8 lb of N and 27.6 lb of phosphorus per acre) down the seed tube at seeding. In addition, a post-emergence application of Bronate (1.0 pint) was applied on the spring wheat, oats, and barley plots. Small grain plots were seeded at 28 pure live seeds per square foot to obtain a density of about 25 seedlings per square foot.

Performance Trial Results

HRS Wheat (Tables 1a-b) - The top entries for yield for the past 3 years (2004-06) by variety or experimental line and top yield frequency were SD 3868 at 100%; Briggs, Grander, and Traverse at 86%; Steele-ND at 71%; Freyr and SD 3860 at 57%; and Forge, Knudson, Oxen, and Reeder at 43% (Tables 1a). These entries exhibited very good yield stability or the ability to adapt to a wide range of production environments by being in the top-performance group for yield at more than 43% of the test locations for the past 3 years. The top yield frequency entries for yield in 2006 included SD 3868, SD 3942, and Traverse at 71%; SD 3860, SD 3870, and SD 3943 at 57%; and Forage, Howard, Oxen, Reeder, and SD 3879 at 43% of the test locations. The top bushel weight entries (based on state averages in Table 1b) included 2 entries at 62 lb; 11 entries at 61 lb; 16 entries at 60 lbs, and 6 entries at 59 lb for year 2006. The check variety Chris (36 inches) tended to be the tallest variety across all locations in 2006 followed by the entries SD 3879 at 33 inches, and CS3100-Q~W, Granger, Russ, SD 3860, SD 3934, SD 3868, and Traverse at 32 inches tall in 2006 (Table 2b). The top protein entries on a state average basis included Chamberlin at 16.6%, Granite at 16.2%, Kelby at 16.1%, and Alsen at 15.8% protein content.

Oat (Table 2a-b) - The top performing entries for yield for the past 3 years (2004-06) by variety and top yield frequency included HiFi, Morton, Loyal, and Stallion at 100%; and Jerry at 60% (Table 2a). These varieties exhibited very good yield stability or the ability to adapt to a wide range of production environments by being in the top-performance group for yield at more than 60% of the test locations for the past 3 years. The top-performing entries for yield in 2006 were the experimental lines SD 011315-15 at 83%; SD 020701 and SD 030888 at 67%; and Baker, Beach, Souris, SD 030324, and SD 021021 at 50% of the test locations. In 2006, on a state basis, the hull-less entries Buff, Paul, and Stark at 44, 42, and 40 lb, respectively, had the best

bushel or test weight average across all locations (table 2b). Among the standard hulled entries the varieties Hytest, Beach, and Stallion at 39 lb followed by Loyal, SD 020883, SD 020536, SD 030888 at 38 lb were the highest in bushel weight. In contrast, GG-304 at 30 lb was the lowest state bushel weight among the standard hulled varieties. Among all entries Hytest at 36 inches was the tallest and GG-304 at 21 inches was the shortest in height. In 2006, there was little if any lodging across the state (Table 2b). The standard variety Hytest at 19.5% and the hull-less varieties Buff and Paul at 18.2% exhibited the highest grain protein levels.

Barley (Table 3a-b) - The top performing entries for yield for the past 3 years (2004-06) by variety and top yield frequency included Eslick at 100%; Haxby at 83%; Excel at 67%; and Conlon, Lacey, and Tradition at 50% (Table 3a). These varieties exhibited very good yield stability or the ability to adapt to a wide range of production environments by being in the top-performance group for yield at more than 50% of the test locations for the past 3 years. The top-performing entries for yield in 2006 included Eslick at 83%; and Haxby and Rawson at 67% of the test locations. The hull-less varieties Stanuwax and Meresse weighed 4 to 5 lb higher in bushel weight than the two-row varieties Eslick and Conlon, which in turn weighed 1 to 2 lb higher than the other varieties across all locations (Table 3b*)*. In contrast, the variety Stellar-ND tended to have the lowest bushel weight average across the state. The varieties Robust, Tradition, Drummond, and Legacy tended to be the tallest varieties across all statewide locations (Table 3b). As seen in Table 3b, the lodging scores for Conlon and Pronghorn were higher than for the other entries and indicated these varieties tended to lodge slightly more than the other entries in 2006. The grain protein content ranged from 12.6 to 16.3% across the state. At the East River locations (Table 3b) the protein ranged 5% from about 13.3 to 17.3%.

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Table 1a. HRS wheat yield results, five South Dakota East River locations, 2004-2006.

Variety (Hdg.)* - sorted by 3-yr then 2006 state avg.	Location Yield Avg. (Bu/A) at 13% moist.										State Yield Avg. (Bu/A)		State Top-Yield Freq. ** (%)	
	Brookings		So. Shore		Spink Co.		Selby		Brown Co.					
	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr
Traverse (0)	58+	63+	53+	59+	65	66+	57+	53+	62+	69+	52	55	71	86
SD 3868	53+	56+	46	56+	68+	70+	53	52+	59+	67+	50	54	71	100
Granger (0)	51	55+	46	53+	65	65+	61+	52+	53	63+	49	52	14	86
Briggs (0)	53+	57+	47	54+	63	67+	52	51+	56+	64+	48	52	29	86
SD 3860	54+	57+	46	51	63	63+	48	43	55+	61	49	51	57	57
Steele-ND (3)	50	53	49+	55+	64	65+	54	49+	54	61	48	51	29	71
Knudson (2)	52	56+	42	52	60	65+	50	47+	48	61	45	50	14	43
Freyr (1)	49	51	46	51	63	60	54	47+	55+	63+	48	49	29	57
Glenn (3)	45	49	42	52	59	63+	50	46	53	59	45	49	14	29
Oxen (2)	52	48	48	46	71+	61	55	47+	51	61	50	48	43	43
Forge (-1)	53+	50	45	47	67	60	51	47+	49	57	48	48	43	43
Walworth (0)	52	50	41	45	66	61	50	47+	54	59	47	48	14	29
Ulen (2)	47	49	43	48	64	63+	49	45	60+	62+	47	48	29	29
Reeder (3)	47	48	43	43	59	57	56+	42	57+	62+	48	47	43	43
Trooper (-1)	54+	51	40	44	64	62	51	47+	49	60	46	47	14	14
Russ (2)	45	49	43	47	53	56	50	43	56+	61	45	47	14	29
Alsen (4)	46	45	45	48	59	58	51	44	53	58	45	46	14	0
Granite (5)	45	47	39	40	56	57	52	44	56+	58	44	45	14	0
Chris,CK (3)	41	39	36	36	50	45	42	37	55+	49	40	38	14	0
SD 3942	57+	.	48	.	69+	.	50	.	59+	.	51	.	71	.
SD 3870	54+	.	45	.	72+	.	52	.	57+	.	50	.	57	.
SD 3943	59+	.	52+	.	65	.	51	.	56+	.	50	.	57	.
Howard (4)	49	.	50+	.	63	.	50	.	59+	.	49	.	43	.
SD 3879	52	.	46	.	65	.	53	.	59+	.	49	.	43	.
SD 3851	51	.	42	.	63	.	45	.	51	.	47	.	29	.
SD 3941	52	.	46	.	60	.	47	.	56+	.	47	.	29	.
Norris (0)	48	.	46	.	63	.	52	.	54	.	47	.	0	.
SD 4001	55+	.	40	.	61	.	49	.	53	.	46	.	0	.
CS3100L~W (6)	46	.	44	.	54	.	49	.	63+	.	45	.	14	.
Kelby (2)	46	.	43	.	60	.	49	.	53	.	45	.	0	.
CS3100Q~W (3)	43	.	41	.	58	.	46	.	59+	.	44	.	14	.
Banton (1)	47	.	43	.	63	.	45	.	46	.	44	.	0	.
SD 3927	46	.	43	.	57	.	45	.	50	.	44	.	0	.
SD 4002	52	.	39	.	60	.	43	.	52	.	44	.	0	.
Chamberlin (0)	39	.	39	.	56	.	40	.	42	.	39	.	0	.
SD 3934	39	.	39	.	57	.	23	.	41	.	37	.	37	.
Test avg. :	49	51	44	49	62	61	49	46	54	61				
High avg. :	59	63	53	59	72	70	61	53	63	69				
Low avg. :	39	39	36	36	50	45	23	37	41	49				
# Lsd(.05) :	6	8	4	6	4	7	5	6	8	7				
## TPG-value :	53	55	49	53	68	63	56	47	55	62				
### C.V. :	8	7	7	7	5	7	7	8	10	7				

* Heading, the relative days to heading, compared to the variety Briggs.

** Frequency or percent of all test locations that a variety was in the TPG for yield.

Lsd, the amount two values in a column must differ to be significantly different.

TPG-value, the minimum value required for the top-performance group (TPG) for yield.

Coef. of variation, a measure of trial experimental error, 15% or less is best.

Table 1b. HRS wheat averages for bushel weight (BW), and lodging (LDG) by location along with state averages for height (HT), and grain protein (PRT) for 2006.

Variety (Hdg.)* - sorted by state BW avg.	Location Avg. - BW, HT, LDG										State Avg. - BW, HT, LDG, PRT			
	Brookings		South Shore		Spink Co.		Selby		Brown Co.					
	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	HT in	LDG **	PRT %
SD 3927	64+	1+	62+	1+	59	1+	62+	1+	64+	1+	62	30	1	15.7
SD 3941	63+	1+	62+	1+	60	1+	62+	1+	64+	1+	62	30	1	15.1
Chamberlin (0)	63+	1+	62+	1+	59	1+	61+	1+	63+	1+	61	28	1	16.6
Glenn (3)	64+	1+	62+	1+	60	1+	62+	1+	62+	1+	61	31	1	15.2
SD 3860	64+	1+	61+	1+	57	1+	62+	1+	64+	1+	61	32	1	14.4
SD 3851	63+	1+	61+	1+	60	1+	62+	1+	62+	1+	61	31	1	14.8
Trooper (-1)	63+	1+	60	1+	60	1+	62+	1+	63+	1+	61	27	1	15.0
SD 3942	63+	1+	61+	1+	60	1+	62+	1+	63+	1+	61	28	1	14.3
Banton (1)	62	1+	61+	1+	59	1+	62+	1+	62+	1+	61	30	1	15.6
SD 3879	63+	1+	59	1+	60	1+	62+	1+	64+	1+	61	33	1	15.1
Forge (-1)	65+	1+	61+	1+	59	1+	62+	1+	60	1+	61	30	1	14.4
Freyr (1)	62	1+	61+	1+	60	1+	62+	1+	62+	1+	61	31	1	15.0
Norris (0)	63+	1+	60	1+	60	1+	62+	1+	63+	1+	61	29	1	15.6
SD 3943	63+	1+	61+	1+	61	1+	62+	1+	62+	1+	60	29	1	14.7
SD 4001	64+	1+	61+	1+	59	1+	61+	1+	62+	1+	60	30	1	15.3
Kelby (2)	63+	1+	63+	1+	57	1+	62+	1+	61	1+	60	26	1	16.1
Ulen (2)	62	1+	59	1+	60	1+	62+	1+	61	1+	60	31	1	15.5
Granite (5)	64+	1+	60	1+	59	1+	62+	1+	62+	1+	60	28	1	16.2
CS3100Q~W (3)	63+	1+	60	1+	59	1+	61+	1+	64+	1+	60	32	1	14.8
Howard (4)	63+	1+	59	1+	59	1+	61+	1+	64+	1+	60	31	1	14.6
SD 4002	64+	1+	61+	1+	58	1+	60	1+	62+	1+	60	30	1	14.4
Granger (0)	62	1+	60	1+	58	1+	62+	1+	62+	1+	60	32	1	14.8
Alsen (4)	61	1+	60	1+	60	1+	62+	1+	61	1+	60	30	1	15.8
Briggs (0)	62	1+	59	1+	59	1+	61+	1+	63+	1+	60	30	1	15.1
Reeder (3)	62	1+	59	1+	58	1+	62+	1+	62+	1+	60	30	1	14.8
Russ (2)	62	1+	60	1+	57	1+	60	1+	63+	1+	60	32	1	15.2
Oxen (2)	62	1+	60	1+	58	1+	62+	1+	58	1+	60	29	1	15.2
Steele-ND (3)	62	1+	60	1+	58	1+	61+	1+	61	1+	60	31	1	15.4
SD 3934	62	1+	60	1+	57	1+	62+	1+	60	1+	60	32	1	15.0
Knudson (2)	62	1+	60	1+	58	1+	61+	1+	58	1+	59	28	1	15.1
Walworth (0)	62	1+	59	1+	57	1+	61+	1+	61	1+	59	30	1	15.2
Chris,CK (3)	62	1+	59	1+	57	1+	59	1+	63+	2	59	36	1	15.6
Traverse (0)	61	1+	59	1+	58	1+	59	1+	61	1+	59	32	1	14.3
SD 3868	61	1+	58	1+	58	1+	59	1+	62+	1+	59	32	1	14.3
SD 3870	61	1+	58	1+	59	1+	59	1+	62+	1+	59	31	1	14.6
CS3100L~W (6)	62	1+	58	1+	56	1+	60	1+	64+	1+	.	25	1	14.3
Test avg. :	63	1	60	1	59	1	61	1	62	1				
High avg. :	65	1	63	1	61	1	62	1	64	1				
Low avg. :	61	1	58	1	56	1	59	1	58	1				
# Lsd(.05) :	2	NS^	2	NS^	2	NS^	1	NS^	2	NS^				
## TPG-value :	63	1	61	1	59	1	61	1	62	1				
### C.V. :	2	0	2	0	3	0	0	0	3	9				

* Heading, the relative days to heading, compared to the variety Briggs.
** Lodging score: 0= all plants erect, 3= 50% of plants lodged at 45° angle, 5= all plants flat.
# Lsd, the amount two values in a column must differ to be significantly different.
TPG-value, the minimum or maximum value required for the top-performance group (TPG).
A plus sign (+) indicates values within a column that qualify for the TPG.
Coef. of variation, a measure of trial experimental error.
^ Variable differences within a column are non-significant (NS) at the .05 level of probability.

Table 2a. Oat yield results - South Dakota East River locations, 2004-2006.

Variety (Hdg.)* - sorted by 3-yr then 2006 state average	Location Yield Avg. (Bu/A at 13% moist.)								State Yield Avg. (Bu/A)		State Yield Freq. ** (%)	
	Brookings		So. Shore		Beresford		Brown Co.					
	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr
HiFi (8)	129	143+	112	143+	137	131+	112+	128+	100	119	17	100
Stallion (8)	136+	132+	120	131+	139	139+	96	118+	100	115	17	100
Morton (7)	117	130+	112	138+	132	127+	97	115+	94	113	0	100
Loyal (8)	124	133+	112	127+	130	125+	99	108+	94	109	0	100
Jerry (5)	111	120	114	118	103	121+	50	100+	80	103	0	60
Don (1)	105	115	110	116	103	113	53	98	79	99	17	0
Reeves (2)	101	110	106	113	99	111	48	96	74	95	0	20
Hytest (4)	91	102	100	107	85	86	71	95	73	88	0	20
Buff, Hls (3)	88	96	91	102	79	92	48	73	64	81	0	0
Stark, Hls (6)	76	86	70	95	48	79	70	80	54	74	0	0
Paul, Hls (7)	78	83	77	92	75	70	77	83	63	72	0	0
SD 011315-15	142+	.	130+	.	137	.	103+	.	106	.	83	.
SD 030324	140+	.	123	.	151+	.	116+	.	106	.	50	.
Souris (5)	134+	.	123	.	133	.	118	.	104	.	50	.
SD 020701	125	.	125+	.	144+	.	92	.	101	.	67	.
SD 021021	124	.	124+	.	137	.	103+	.	101	.	50	.
SD 030888	140+	.	132+	.	144+	.	75	.	101	.	67	.
SD 020536	123	.	115	.	146+	.	102+	.	100	.	50	.
Baker (4)	125	.	118	.	131	.	98	.	98	.	33	.
Beach (6)	127	.	118	.	123	.	100+	.	97	.	50	.
SD 031128	118	.	128+	.	125	.	62	.	91	.	34	.
Maida (7)	114	.	110	.	124	.	78	.	88	.	17	.
SD 020883	93	.	112	.	117	.	49	.	79	.	17	.
GG-304	94	.	96	.	63	.	69	.	69	.	0	.
Test avg.:	115	114	112	117	117	109	83	99				
High avg. :	142	143	132	143	151	139	118	128				
Low avg. :	76	83	70	92	48	70	48	73				
# Lsd(.05) :	9	20	8	16	11	24	18	29				
## TPG-value :	133	123	124	127	140	115	100	99				
### C.V. :	5	8	5	7	7	12	15	10				

* Heading, the relative days to heading, compared to the variety Don.
# Lsd, the amount two values in a column must differ to be significantly different.
TPG-value, the minimum value required for the top-performance group (TPG) for yield.
A plus sign (+) indicates values within a column that qualify for the TPG.
Coef. of variation, a measure of trial experimental error, 15% or less is best.
** Frequency or percent of all test locations that a variety was in the TPG for yield.

Table 2b. Oat averages for bushel weight (BW), height (HT), lodging (LDG) by location along with state average for grain protein (PRT) in 2006.

Variety (Hdg.)* - sorted by state BW avg.	Location Avg. - BW, HT, LDG												State Avg. - BW, HT, LDG, PRT			
	Brookings			South Shore			Beresford			Brown Co.						
	BW lb	HT in	LDG **	BW lb	HT in	LDG **	BW lb	HT in	LDG **	BW lb	HT in	LDG **	BW lb	HT in	LDG **	PRT %
Buff, Hls (3)	45+	35	1+	42+	33	1+	46+	35	1+	44+	27	1+	44	29	1	18.2
Paul, Hls (7)	42	42	2+	41+	37	1+	42	38	1+	46+	32	1+	42	33	1	18.2
Stark, Hls (6)	41	42	1+	41+	37	1+	40	38	1+	42	32	1+	40	34	1	17.8
Hytest (4)	39	42	3	41+	40	3	41	40	1+	39	36	1+	39	36	1	19.5
Beach (6)	38	42	2+	43+	39	2+	40	40	1+	39	33	1+	39	34	1	15.5
Stallion (8)	39	42	2+	40	37	2+	41	40	1+	39	33	1+	39	34	1	17.2
SD 030888	40	33	2+	38	31	1+	40	32	1+	38	27	1+	38	27	1	15.9
SD 020536	38	39	2+	37	33	3	40	34	1+	39	29	1+	38	30	1	16.2
SD 020883	39	37	2+	38	35	2+	38	34	1+	36	29	1+	38	31	1	17.2
Loyal (8)	38	41	2+	40	38	3	40	38	1+	38	34	1+	38	34	1	17.8
SD 031128	38	39	1+	38	37	1+	39	36	1+	35	29	1+	37	32	1	16.3
SD 020701	36	40	2+	39	36	3	39	37	1+	37	33	1+	37	33	1	16.5
Souris (5)	37	36	1+	38	33	2	38	34	1+	38	29	1+	37	29	1	15.9
SD 011315-15	36	41	2+	36	36	2+	39	37	1+	39	30	1+	37	32	1	15.5
Jerry (5)	38	40	2+	36	38	2+	39	37	1+	34	31	1+	37	32	1	16.6
Morton (7)	38	43	1+	38	37	1+	38	40	1+	37	35	1+	37	34	1	16.5
Reeves (2)	37	39	2+	38	37	3	38	38	1+	33	32	1+	36	33	1	16.1
SD 030324	34	42	2+	38	38	3	40	38	1+	38	33	1+	36	34	1	16.3
Maida (7)	36	42	2+	38	37	2+	36	40	1+	37	32	1+	36	34	1	17.4
SD 021021	37	37	1+	37	34	1+	38	35	1+	38	30	1+	36	30	1	17.6
HiFi (8)	36	42	1+	36	36	1+	38	37	1+	36	32	1+	36	33	1	15.6
Don (1)	36	32	2+	36	32	1+	37	32	1+	34	26	1+	36	28	1	15.6
Baker (4)	34	38	1+	36	35	1+	38	36	1+	35	31	1+	35	32	1	15.9
GG-304	29	25	1+	28	23	1+	31	24	1+	34	20	1+	30	21	1	16.1
Test avg. :	37	39	2	38	35	2	39	36	1	38	30	1				
High avg. :	45	43	3	43	40	3	46	40	1	46	36	1				
Low avg. :	29	25	1	28	23	1	31	24	1	33	20	1				
# Lsd(.05) :	2	2	1	2	2	1	2	2	NS^	3	3	NS^				
## TPG-value :	43	+	2	41	+	2	44	+	1	43	+	1				
### C.V. :	4	3	35	4	3	26	4	3	0	5	7	0				

* Heading, the relative days to heading, compared to the variety Don.

** Lodging score: 0= all plants erect, 3= 50% of plants lodged at 45° angle, 5= all plants flat.

Lsd, the amount two values in a column must differ to be significantly different.

TPG-value, the minimum or maximum value required for the top-performance group (TPG). A plus sign (+) indicates values within a column that qualify for the TPG.

Coef. of variation, a measure of trial experimental error.

^ Variable differences within a column are non-significant (NS) at the .05 level of probability.

Table 3a. Barley yield results, five South Dakota East River locations, 2004-2006.

Variety (Hdg.)*- sorted by 3-yr then 2006 state avg.	Location Yield Avg. (Bu/A at 13% moist.)										State Yield Avg. (Bu/A)		State Top-Yield Freq. ** (%)	
	Brookings		So. Shore		Miller		Selby		Brown Co.					
	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr	2006	3-Yr
Eslick (3)	96+	97+	78	94+	56+	72+	95+	90+	81+	88+	71	77	83	100
Haxby (2)	86	87	90+	99+	42	69+	94+	83+	79+	81+	71	75	67	83
Lacey (0)	77	84	78	91+	51+	62	72	82+	64	87+	62	71	17	50
Excel (3)	82	86	75	87	44	63+	77	83+	72+	86+	61	71	34	67
Tradition (0)	62	77	76	92+	37	59	71	78+	65	84+	55	69	0	50
Drummond (2)	69	76	77	88	36	56	73	82+	68	81+	58	68	0	33
Legacy (3)	78	81	72	88	40	57	73	77+	57	85	57	68	0	17
Conlon (0)	61	68	82	90	54+	65+	70	69	65	80+	60	65	17	50
Stellar-ND (2)	74	81	69	84	38	55	63	77+	63	79+	53	65	0	33
Robust (3)	68	76	71	77	36	51	53	65	68	75	52	61	0	17
Rawson (2)	81	.	84+	.	50+	.	74	.	74+	.	66	.	67	.
Meresse~(2)	55	.	59	.	36	.	60	.	63	.	50	.	0	.
Pronghorn~ (3)	52	.	54	.	41	.	52	.	60	.	45	.	0	.
Stanuwax~ (1)	54	.	58	.	37	.	49	.	52	.	45	.	0	.
Test avg. :	71	81	73	89	43	61	70	79	67	83				
High avg. :	96	97	90	99	56	72	95	90	81	88				
Low avg. :	52	68	54	77	36	51	49	65	52	75				
# Lsd(.05) :	7	9	7	8	7	9	9	14	10	12				
## TPG-value :	89	88	83	91	49	63	86	76	71	76				
### C.V. :	6	9	7	7	11	8	9	8	11	8				

* Heading, the relative days to heading, compared to the variety Lacey.

~ Hull-less type, used in food.

Lsd, the amount two values in a column must differ to be significantly different.

TPG-value, the minimum value required for the top-performance group (TPG) for yield.
A plus sign (+) indicates values within a column that qualify for the TPG.

Coef. of variation, a measure of trial experimental error, 15% or less is best.

** Frequency or percent of all test locations that a variety was in the TPG for yield.

Table 3b. Barley averages for bushel weight (BW) and lodging (LDG) by location along with state averages for height (HT) and grain protein (PRT) for 2006.

Variety (Hdg.)* - sorted by state BW avg.	Location Avg. - BW, HT, LDG										State Avg. - BW, HT, LDG, PRT			
	Brookings		South Shore		Miller		Selby		Brown Co.					
	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	LDG **	BW lb	HT in	LDG **	PRT %
Stanuwax~(1)	51	1+	53+	1+	57+	1+	58+	2	53	1+	54	24	1	15.3
Meress~(2)	55+	1+	51+	1+	56+	1+	58+	2	56+	1+	53	22	1	16.3
Haxby (2)	51	1+	51+	1+	50	2	53	2	51	1+	50	24	1	13.1
Eslick (3)	51	1+	47	1+	51	2	53	3	52	1+	49	24	1	12.6
Conlon (0)	49	3	44	3	50	3	53	3	49	1+	48	24	2	13.3
Pronghorn~ (3)	48	2	45	2	53	3	52	3	52	1+	48	24	2	15.4
Rawson (2)	49	1+	46	1+	50	1+	50	1+	49	1+	47	25	1	13.8
Tradition (0)	49	1+	47	1+	48	1+	51	2	47	1+	47	26	1	13.7
Robust (3)	49	1+	46	3	47	1+	51	2	49	1+	46	26	1	13.7
Lacey (0)	48	1+	46	3	49	1+	52	2	46	1+	46	25	1	13.7
Drummond (2)	48	1+	47	2	46	1+	50	2	46	1+	46	26	1	14.1
Excel (3)	48	1+	46	3	49	1+	51	2	48	1+	46	25	1	13.3
Legacy (3)	48	1+	44	3	48	1+	51	2	46	1+	46	25	1	13.7
Stellar-ND (2)	47	1+	45	2	48	1+	49	2	46	1+	45	25	1	13.7
Test avg. :	49	1	47	2	50	1	52	2	49	1				
High avg. :	55	3	53	3	57	3	58	3	56	1				
Low avg. :	47	1	44	1	46	1	49	1	46	1				
# Lsd(.05) :	2	0	3	0	1	1	2	1	2	NS+				
## TPG-value :	53	1	50	1	56	1	56	1	54	1				
### C.V. :	2	16	4	20	2	28	2	19	3	0				

* Heading, the relative days to heading, compared to the variety Lacey.

** Lodging score: 0= all plants erect, 3= 50% of plants lodged at 45° angle, 5= all plants flat.

~ Hull-less type, used for food.

Lsd, the amount two values in a column must differ to be significantly different.

TPG-value, the minimum or maximum value required for the top-performance group (TPG).
A plus sign (+) indicates values within a column that qualify for the TPG.

Coef. of variation, a measure of trial experimental error.

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