Plant Science Pamphlet 2
Annual Progress Repo

PROGRESS REPORT 2005

Central Crops and Soils Research Station
Highmore, South Dakota

SDSU South Dakota State University • Plant Science Department • Brookings, South Dakota 5700

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Highmore Progress Report: 125 copies at $1 98 each printeted by Plant Science Department February 2006

Contents

The weather was nice and the Station looked great for the 2005 Field Days on June 29th. The 3 pm tour 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 exchange ideas with specialists in 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 who were involved: Mike Volek and crew, several Plant Science personnel, and all the speakers, Dixie Volek and daughters Shandra and 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. A special thanks to Nancy Kleinjan for her assistance in preparing this report. Support and input from area producers, ranchers, Advisory Board members, and county Extension educators are also greatly appreciated.

Robin Bortnem
Manager,
Central Crops and Soils Research Station

Welcome to this year's edition of the Highmore Research Station summary. We thank you for taking the time to review the information and hope you will give us some feedback on the projects conducted at the Station, as well as ideas on those you would like to see us get involved in.

I want to thank Mike Volek for his continued excellent management of the Station on a day-to-day basis. Project leaders appreciate Mike's dedication and commitment to research and Extension activities conducted there. I would also like to thank Robin Bortnem for her work with Mike in ensuring efficient and effective operation of the Station.

Once again, thank you for taking the time to read this report and evaluating the work done at the Station. Let us know how we're doing!

Dale Gallenberg
Head, Plant Science Department

2005 Central Substation Advisory Board

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Kevin Kephart	Director, Agricultural Experiment Station	Brookings	688-4149	SDSU

Growing season temperature and precipitation data for the Highmore research station during 2005.

Month	*Temperature (°F) Maximum Average*	*Minimum*	*No. days Max > 90°*	*Precipitation (inches)*
April	62	35	0	1.65
May	68	42	0	3.80
June	80	58	2	5.72
July	91	61	18	0.73
August	88	60	12	0.87
September	84	54	10	3.40

Field Evaluation of Woody Plant Materials Highmore, South Dakota

Dwight Tober
Plant Materials Specialist, USDA/NRCS, Bismarck, N.D.

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 2005

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 (*R. 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 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 wants a copy 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. Mike Knudson also 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 and I collected data on selected entries on August 6, 2005. 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 continue 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 this year as showing disease symptoms or die-back include tamarack, white cedar, forsythia, chokeberry (rust), river birch, and seaberry.

New releases

Data collected from this site was used to support the formal release of two new shrubs this year in cooperation with SDSU and the Agricultural Experiment Station. Silver Sands sandbar willow, which was planted in 1990, and Survivor false indigo, which was 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 will soon be 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
'Oahe' hackberry
'Centennial' cotoneaster
'Scarlet' Mongolian cherry
'Sakakawea' silver buffaloberry
'McDermand' Ussurian pear
'Indigo' silky dogwood
'Regal' Russian almond
ND-1134 hybrid plum
ND-21 nannyberry
'Silver Sands' sandbar willow
9047238 seaberry
ND-1879 honeylocust
'Survivor' false indigo
'Legacy' late lilac
ND-1863 honeylocust
9058862 tamarack
'Meadowlark' forsythia
ND-170 cotoneaster
'Midwest' Manchurian crabapple
'Bighorn' skunkbush sumac
323957 chokeberry
14272 hybrid poplar
ND-2103 highbush cranberry
9069081 littleleaf linden
hybrid poplar 9069086 (Theves)
9063130 river birch
9047228 pygmy caragana
9016318 Siberian elm
ND-46 Timm's juneberry
Arnold's Red honeysuckle
ND-3744 Korean barberry
9057409 American hazel
Siberian larch (SL-383, ND-1765)
ponderosa pine (ND-1763, 9067413)
9057411 lodgepole pine
Scot's pine (9063156, 9063154)
9057410 hackberry
9063148 corktree
9063116 black ash

Data from this planting has been used to document the cooperative release of the cultivars listed next. 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.

2005 Alfalfa Production

Vance Owens and **Chris Lee**
South Dakota State University

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 in cultivar selection.

Even though our yield trials do not contain all available cultivars, they should be a helpful tool in identifying those that are suitable for your specific needs. Table 1 includes 11 cultivars planted in a new trial at Highmore in 2005. Table 2 provides forage production data from 18 cultivars planted at Highmore in 2003 and harvested through 2005.

In 2005, two cuttings were harvested from the trial established in 2003 and one cutting from the new trial established in 2005. 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) were applied preplant, as was Treflan for weed control.

Plots were harvested once in the establishment year with a sickle-type harvestor 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 11 alfalfa cultivars entered in the South Dakota State University alfalfa testing program at the Central Research Station. Plots were planted 3 May 2005.

Entry	*11-Jul*
	Tons DM/Acre
Mountaineer 2.0	1.68
Labrador	1.64
6400 HT	1.61
4A421	1.57
Vernal	1.57
361 HY	1.56
Rebound 5.0	1.55
LegenDairy 5.0	1.43
54V46	1.32
WL 335HQ	1.23
Integrity	1.22
Average	1.49
Maturity (Kalu & Fick)	6.5
LSD (P=0.10)	NS
CV(%)	29.0
P-value	0.567

NS = not significant at 0.10 level of probability
Trellan applied before planting
50 lbs P_2O_5/Acre - preplant

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

Table 2. 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.

	2005				2004	2003	3-year
Entry	16-Jun	11-Jul	Total		Total	Total	Total
				Tons DM/Acre			
A 30-06	1.69	1.27	2.96		4.75	1.03	8.75
DKA 42-15	1.65	1.42	3.07		4.18	1.07	8.33
Hybriforce 400	1.71	1.27	2.98		4.04	1.17	8.18
Vernal	1.63	1.35	2.97		4.19	0.93	8.09
WL319HQ	1.56	1.43	2.98		4.24	0.86	8.08
Journey Brand 204 Hyb.	1.66	1.29	2.95		4.03	1.04	8.02
Somerset	1.66	1.31	2.97		3.82	1.22	8.01
Hybriforce 420 Wet	1.58	1.33	2.91		3.83	1.23	7.97
WL 357HQ	1.67	1.37	3.03		3.77	1.15	7.96
Maverick	1.52	1.45	2.96		3.87	1.05	7.89
Notice II	1.53	1.32	2.85		3.99	1.04	7.89
Husky Supreme	1.51	1.28	2.79		3.89	1.13	7.82
54V54	1.56	1.33	2.90		3.92	0.98	7.80
Alfastar II	1.42	1.03	2.45		3.93	1.18	7.56
Gold Rush 747	1.43	1.24	2.67		3.71	1.11	7.48
Setter	1.44	1.21	2.64		3.58	1.21	7.43
FK421	1.39	1.07	2.46		3.40	1.15	7.01
Multiplier 3	1.31	1.07	2.38		3.43	1.13	6.94
Average	1.56	1.29	2.85		3.99	1.06	7.90
Maturity (Kalu & Fick)	5.3	6.3					
LSD (P=0.10)	NS	0.23	0.39		NS	0.20	NS
CV (%)	15.2	19.0	14.4		18.5	19.6	11.8
P-value	0.254	0.044	0.053		0.526	0.037	0.247

NS = not significant at 0.10 level of probability
Treflan applied pre-planting
50 lbs P_2O_5/Acre - preplant

Winter Wheat Breeding and Genetics

Amir Ibrahim, Steve Kalsbeck, and **Rich Little**
South Dakota State University

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 17 released varieties (including new releases from other states), 11 advanced experimental lines from our program, and two experimental lines from Nebraska. 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 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, consisting of 35 advanced experimental lines and 10 checks. Twelve 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 1.5 inches deep into fallow soil with good moisture conditions on September 18, 2004. Plots were sprayed in late April 2005 with 5 quarts Ramrod per acre and in early May 2005 with 1.5 pints Bronate per acre. Yield and test weight data for Highmore and other CPT locations are presented in Table 1.

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 2005 Crop Performance Testing (CPT) nursery.

	Grain Yield (bu/ac)												TW (lb/bu)
Entry	Brookings	Platte	Highmore	Dakota Lakes	Winner	Kennebec	Hays	Martin	Oelrichs	Sturgis	Wall	Avg	Avg
ALLIANCE	32	39	68	64	48	57	57	60	50	28	52	51	57
ARAPAHOE	47	36	71	66	48	52	61	57	46	29	45	51	58
CRIMSON	33	41	66	62	48	56	54	53	51	26	46	49	60
EXPEDITION	35	32	66	64	43	60	67	66	50	29	42	51	59
HARDING	43	37	66	62	52	52	56	55	49	25	46	49	59
HARRY	32	28	65	64	46	50	54	58	58	29	41	48	54
HATCHER	27	34	72	68	50	63	59	72	62	36	48	54	58
JAGALENE	20	42	62	74	52	64	61	72	48	28	47	52	59
JERRY	53	40	66	64	46	58	56	60	55	24	54	53	59
MILLENNIUM	54	47	71	68	49	65	65	65	48	33	56	57	60
NE01643	53	45	70	75	51	70	69	67	49	27	51	58	60
NE99533-4	24	36	62	69	48	59	51	61	42	33	46	49	58
NEKOTA	26	38	58	59	45	45	43	43	46	30	46	44	57
OVERLEY	32	30	60	67	43	68	79	67	41	29	40	51	60
SD00032	43	39	51	55	48	56	66	62	44	26	42	48	59
SD00W024	37	38	61	56	51	45	39	43	51	22	42	45	58
SD01104	32	33	52	59	48	55	50	56	53	30	45	47	57
SD01122	42	40	67	61	54	55	49	55	54	26	44	50	58
SD01W064	26	42	62	65	60	57	56	63	53	29	64	53	60
SD96240-3-1	40	36	68	63	54	69	66	71	61	31	48	56	58
SD97059-2	49	38	73	74	57	57	52	59	52	28	51	54	58
SD97380-2	48	37	69	56	52	57	61	58	52	30	54	53	58
SD97538	39	35	66	67	48	55	52	59	52	31	53	51	58
SD97W609	31	33	68	62	56	57	64	66	50	26	48	52	59
SD98102	30	49	67	64	58	48	46	55	50	30	56	50	59
TANDEM	36	40	64	55	48	61	67	59	47	29	43	50	60
TREGO	20	32	63	66	52	55	57	59	50	31	50	49	58
WAHOO	43	41	72	64	49	58	60	64	50	29	54	53	56
WENDY	38	26	68	77	51	58	53	58	47	29	45	50	59
WESLEY	35	39	62	64	43	61	62	68	41	27	43	50	57
Mean	37	37	65	64	49	58	58	60	50	29	48	52	59
CV%‡	11	12	6	11	11	11	9	8	10	10	15	11	2
LSD0.05†	6	6	5	10	8	9	8	7	7	5	10	2	1

‡ 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.

† 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.

Oat Research

Lon Hall
South Dakota State University

Yield, yield stability, and test weight are the most important characteristics associated with the identification and eventual release of oat varieties. There are, however, several additional factors that contribute to the expression of these primary characteristics. Resistance to lodging, Barley Yellow Dwarf Virus (BYDV), stem rust, and crown rust all affect yield potential and test weight.

Other traits that are considered prior to varietal release include hull, protein, and oil percentages, as well as maturity, hull color, plant height, and whether the variety is hulled or hulless.

Consumers desire different characteristics for specific needs. Millers generally want oats with high protein, high beta-glucan content, and low oil. Livestock producers prefer tall varieties with high levels of protein and oil. The racehorse industry wants a high quality, white-hulled or hulless oat variety. Tall varieties, such as Loyal, are popular forage oats.

The main emphasis of the oat breeding programs is development of hulled varieties. Market demand for milling and feed oats isn't affected by hull color; however, the racehorse industry desires white-hulled varieties. Therefore, emphasis is placed on development of white-hulled varieties with desirable traits for milling and/or feed.

Recently there has been interest in hulless oats for feed and other specialty uses; therefore, we are continuing our effort to develop hulless oat varieties. Hulless oats tend to have a lower lignin content, making them a viable option for a forage crop. Approximately 50% of the acres of oats planted are harvested for forage.

Plant breeding is a long drawn-out process. The bulk breeding method takes, on average, at least 10 years from initial cross to variety release. This process may be shortened by 2 to 3 years by using a mass selection and modified single seed descent method, which involves two extra generations in the greenhouse, and bulking increases of similar purification derivatives. Each year there are approximately 20,000 non-segregating plants and head rows observed within this program. In 2005, there were 3,197 unique populations and lines yield tested. The total number of yield plots was 5,384.

Data collected from regional nurseries provide valuable information for variety release and germplasm selection for crossing in our program. The Tri-State regional nursery is made up of 30 hulled lines and 6 checks. The 30 lines consist of 10 advanced lines each from Minnesota, North Dakota, and South Dakota. Advanced increase lines are entered in the Uniform Early Nursery, Uniform Midseason Nursery, Quaker Uniform Oat Nursery, and/or South Dakota Standard Variety Oat Trials (SVO). Hulless lines are tested in the Cooperative Naked Oat Trial and/or SVO.

Experimental line SD000366-36 was released December 1, 2005, as the variety 'Stallion.' The three-parent pedigree is SD89507/Settler//SD93068. The following tables are Crop Performance Testing data and trait summary data, respectively.

This research is funded in part by annual grants from The Quaker Oats Company. We also appreciate the financial support provided by the SDSU Agricultural Experiment Station, Crop Improvement Association, Foundation Seed Stocks, and the SDSU Plant Science Department.

Table 1. 2004-2005 standard variety oat data.

South Dakota [illegible]	15 loc/yrs yield	15 loc/yrs test wt	3 loc/yrs head	14 loc/yrs height	8 loc/yrs lodging	3 loc/yrs Crown rust	9 loc/yrs protein
	bu/a	lbs/bu	(don=1)	inches	1-5	%	%
JERRY	106.7	36.1	3.8	36.5	3.0	70	15.4
STALLION	112.4	36.7	5.5	38.0	4.1	1	15.5

Table 2. Trait summary.

Yield:	Very good
Test weight:	Very good
Maturity:	Medium-late
Straw strength:	Fair
Height:	Tall
Groat %:	Average
Crown rust:	Resistant
Stem rust:	Susceptible
Smut:	Moderately resistant
Barley yellow dwarf:	Moderately resistant
Protein %:	Average
Oil %:	Average

Resistance of Sunflower Germplasm to the Red Sunflower Seed Weevil, Highmore, South Dakota, 2005

Kathleen Grady
South Dakota State University
Larry Charlet and **Jerry Miller**
USDA-ARS, Northern Crop Science Lab, Fargo, N.D.

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, the eggs hatch, 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 fourth 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 were lines developed by the USDA-ARS through a recurrent selection breeding procedure, interspecific crosses, and accessions obtained from the North Central Plant Introduction Station, Ames, Iowa.

In 2002, 41 lines and 15 accessions were screened at Highmore. The treatments were replicated four times in a randomized block experiment. Up to four heads from each row (treatment) were threshed and a pooled sample of seed sent to the USDA-ARS, Northern Crop Science Laboratory, Fargo, for evaluation of seed damage. A random sample of 200 seeds from each plot was examined and the percentage of seeds damaged by larval feeding determined. Red seed weevil infestation levels were high at Highmore in 2002, and seed damage levels ranged from 8% to 55%.

The 2003 trials at Highmore retested 20 lines and four accessions that showed low numbers of damaged seeds in the 2002 trials, plus eight new accessions. Four replications were planted and five sunflower heads were harvested from each plot. Heads were threshed individually and seed shipped to the USDA-ARS sunflower insect laboratory, where 100 seeds from each head were evaluated for seed weevil damage. Seed damage ranged from 5% to 41%.

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 was sent to Fargo for damage evaluation. The results showed that a high level of red seed weevil infestation occurred at Highmore in 2004. Seed damage 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 20 accessions and Hybrid 894 planted in two-row plots with three replications. Eight of the accessions were previously tested and 12 were new. Up to 10 heads from each plot were harvested and threshed individually. Seed was sent to the USDA-ARS, Northern Crop Science Laboratory for evaluation of seed damage. Results are pending. Results of the 2002 to 2004 screenings are outlined in Table 1.

The Highmore 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, SD from 2002 to 2005.

Line or accession	*ID*	*% Damaged seed*			
		2002	*2003*	*2004*	*2005*
98 1854	USDARSSW	13 1	11	--	--
9 81855	USDARSSW	17	22	--	--
98 1859	USDARSSW	22 8 ± 5 2	10	--	--
9 81860	USDA RSSW	19 8 ± 9 9	2	--	--
98 1864	USDA RSSW	21	11	--	--
98 1865	USDA RSSW	26.3 ± 12.8	23	--	--
98 1867	USDA RSSW	18 8 ± 0 8	12	--	--
98 1871	USDARSSW	13.5	20	--	--
98 1873	USDARSSW	22 0 ± 8.1	12	--	--
9 81875	USDARSSW	24 2 ± 14 9	14	--	--
9 81879-4	USDARSSW	13.8 ± 5.9	5	--	--
98 1881	USDA RSSW	12.6 ± 3.6	13	--	--
98 1882	USDA RSSW	8 1 ± 4 1	17	--	--
98 1883	USDA RSSW	23.8 ± 5 3	25	--	--
9 81884	USDA RSSW	7.8 ± 1.8	8	--	--
98 1885	USDA RSSW	9 3 ± 1 8	17	--	--
98 1892	USDA RSSW	15 6 ± 11 4	22	--	--
98 1893	USDA RSSW	22	18	--	--
98 1898	USDA RSSW	13 0 ± 6.2	27	--	--
98 1868	USDA RSSW	36 8 ± 3 1	15	--	--
TUB-346	TUB-346	--	27	--	--
TUB-1709-2	TUB-1709-2	--	32	--	--
RF-TUB-346	RF-TUB-346	--	30	--	--
GIG-1616-2	GIG-1616-2	--	35	--	--
PI 251465	NO K1918	24.7 ± 4 6	23	--	--
PI 486366	CAKSISKIJ 269	8.0 ± 4.0	25	--	--
PI 294658	SMENA (SUS)	--	18	--	--
Str 1622-1		--	17	27.2 ± 2 7	--
PI 170385		--	--	37 7 ± 2 9	--
PI 253776		--	--	33 5 ± 3 0	--
PI 267555		--	--	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	--
HYB894	Hybrid 894(check)	29 8 ± 13.8	26	23 9 ± 1.2	*
PI431506	(Susceptible)	42.3 ± 20.9	21	--	*
Hir 828-3	(Susceptible)	--	41	49 0 ± 3.7	*
Str 1622-2	(Susceptible)	--	15	32.4 ± 4.5	*
Ames 3269	PURPUREUS	18.2 ± 1.3	13	12 5 ± 1 6	*
Ames 3391		--	--	23 6 ± 1.9	*
Ames 3454		--	--	16 7 ± 5 3	*
PI 431542		--	--	6 0 ± 1.6	*
PI 497939		--	--	12 6 ± 1.8	*
PI431516		--	--	--	*
PI431514		--	--	--	*
PI431518		--	--	--	*
PI 431520		--	--	--	*
PI 431524		--	--	--	*
PI 431528		--	--	--	*
PI 431529		--	--	--	*
PI 431545		--	--	--	*
PI 431549		--	--	--	*
PI 431563		--	--	--	*
PI 431568		--	--	--	*
PI 431569		--	--	--	*

* Seed damage evaluations from 2005 are in process.

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.

2005 projects

This was the third year of extended studies with minor crops. A pulse crop herbicide screen was conducted to expand the data base for crop safety with a number of herbicide treatments. The study looked at 1X and 2X rates to document herbicide injury and crop safety. Additional work was also completed on herbicide options for sunflower, safflower, and grain sorghum.

2005 season

Early rain showers started the season with adequate moisture. Cool temperatures early in the spring slowed weed development. Moisture subsided early in the season and the crop showed moisture stress by late growing season.

2005 reports

Cheatgrass Control in Winter Wheat
Olympus Flex Tank-Mixes in Winter Wheat
Grain Sorghum Demonstration
Weed Control in Safflower
Field Pea Herbicide Tolerance
Chickpea Herbicide Tolerance
Lentil Herbicide Tolerance
Pulse Crop Herbicide Tolerance

Acknowledgements

The cooperation and direct assistance of Mike Volek is acknowledged. Field equipment and management of the plot areas are important contributions to the project.

Program input and partial support for field programs is also acknowledged:
South Dakota Soybean Research and Promotion Council
South Dakota Oilseed Council
National Canola Research Association
National Sunflower Association
Consortium for Alternative Crops
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 sheet available from county Extension offices for herbicide recommendations.

Table 1. Chaatgrass control in winter wheat

RCB; 4 reps
Variety: Arapahoe
Planting Date: 9/22/05
FALL: 10/27/04; Winter wheat 2 lf, 3-4 in; Dobr 1 lf, 2 in.
ESPRING: 4/15/05; Winter wheat 4 lf, tiller, 4-5 in; Dobr 3-4 lf, 1-4 in.
Soil: Clay loam; 2.5% OM; 6.2 pH

Precipitation:

FALL:	1st week	1.13 inches
	2nd week	0.00 inches
ESPRING:	1st week	0.40 inches
	2nd week	Trace

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

COMMENTS: When applied in the fall, Olympus, Olympus Flex, Maverick, Everest, and Amber resulted in approximately 90% downy brome control. When applied in the spring rather than fall, Olympus or Everest resulted in similar brome control, but control with Maverick was approximately 10% less. Downy brome control with Maverick was not reduced when tank-mixed with 2,4-D.

Treatment	*Rate/A*	*% VCRR Stunt 4/26/05*	*% VCRR Heads 6/29/05*	*% Dobr 4/15/05*	*% Dobr 6/29/05*
Check	—	0	0	0	0
FALL					
Olympus+NIS	.92 oz+.5%	0	0	94	95
Olympus Flex+NIS	3.5 oz+.5%	0	0	91	97
Amber+NIS	.56 oz+.5%	0	0	82	88
Maverick+NIS	.67 oz+.5%	0	0	93	96
Maverick+2,4-D ester+NIS	.67 oz+1 pt+.5%	0	22	91	93
Everest+NIS	.61 oz+.5%	0	0	93	91
EARLY SPRING					
Maverick+NIS	.67 oz+.5%	0	0	—	83
Maverick+2,4-D ester+NIS	.67 oz+1 pt+.5%	0	0	—	81
Everest+NIS	.41 oz+.5%	0	0	—	86
Everest+NIS	.61 oz+.5%	10	0	—	85
Olympus+NIS	.62 oz+.5%	12	0	—	83
Olympus+NIS	.92 oz+.5%	10	0	—	91
LSD (.05)		*7*	*1*	*3*	*7*

Table 2. Olympus flex tank-mixes in winter wheat

RCB; 3 reps
Variety: Arapahoe
Planting Date: 9/22/05
FALL: 10/27/04; Winter wheat 2 lf, 3-4 in; Dobr 1 lf, 2 in.
SPRING: 4/15/05; Winter wheat 4 lf, tiller, 4-5 in; Dobr 3-4 lf, 1-4 in
Soil: Clay loam; 2.5% OM; 6.2 pH

Precipitation:

FALL:	1st week	1.13 inches
	2nd week	0.00 inches
SPRING:	1st week	0.40 inches
	2nd week	0.00 inches

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

COMMENTS: Olympus Flex provided +90% downy brome control, even with a tank mixture including dicamba (Clarity). Downy brome control was similar with Olympus, Maverick, or Olympus Flex. Osprey resulted in greater downy brome control with a spring application compared to a fall application, and tank mixing with Clarity did not affect brome control.

Treatment	*Rate/A*	*% VCRR Stunt 4/26/05*	*% Dobr 4/15/05*	*% Dobr 6/29/05*
Check	----	0	0	0
FALL				
Olympus Flex+NIS+28% N	3 oz+.5%+4 pt	0	96	93
Olympus Flex+Clarity+NIS+28% N	3 oz+8 oz+.5%+4 pt	0	94	90
Olympus Flex+NIS+28% N	3.5 oz+.5%+4 pt	0	96	96
Olympus Flex+Clarity+NIS+28% N	3.5 oz+8 oz+.5%+4 pt	0	96	94
Olympus+NIS	.92 oz+.5%	0	91	90
Osprey+NIS+28% N	4.76 oz+.5%+4 pt	0	73	63
Maverick+NIS	.66 oz+.5%	0	91	90
SPRING				
Osprey+NIS+28% N	4.76 oz+.5%+4 pt	20	—	91
Osprey+Clarity+NIS+28% N	4.76 oz+8 oz+.5%+4 pt	23	—	89
LSD (.05)		*2*	*4*	*7*

Table 3. Grain sorghum demonstration

RCB; 3 reps
Planting Date: 6/23/05; Variety Garst 5624
PRE: 6/23/05
POST: 7/13/05; Sorghum V3-4; Grft 2-4 in; Bdlf 2-4"
Soil: Clay loam; 2.8% OM; 5.9 pH

VCRR=Visual Crop Response Rating
(0=no injury; 100=complete kill)
Grtt=Green foxtail
Bdlf=Redroot pigweed, kochia

COMMENTS: Preemergence: Control of broadleaf weeds (pigweed and kochia) was better than expected with the chloroacetamide herbicides. Applications of Sequence, a relatively new premix of glyphosate and s-metolachlor (Dual II), resulted in similar weed control as the other preemergence herbicides.

Preemergence followed by postemergence: Grass control with Outlook ranged from 89-90% and postemerence broadleaf herbicides provided nearly complete control.

Postemergence: Grass control from Paramount was generally slightly greater than that of Outlook. Broadleaf weed control with tank mix partners was similar to that of Paramount alone.

Treatment	*Rate/A*	*% VCRR Lodging 7/19/05*	*% VCRR Lf Burn 7/19/05*	*% Grft 8/25/05*	*% Bdlf 8/25/05*
Check	----	0	0	0	0
PREEMERGENCE					
Dual II Magnum	1.67 pt	0	0	72	98
Outlook	19 oz	0	0	73	98
Bicep Lite II Magnum	1.9 qt	0	0	99	99
G-Max Lite	2 pt	0	0	99	99
Sequence	4 pt	0	0	99	99
PREEMERGENCE & POSTEMERGENCE					
Outlook&Marksman	19 oz&2 pt	12	0	83	99
Outlook&Clarity	19 oz&8 oz	20	0	86	99
Outlook&2,4-D amine	19 oz&8 oz	10	0	89	99
Outlook&Shotgun	19 oz&3 pt	0	0	85	99
Outlook&Aim EW+COC	19 oz&.5 oz+1 qt	0	17	92	99
POSTEMERGENCE					
Paramount+MSO	5.33 oz+1 qt	0	0	89	99
Paramount+atrazine+MSO	5.33 oz+1 pt+1 qt	0	0	95	99
Paramount+Clarity+MSO	5.33 oz+4 oz+1 qt	22	0	91	99
Paramount+Permit+MSO	5.33 oz+.67 oz+1 qt	0	0	95	99
Paramount+Starane+MSO	5.33 oz+.67 pt+1 qt	0	0	89	99
Starane+atrazine	.67 pt+1 pt	0	0	91	99
LSD (.05)		*2*	*1*	*2*	*1*

Table 4. Weed control in safflower

RCB; 3 reps
Variety: Finch
Planting Date: 4/26/05
PRE: 4/26/05
POST: 6/9/05; Safflower 6 in; Grft 1-3 in; KOCZ 1-2 in.
Soil: Clay loam; 2.1% OM; 6.7 pH

Precipitation:

PRE:	1st week	Trace
	2nd week	0.50 inches
POST:	1st week	3.55 inches
	2nd week	0.75 inches

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

COMMENTS: Nearly complete grass control and approximately 90% kochia control with preemergence herbicides. Callisto caused substantial safflower injury and did not provide greater kochia control than the chloroacetamide herbicides or Prowl. Spartan and Valor provided nearly complete kochia control and Poast provided nearly complete foxtail control.

Treatment	Rate/A	Saff'lower % VCRR Std Red 6/29/05	% Grft 6/29/05	% KOCZ 6/29/05	% Grft 9/8/05	% KOCZ 9/8/05	Yield lbs/A
Check	----	0	0	0	0	0	516
PREEMERGENCE							
Prowl H_2O	3 pt	0	87	88	98	82	841
Callisto	6 oz	100	20	95	—	—	0
Stalwart	2 pt	0	93	88	97	90	864
Dual II Magnum	2 pt	0	96	82	98	89	775
Outlook	19 oz	0	93	89	98	92	904
PREEMERGENCE & POSTEMERGENCE							
Spartan&Poast+COC	4 oz&1 pt+1 pt	13	98	98	99	99	795
Spartan&Poast+COC	8 oz&1 pt+1 pt	18	98	98	99	99	912
Valor&Poast+COC	3 oz&1 pt+1 pt	28	98	97	99	99	748
POSTEMERGENCE							
Select+COC	6 oz+1 pt	0	98	0	99	0	864
Callisto+COC	3 oz+1%	100	20	87	—	—	0
LSD (.05)		5	2	7	1	9	284

Table 5. Field pea herbicide tolerance

RCB; 3 reps
Planting Date: 4/26/05
POST: 6/9/05; Kochia 1-2 in.
Soil: Clay loam; 2.6% OM; 5.9 pH

Precipitation:

PRE:	1st week	0.00 inches
	2nd week	0.50 inches
POST:	1st week	3.55 inches
	2nd week	0.75 inches

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

COMMENTS: Several preemergence treatments had no or slight visual crop response at both rating periods. Valor, Python, and Callisto had significant injury at both rating periods. Sencor and Princep had less than 10% injury. Labeled postemergence treatments had little or no injury at labeled rates and 15% or less injury at 2X rates. FirstRate, Aim EW, and Basagran alone had significant injury.

Treatment	Rate/A	Field Pea %VCRR St Red 6/29/05	Field Pea %VCRR Stunt 6/29/05	Field Pea %VCRR 6/29/05	2X Field Pea %VCRR St Red 6/29/05	2X Field Pea %VCRR Stunt 6/29/05	2X Field Pea %VCRR 6/29/05	Field Pea %VCRR Std-Stunt 8/25/05	Field Pea %VCRR Std-Stunt 8/25/05
Check	----	0	0	0	0	0	0	0	0
PREEMERGENCE									
Outlook	19 oz	10	0	10	0	0	0	0	0
Dual II Magnum	1.67 pt	0	0	0	0	0	0	0	0
Stalwart	1.67 pt	0	3	3	5	0	5	0	0
Degree	4.25 pt	5	0	5	0	0	0	0	0
Define SC	15 oz	5	0	5	0	0	0	0	0
Sencor	.5 lb	5	3	8	10	5	10	0	0
Axiom	10 oz	0	0	0	0	0	0	0	0
Valor	3 oz	20	0	18	30	20	40	8	30
Spartan	4 oz	3	0	3	0	0	0	0	0
FirstRate	.6 oz	13	0	13	10	0	10	8	5
Python	1 oz	15	3	18	15	5	20	3	0
Callisto	6 oz	100	100	100	100	100	100	100	100
Princep	1 qt	3	0	3	10	0	10	0	0
Pursuit 2L	3 oz	0	0	0	5	0	5	0	0
Pursuit Plus	2.5 pt	8	0	8	0	0	0	0	0
POSTEMERGENCE									
Raptor+NIS	4 oz+.25%	0	3	3	0	10	10	0	0
Raptor+ Basagran+NIS	4 oz+ 1 pt+.25%	0	5	5	0	15	15	5	0
Pursuit 2L+NIS	3 oz+.25%	0	10	10	0	10	10	0	0
FirstRate+NIS	.3 oz+.125%	15	80	85	10	70	70	98	100
Aim EW+NIS	.5 oz+.25%	0	38	45	10	60	60	10	20
Basagran+COC	1 qt+1 pt	0	10	10	0	20	20	15	30
Resource+COC	4 oz+1 qt	0	5	5	0	20	20	3	25
Ultra Blazer+NIS	8 oz+.125%	0	13	13	0	20	20	3	0
LSD (.05)		*12*	*9*	*11*	—	—	—	*7*	—

Table 6. Chickpea herbicide tolerance

RCB; 3 reps
Planting Date: 4/26/05
POST: 6/9/05; Kochia 1-2 in.
Soil: Clay loam; 2.6% OM; 5.9 pH

Precipitation:

PRE:	1st week	0.00 inches
	2nd week	0.50 inches
POST:	1st week	3.55 inches
	2nd week	0.75 inches

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

COMMENTS: Several preemergence treatment had little or no injury at the 1X rate, however significant injury resulted at the 2X rates. Callisto and Pursuit Plus also had significant injury at the 1X rate. Postemergence treatments had significant injury to chickpea both at 1X and 2x rates.

Treatment	Rate/A	Chickpea %VCRR St Red 6/29/05	Chickpea %VCRR Stunt 6/29/05	Chickpea %VCRR 6/29/05	2X Chickpea %VCRR St Red 6/29/05	2X Chickpea %VCRR Stunt 6/29/05	2X Chickpea %VCRR 6/29/05	Chickpea %VCRR Std-Stunt 8/25/05	Chickpea %VCRR Std-Stunt 8/25/05
Check	----	0	0	0	0	0	0	0	0
PREEMERGENCE									
Outlook	19 oz	0	0	0	20	20	30	0	10
Dual II Magnum	1.67 pt	5	0	5	30	40	50	0	15
Stalwart	1.67 pt	5	0	5	20	30	40	5	25
Degree	4.25 pt	5	0	5	10	10	10	3	0
Define SC	15 oz	0	0	0	10	10	10	0	0
Sencor	.5 lb	0	0	0	10	0	10	0	0
Axiom	10 oz	8	3	10	0	0	0	8	0
Valor	3 oz	20	10	23	20	20	30	8	30
Spartan	4 oz	0	0	0	15	15	20	0	0
FirstRate	.6 oz	13	0	10	15	20	25	5	10
Python	1 oz	3	0	3	10	20	25	5	0
Callisto	6 oz	25	8	28	50	20	60	20	15
Princep	1 qt	0	0	0	10	10	15	0	0
Pursuit 2L	3 oz	15	10	25	20	30	40	10	0
Pursuit Plus	2.5 pt	25	10	28	15	30	40	8	0
POSTEMERGENCE									
Raptor+NIS	4 oz+.25%	10	35	55	30	50	70	10	5
Raptor+ Basagran+NIS	4 oz+ 1 pt+.25%	10	28	35	30	40	50	10	15
Pursuit 2L+NIS	3 oz+.25%	5	35	40	20	30	40	3	0
FirstRate+NIS	.3 oz+.125%	10	50	55	30	60	80	65	90
Aim EW+NIS	.5 oz+.25%	5	23	30	10	15	20	18	15
Basagran+COC	1 qt+1 pt	45	30	65	90	90	90	55	100
Resource+COC	4 oz+1 qt	0	20	23	0	30	30	0	20
Ultra Blazer+NIS	8 oz+.125%	0	18	23	0	30	30	0	0
LSD (.05)		*26*	*13*	*23*	—	—	—	*28*	—

Table 7. Lentil herbicide tolerance

RCB; 3 reps
Planting Date: 4/26/05
POST: 6/9/05; Kochia 1-2 in.
Soil: Clay loam; 2.6% OM; 5.9 pH

Precipitation:

PRE:	1st week	0.00 inches
	2nd week	0.50 inches
POST:	1st week	3.55 inches
	2nd week	0.75 inches

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

COMMENTS: Several preemergence treatments had little or no injury; however, Valor, Spartan, FirstRate, and Callisto had significant injury to lentils at the 1X rate. All postemergence treatments including Pursuit 2L had some injury, many with significant injury symptoms.

Treatment	Rate/A	Lentil %VCRR St Red 6/29/05	Lentil %VCRR Stunt 6/29/05	Lentil %VCRR 6/29/05	2X Lentil %VCRR St Red 6/29/05	2X Lentil %VCRR Stunt 6/29/05	2X Lentil %VCRR 6/29/05	Lentil %VCRR Std-Stunt 8/25/05	Lentil %VCRR Std-Stunt 8/25/05
Check	----	0	0	0	0	0	0	0	0
PREEMERGENCE									
Outlook	19 oz	0	0	0	0	0	0	0	0
Dual II Magnum	1.67 pt	0	0	0	0	0	0	0	0
Stalwart	1.67 pt	0	0	0	0	0	0	0	0
Degree	4.25 pt	10	0	10	10	15	15	0	0
Define SC	15 oz	0	3	3	10	20	25	0	0
Sencor	.5 lb	10	0	10	10	10	15	0	0
Axiom	10 oz	5	0	5	90	80	90	0	0
Valor	3 oz	55	18	65	90	90	90	45	90
Spartan	4 oz	33	0	33	50	40	60	5	50
FirstRate	.6 oz	28	0	28	40	20	50	5	15
Python	1 oz	10	5	10	5	0	5	0	0
Callisto	6 oz	100	100	100	100	100	100	100	100
Princep	1 qt	0	0	0	0	5	5	0	0
Pursuit 2L	3 oz	0	3	3	0	10	10	0	0
Pursuit Plus	2.5 pt	15	0	15	10	10	15	0	0
POSTEMERGENCE									
Raptor+NIS	4 oz+.25%	0	33	33	10	50	50	0	0
Raptor+ Basagran+NIS	4 oz+ 1 pt+.25%	50	70	80	100	100	100	88	95
Pursuit 2L+NIS	3 oz+.25%	0	20	20	0	20	20	0	0
FirstRate+NIS	.3 oz+.125%	85	85	90	100	100	100	95	100
Aim EW+NIS	.5 oz+.25%	5	25	25	10	30	30	10	25
Basagran+COC	1 qt+1 pt	100	100	100	100	100	100	90	100
Resource+COC	4 oz+1 qt	10	30	35	50	40	80	0	70
Ultra Blazer+NIS	8 oz+.125%	0	30	30	10	50	50	0	0
LSD (.05)		*21*	*9*	*13*	—	—	—	*23*	—

Table 8. Pulse crop herbicide tolerance

RCB; 3 reps
Planting Date: 4/26/05
POST: 6/9/05; Kochia 1-2 in.
Soil: Clay loam; 2.6% OM; 5.9 pH

Precipitation:

PRE:	1st week	0.00 inches
	2nd week	0.50 inches
POST:	1st week	3.55 inches
	2nd week	0.75 inches

KOCZ=Kochia

COMMENTS: Several preemergence treatments including Sencor, Axiom, Valor, Spartan, FirstRate, Python, Callisto, Princep, and Pursuit had kochia control over 86% and held through the 8-25-05 rating period. All postemergence treatments except for FirstRate and Ultra Blazer had over 90% kochia control.

Treatment	Rate/A	% KOCZ 8/25/05	2X % KOCZ 8/25/05
Check	—	0	0
PREEMERGENCE			
Outlook	19 oz	83	90
Dual II Magnum	1.67 pt	56	75
Stalwart	1.67 pt	73	75
Degree	4.25 pt	78	85
Define SC	15 oz	83	90
Sencor	.5 lb	98	99
Axiom	10 oz	89	98
Valor	3 oz	99	99
Spartan	4 oz	99	99
FirstRate	.6 oz	87	92
Python	1 oz	87	88
Callisto	6 oz	94	99
Princep	1 qt	89	98
Pursuit 2L	3 oz	98	99
Pursuit Plus	2.5 pt	93	99
POSTEMERGENCE			
Raptor+NIS	4 oz+.25%	95	92
Raptor+ Basagran+NIS	4 oz+ 1 pt+.25%	98	99
Pursuit 2L+NIS	3 oz+.25%	97	99
FirstRate+NIS	.3 oz+.125%	23	80
Aim EW+NIS	.5 oz+.25%	99	99
Basagran+COC	1 qt+1 pt	98	99
Resource+COC	4 oz+1 qt	98	98
Ultra Blazer+NIS	8 oz+.125%	75	92
LSD (.05)		*18*	—

Fertilizer and Soil Test Effects on Soybeans

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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), no fertilizer, or phosphorus and nitrogen plus either potassium (0-0-60), and sulfur (gypsum) or zinc ($ZnSO_4$-35%). Fertilizer was broadcast on May 16, 2005, and soybeans no-till planted into the wheat residue the following day.

Fertilizer treatments have been applied on the same plots since 1997. Fertilizer rates were the same each year except nitrogen varied according to soil test. 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 October 18, 2004, is reported in Table 2. The 50 lb of nitrogen applied to the previous wheat crop increased soil residual nitrate by only 12 lb/a over where no nitrogen had been applied since the start of the study in 1997. No nitrogen was applied to the soybeans this year.

The sulfur soil test was high and no sulfur would have been recommended. Previous applications of sulfur increased sulfur soil test by 96 lb/a.

The 25 lb of phosphorus and 50 lb of potassium applied each year since 1997 increased phosphorus soil test from 10 ppm in the check to 26 ppm and potassium soil test from 456 to 602 ppm. The check phosphorus test (10 ppm) was in the medium range and 100 lb of phosphorus fertilizer would have been recommended for a 40-bu soybean yield goal. The potassium soil test was very high and none would have been recommended. The zinc soil test was raised from 1.14 ppm to 8.40 ppm by the annual addition of 5 lb of zinc for five years. The check zinc soil test (1.14 ppm) was in the very high soil test range. No zinc would have been recommended regardless of soil test since soybeans do not usually respond to zinc fertilization.

Dry, hot conditions during summer severely stressed soybeans during the 2005 growing season. A few days prior to the planned harvest date, a hail storm caused shattering of an estimated half of the potential yield and the decision was made not to harvest the plots. Yields prior to the hail would likely have been in the 15- to 20-bushel range. There were no obvious visual differences due to the fertilizer treatments during the growing season.

This site will be rotated back to wheat in 2006. Similar fertilizer treatments will be applied to the same plots. Yields and soil tests from the previous years of this study can be found in the 1997-2004 Highmore annual reports or in the 1997-2004 SDSU Plant Science Department Soil/Water Science Research Annual Report, TB No. 99.

Support for these studies came from various sources including the Ag Experiment Station, Plant Science Department, Extension Service, and the SDSU Soil Testing Lab.

Table 1. Fertilizer treatments, Highmore, 2005

Fertilizer treatment lb/a
1. 0 N + 35 P
2. 0 N + 0 P
3. 0 N + 35 P
4. 0 N + 35 P + 50 K
5. 0 N + 35 P + 25 S
6. 0 N + 35 P + 5 Zn

Table 2. Soil test levels, Highmore, 2005.

Soil Test[1]	Check	Treated
Nitrate-N, lb/a		
0 – 6 inches	16	16
6 – 24 inches	36	48
Sulfate-S, lb/a		
0 – 6 inches	12	24
6 – 24 inches	42	126
Phosphorus, ppm	10	26
Potassium, ppm	456	602
Zinc, ppm	1.14	8.40
OM, %	3.1	
pH	6.7	
Salts, mmho/cm	0.4	

[1] Sampled 10/18/04

Small Grain Variety Performance Trials

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This is a report of the 2005 Nelson Brothers Farm performance trials for hard red spring wheat, oat, and barley varieties and experimental lines conducted by the South Dakota State University Crop Performance Testing (CPT) program. These trials were located 4 miles south and 2.5 miles east of the four-way stop in Miller, S.D.

Experimental procedures

Four plots measuring 5 x 20 feet for each entry were seeded and later cut back to a uniform dimension prior to harvest. A cone-drill seeder with seven seed tubes spaced on 7-inch rows was used. Plots were seeded at 1.2 million pure-live-seeds per acre on April 4, 2005, into a Williams-Bonilla loam previously cropped to soybeans. Research funding & support sources: The South Dakota Agricultural Experiment Station and testing fees obtained from the SD Crop Performance Testing Program.

Measurements of performance

Yield (bu/a) and bushel weight (lb) values are an average of four replicates. Yields are adjusted to 13.5% grain moisture (dry matter basis) and bushel weights of 60 (wheat), 32 (oat), or 48 lb (barley). Grain protein values were obtained from one sample per entry as determined by a FOSS TECATOR Model Infratec 1229 grain analyzer. Yield values are reported for year 2005 and for 3 years (2003-05), while bushel weight, plant height, and plant lodging score values are reported for year 2005.

Performance results

Hard red spring wheat: As indicated in Table 1, the average yield for 2005 was 35 bu/a and for 3 years 39 bu/a; and varieties had to yield 39 bu/acre in 2005 and for 3 years to be in the top performance group for yield. The top performance group for yield for 3 years included the varieties Russ, Oxen, Briggs, Steele-ND, Walworth, Forge, Reeder, Norpro, Granger, Knudson, and Alsen. The top performance group for yield for 2005 included the entries SD 3687, SD 3868, SD 3860, and SD 3879.

In 2005, the average bushel weight was 58 lb, the average plant height was 29 inches, and the plant lodging score was 1. In 2005, varieties with a bushel weight of 59 lb or higher were in the bushel weight top performance 13 entries. Entries had to attain a height of 31 inches or more to be in the maximum plant height top performance group of 14 entries. In contrast, entries had to attain a height of 24 inches or less to be in the minimum plant height top performance group of one entry, SD 3900. Entries had to attain a plant lodging score of 2 or less to be in the plant lodging score top performance group of 39 entries.

Oat: The average yield for 2005 was 91 bu/a and for 3 years was 78 bu/a (Table 2). Varieties had to yield 103 bu/a for 2005 and 67 bu/a for 3 years to be in the top performance group for yield. The top performance group for yield in 2005 included the entries SD 011315-15, SD 011315-61, and Loyal; and for 3 years, all the entries except Paul, a hulless variety.

In 2005, the average bushel weight was 39 lb, the average plant height was 36 inches, and the average plant lodging score was 3. The hulless variety Buff was the only entry in the top performance group for bushel weight. Entries had to attain a height of 38 inches or more to be in the top performance group for maximum plant height. This group included the hulless varieties Stark and Paul, the standard varieties Loyal and Morton, and the experimental line SD 011315-61. Entries had to attain a plant lodging score of 3 or less to be in the plant lodging score top performance group. Half of the entries were in to the top performance group for lodging (lower scores, less lodging) while the others lodged more.

Table 1. HRS wheat yield averages, Miller, 2003-05.

Variety (hdg)*	Bu/a at 13% moisture 2005	3 yr	2005 averages Bu wt lb	Prot %	Ht in	Ldg **
Oxen (2)	36	43+	56	14.3	27	1+
Russ (2)	36	43+	55	13.2	32+	1+
Briggs (0)	35	42+	55	13.2	30	2+
Steele-ND (3)	34	42+	59+	14.0	30	1+
Walworth (0)	35	41+	57	13.6	30	3
Reeder (3)	34	41+	58	14.2	29	1+
Forge (-1)	34	41+	59+	13.0	30	2+
Norpro (3)	32	40+	57	13.1	28	1+
Granger (0)	37	39+	58	13.4	31+	2+
Knudson (2)	34	39+	58	13.2	26	1+
Alsen (4)	32	39+	60+	14.2	29	1+
Ingot (-1)	33	38	59+	13.9	29	2+
Oklee (2)	33	38	58	13.7	28	1+
Ulen (2)	32	38	58	13.9	29	2+
Granite (5)	31	37	60+	14.1	28	1+
Dapps (2)	31	36	59+	14.3	31+	1+
Chris,CK (3)	29	32	56	14.2	33+	3
SD 3687* (-)	42+	-	59+	13.0	32+	1+
SD 3860* (-)	41+	-	58	12.3	31+	2+
SD 3868* (-)	41+	-	57	12.2	31+	2+
SD 3879 (-)	39+	-	58	11.8	31+	2+
SD 3851 (-)	38	-	60+	13.0	29	2+
SD 3854 (-)	38	-	60+	12.6	32+	2+
SD 3870 (-)	37	-	59+	12.9	32+	2+
Dandy (5)	35	-	58	13.1	32+	1+
SD 3875 (-)	35	-	58	13.6	32+	2+
SD 3880 (-)	35	-	58	11.9	28	1+
SD 3889 (-)	35	-	58	13.6	30	2+
Trooper (-1)	35	-	57	13.1	26	1+
MN 00261-4 (-)	35	-	61+	14.5	29	1+
Freyr (1)	35	-	58	13.4	29	1+
SD 3888 (-)	34	-	58	13.3	30	2+
SD 3899 (-)	34	-	56	13.2	30	2+
Express (-)	34	-	56	13.9	23	1+
ND 800 (-)	33	-	58	14.2	29	1+
SD 3882 (-)	33	-	58	13.6	31+	1+
SD 3897 (-)	33	-	57	13.5	32+	1+
Banton (1)	32	-	60+	14.2	28	1+
SD 3900 (-)	32	-	56	13.3	30	1+
Mercury (5)	32	-	57	13.6	25	1+
Glenn (3)	31	-	60+	13.6	29	1+
Test avg. :	35	39	58	13.4	29	1
High avg. :	42	43	61	14.5	33	3
Low avg. :	29	32	55	11.8	23	1
# Lsd(.05) :	3	4	2		2	1
## TPG-value :	39	39	59		31	2
### C.V. :	7	7	2		5	26

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

** Lodging score: 0 = all plants erect, 3 = 50% of plant 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.

Table 2. Oat yield averages, Miller, 2003-05.

Variety (hdg)*	Bu/A at 13% moisture		2005 averages			
	2005	3-yr	Bu wt, lb	Prot %	Ht, in	Ldg sc**
Morton (7)	102	89+	37	13.8	39+	3+
HiFi (8)	91	86	36	13.5	36	4
Jerry (5)	97	85+	38	14.6	36	3+
Loyal (8)	108+	82+	38	14.0	38+	4
Don (1)	99	80+	37	13.3	29	3+
Reeves (2)	85	77+	38	15.6	36	4
Hytest (4)	77	76+	40	17.0	37	3+
Buff His (3)	56	69+	45+	16.2	34	2+
Paul His (7)	60	59	41	16.2	40+	3+
SD 011315-15 (-)	113+	.	38	12.9	37	4
SD 011315-61 (-)	104+	.	39	12.8	38+	4
SD 020701 (-)	102	.	39	13.9	35	4
SD 021021 (-)	102	.	38	14.6	33	4
SD 020536 (-)	100	.	40	13.8	35	5
Drumlin (7)	100	.	37	13.3	35	3+
SD 011315-59 (-)	98	.	37	13.8	35	3+
SD 366-36* (-)	97	.	39	13.9	37	4
Beach (6)	96	.	40	13.7	37	3+
SD 96024A-21 (-)	94	.	37	13.7	34	4
SD 020883 (-)	92	.	38	13.8	32	4
SD 366-15* (-)	86	.	40	14.8	37	4
Morraine (2)	80	.	36	13.3	37	3+
Stark His (6)	63	.	43	15.2	39+	3+
Test avg. :	91	78	39	14.2	36	3
High avg. :	113	89	45	17.0	40	5
Low avg :	56	59	36	12.8	29	2
# Lsd(.05) :	10	22	1		2	1
## TPG-value :	103	67	44		38	3
### C.V. :	8	10	2		5	16

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

** Lodging score: 0 = all plants erect, 3 = 50% of plant 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.

Barley: As indicated in Table 3, the average yield for 2005 was 52 bu/a and varieties had to yield 62 bu/a to be in the top performance group for yield. The top performance group for yield in 2005 included the varieties Haxby and Eslick. The 3-year yield average was 61 bu/a and varieties had to yield 64 bu/a to be in the top performance group for yield. Only Haxby and Eslick were in the top performance yield group for the longer 3-year period.

In 2005 (Table 3b), the average bushel weight was 45 lb, the average plant height was 26 inches, and the average plant lodging score was 2. In 2005, entries had to weigh 48 lb or more to be in the top performance group for bushel weight that included two varieties, Haxby and Valier. In 2005, entries had to attain a height of 25 inches or more to be in the top performance group for maximum plant height. The top performance group for plant height included all the entries because height differences among the entries were not significant. Entries had to attain a plant lodging score of 2 or less to be in the plant lodging score top performance group. All the entries, except Haxby and Conlon, were in this group, indicating these two varieties were more prone to lodging than the others.

Table 3. Barley yield averages, Miller, 2003-05.

	Bu/a at 13% moisture		2005 averages			
Variety (rtng)*	2005	3-yr	Bu wt, lb	Prot %	Ht, in	Ldg sc.**
Haxby (2)	69+	72+	50+	11.2	26+	3
Eslick (3)	63+	68+	46	11.5	25+	2+
Excel (3)	54	63	43	12.1	26+	1+
Valier (4)	50	62	48+	12.5	27+	1+
Conlon (0)	60	60	47	12.3	27+	4
Lacey (0)	50	60	44	12.1	25+	1+
Drummond (2)	47	59	43	11.9	26+	1+
Stellar-ND (2)	44	55	42	12.0	25+	1+
Robust (3)	41	54	44	13.0	28+	2+
Tradition (0)	55	.	46	11.6	27+	2+
Legacy (3)	42	.	41	12.0	27+	1+
Test avg. :	52	61	45	12.0	26	2
High avg. :	69	72	50	13.0	28	4
Low avg. :	41	54	41	11.2	25	1
# Lsd(.05) :	7	8	2		NS^	1
## TPG-value :	62	64	48		25	2
### C.V. :	9	8	2		9	21

* Heading, the relative days to heading, compared to Lacey.
** 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.
^ Value differences within a column are non-significant (NS) at the .05 level of probability.

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

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Previous SDSU research has demonstrated the need for turfgrasses with improved environmental stress resistance. The richness of genetic resources among the largely untapped grasslands of the western U.S. represents tremendous potential for new turfgrasses. The need to expand existing germplasm collections is widely recognized, and the development of new turfgrasses may provide an economic stimulus to the region.

Two species of native grasses are currently being collected from multiple locations in South Dakota and established at the Highmore station for evaluation as reduced-input turfgrasses. Buffalograss and blue grama are warm-season, sod-forming grasses that require less water, fertilizer, pesticides, and culture than typical cool-season turfgrasses, and they have been used increasingly 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 multistate scientists to enhance the value of the project.

Progress to date

Ninety buffalograss and 56 blue grama accessions were planted in three replications at the Central Crops and Soils Research Station in 2004. Winter survival was excellent except for some accessions planted in late summer.

Severe weed pressure negatively affected grass growth and development in 2004 and 2005. Kochia and common lambsquarters in 2004 formed a canopy over the lower-growing native grasses. In 2005, carfentrazone-ethyl (18.3 g ai/ha) + NIS (0.25% v/v) was broadcast-applied to buffalograss on 16 May in an attempt to control seedlings of both weed species. No visual phytotoxicity to buffalograss was observed; however, weed control was highly unacceptable.

Due to limited availability of effective broadleaf herbicides that are not injurious to buffalograss, actively growing buffalograss plots were hand weeded during the remainder of the growing season. Spot treatments of glyphosate (0.84 kg ac/ha) were applied in mid-June and mid-July to control emerged weeds surrounding established grasses.

Buffalograss is typically dioecious; i.e., male and female flowers are produced on different plants. In 2005, 43 male (47.8%), 42 female (46.7%), and 5 accessions of undetermined sex (5.6%) were recorded.

High plant density, often expressed as the number of plants per unit area, is a highly desirable characteristic of turfgrass. Visual ratings (1 to 9 scale) taken on Aug. 1, 2005, showed no differences among the 36 highest ranked buffalograss accessions for turfgrass density (Table 1). Turfgrass density was acceptable ($\geq$ 5.0) for 72 of 90 (80%) accessions.

Continued active green growth during early fall is desirable, particularly in warm-season turfgrasses in the Northern Plains. Visual ratings (1 to 9 scale) taken on Oct. 10, 2005, indicated no differences among the eight highest ranked buffalograss accessions for fall dormancy (Table 1). Fall dormancy ratings were unacceptable (< 5.0) for a majority (56%) of buffalograss accessions.

Table 2 indicates the county of origin for each of the 56 blue grama accessions established at the station in 2004. No data were recorded for blue grama accessions in 2005 due to the limited annual spread from a single plug of this bunch-type grass. Seed obtained from greenhouse production will be used to seed entire plots in 2006.

Geographical locations of origin are illustrated in Fig 1 for buffalograss accessions and Fig 2 for blue grama accessions.

Plans for 2006 include collection of additional buffalograss and blue grama from South Dakota regions not yet represented. Additionally, preemergence herbicides will be applied for weed control and plots will be mowed. Grasses will be evaluated for winter survival, spring dormancy, turfgrass density, turfgrass color, rate of spread, drought tolerance, and fall dormancy.

Acknowledgement

The authors would like to thank the Central Crop and Soils Research Station staff as well as undergraduate research assistants Elizabeth Albrecht, Andy Kardoes, and Nick McGinnis. This project is partially funded and supported by the SDSU Agricultural Experiment Station and the South Dakota Turf Foundation.

Table 1. Mean density and fall dormancy ratings of 90 buffalograss accessions maintained at the Central Crops and Soils Research Station, Highmore, S.D., in 2005.

Accession	*County of Origin*	*Sex†*	*Density‡*	*Dormancy§*	Accession	County of Origin	Sex†	Density‡	Dormancy§
001-04	Meade	f	5.7	5.0	036-04	Jackson	f	5.3	6.0
002-04	Meade	m	4.3	3.7	037-04	Jackson	f	6.0	3.7
003-04	Meade	m	3.3	5.3	038-04	Jackson	m	4.0	6.0
004-04	Meade	f	5.0	3.0	039-04	Jackson	f	5.7	3.7
005-04	Meade	m	5.0	2.7	040-04	Jackson	u	5.0	5.0
006-04	Meade	f	6.3	7.0	041-04	Meade	m	6.0	6.7
007-04	Meade	m	4.7	5.0	042-04	Butte	f	5.7	5.0
008-04	Meade	m	6.0	3.7	043-04	Butte	f	6.3	4.7
009-04	Jackson	m	6.5	5.5	044-04	Spink	m	5.0	1.0
010-04	Jackson	f	5.7	5.7	045-04	Butte	f	5.7	3.7
011-04	Jackson	f	7.0	5.5	046-04	Butte	f	5.7	5.0
012-04	Jackson	f	5.0	8.0	047-04	Butte	m	5.7	3.3
013-04	Jackson	m	5.7	4.3	048-04	Brule	f	5.5	3.5
015-04	Jackson	m	6.3	4.3	049-04	Custer	m	4.0	7.7
016-04	Jackson	f	5.5	2.5	050-01	Jackson	f	5.3	3.7
018-04	Jackson	m	5.3	4.0	051-04	Pennington	f	6.0	5.5
019-04	Jackson	m	5.0	4.7	052-04	Pennington	m	5.7	5.0
020-04	Jackson	m	4.0	5.0	053-04	Pennington	u	5.0	2.0
021-04	Haakon	m	4.0	4.0	054-04	Haakon	f	6.3	5.0
022-04	Haakon	f	6.5	3.0	055-04	Haakon	m	5.5	6.5
023-04	Haakon	f	5.3	4.7	056-04	Haakon	f	6.0	3.3
024-04	Jackson	f	6.0	4.7	057-04	Haakon	m	7.5	3.5
025-04	Jackson	m	5.0	3.3	058-04	Haakon	m	6.0	4.3
026-04	Jackson	m	4.7	3.0	059-04	Haakon	m	5.7	5.3
027-04	Jackson	f	5.0	4.3	060-04	Haakon	f	5.0	6.0
028-04	Jackson	m	5.0	3.7	061-04	Haakon	f	6.3	5.7
029-04	Jackson	m	5.3	4.0	062-04	Haakon	f	5.7	3.7
030-04	Jackson	f	5.7	4.5	063-04	Haakon	m	6.0	4.0
031-04	Jackson	m	5.3	4.0	064-04	Jones	u	5.0	7.0
032-04	Jackson	f	5.0	3.7	065-04	Jones	f	4.0	3.0
033-04	Jackson	f	5.3	4.0	066-04	Jones	m	5.0	5.3
034-04	Jackson	f	4.3	6.3	067-04	Jones	f	5.0	3.7
035-04	Jackson	f	4.7	4.3	068-04	Jones	f	5.0	5.0

069-04	Jones	m	5.0	4.0	088-04	Lyman	m	5.5	5.0
070-04	Jones	m	5.0	5.3	089-04	Mellette	m	4.3	5.3
071-04	Jones	f	6.0	3.0	090-04	Spink	u	6.5	5.0
073-04	Jones	m	5.7	3.7	091-04	Spink	m	5.5	3.5
074-04	Mellette	m	4.7	6.0	092-04	Beadle	f	5.7	4.3
075-04	Mellette	f	5.3	5.7	093-04	Beadle	u	5.3	5.3
076-04	Mellette	m	5.7	5.3	097-04	Beadle	m	4.3	4.7
077-04	Mellette	m	5.3	3.7	098-04	Spink	m	3.7	4.5
078-04	Gregory	m	5.5	4.7					
079-04	Gregory	f	6.0	7.3	Mean			5.3	4.6
081-04	Lyman	m	6.0	5.0	LSD ($P \leq 0.05$)			2.0	2.0
082-04	Lyman	f	4.7	5.7					
083-04	Gregory	f	3.5	5.0	† f=female, m=male, u=undetermined				
084-04	Gregory	f	5.3	3.3	‡ turfgrass density, 1 to 9, where 5=acceptable, 9=excellent				
086-04	Gregory	m	3.7	4.3	§ fall dormancy, 1 to 9, where 1=fully dormant, 9=no dormancy				
087-04	Gregory	f	5.3	5.0					

Table 2. Blue grama accessions maintained at the Central Crops and Soils Research Station, Highmore, S.D., in 2005.

Accession	*County of origin*	*Accession*	*County of origin*	*Accession*	*County of origin*	*Accession*	*County of origin*
501-04	Haakon	515-04	Perkins	529-04	Custer	542-04	Jones
502-04	Jackson	516-04	Butte	530-04	Custer	543-04	Jones
503-04	Jackson	517-04	Butte	531-04	Custer	544-04	Jones
504-04	Jackson	518-04	Harding	532-04	Campbell	545-04	Jones
505-04	Jackson	519-04	Jackson	533-04	Hand	546-04	Jones
506-04	Jackson	520-04	Jackson	534-04	Haakon	547-04	Mellette
507-04	Jackson	521-04	Meade	535-04	Haakon	548-04	Brule
508-04	Jackson	522-04	Meade	536-04	Haakon	549-04	Harding
509-04	Jackson	523-04	Jackson	537-04	Haakon	550-04	Hand
510-04	Jackson	524-04	Jackson	538-04	Jones	551-04	Hand
511-04	Harding	525-04	Jackson	539-04	Jones	552-04	Spink
512-04	Harding	526-04	Jackson	540-04	Jones	553-04	Spink
513-04	Meade	527-04	Custer	541-04	Jones	554-04	Campbell
514-04	Perkins	528-04	Custer	555-04	Campbell	556-04	Campbell

Fig. 1. Geographical locations of origin of buffalograss accessions maintained at the Central Crops and Soils Research Station, Highmore, S.D., in 2005.

Fig. 1. Geographical locations of origin of blue grama accessions maintained at the Central Crops and Soils Research Station, Highmore, S.D., in 2005.

Highmore Drip Irrigation Study Final Report, Executive Summary

Gregory Yapp
Natural Resources Conservation Service

Late in 1981 there was a desire to determine if a drip irrigation system could significantly shorten the length of time required to establish a functioning windbreak.

The Soil Conservation Service (SCS), now known as the Natural Resource Conservation Service (NRCS), entered into a cooperative agreement with South Dakota State University (SDSU), the Agricultural Experiment Station's Central Research Station, and the South Dakota Association of Conservation Districts (SDACD) in May 1984. The SCS used $8,045 of Resource Conservation Act (RCA) funds to secure materials to establish the plots, install the drip irrigation system, fence the area for rabbit control, and pay for the first 2 years of weed control. The Highmore Research station supplied the land and performed weed control operations. The SDACD reimbursed the station for weed control costs for up to 8 additional years.

The drip irrigation study was established at Highmore, SD in 1985. The objectives of the study were threefold:

1. To determine the effect of drip irrigation on the growth and establishment of selected species of windbreak trees and shrubs.
2. To determine if there are any detrimental effects related to longevity after the irrigation is stopped.
3. To determine the effect of drip irrigation on the survival of hard-to-establish species, especially conifers.

Thirty different species were planted in replicated five-tree plots on April 22 and 23, 1985. Species selected included hard-to-establish trees and conifers along with many other commonly used windbreak trees and shrubs. The drip irrigation lines were installed at the same time as the sets were planted.

The rows are spaced 14 feet apart. Shrubs were planted 5 feet apart in the row. Trees were planted 10 feet apart in the row. The different classes of plants were separated into four planting blocks (or sets): shrubs, small trees, conifers, and tall trees.

A fifth set was established just south of the other four plots. This set was annually planted to determine the effect of drip irrigation on initial survival. After survival was noted in early spring of the year following planting, the trees were removed and another set was planted. This continued annually until 1991.

Highmore is located in central South Dakota in the northern Great Plains spring wheat region. Based on 1971 to 2000 data, annual precipitation was 21.38 inches, with 75% of it falling during the growing season.

The soils on the site are mapped as GrA Glenham-Prosper loams 0 – 2% slopes. These soils are deep and well drained with high available water capacity.

Initially the watering cycle for the drip treatment was Monday, Wednesday, and Friday. The amount of water applied during each cycle averaged 1.5 gallons per plant. The site was watered until August 15, when the water was shut off to allow the trees to harden off for the winter. After October 15, water was added if needed to bring the soil profile to field capacity.

In the second year, tensiometers were installed to a depth of 4 feet to gauge water needs. The amount of water supplied to the trees and shrubs was determined by the tensiometer readings. Water was added when field capacity was down to 50% and added until field capacity was reached.

The last year of irrigation was 1991; so the trees were irrigated for 7 growing seasons. After that, the trees were measured to see if any detrimental effects related to longevity show up after the irrigation is stopped.

In the initial report, it was noted that there were some differences in growth between the two treatments, but the most obvious difference was the increased canopy and leaf size of the plants in the drip treatment. The only significant difference in survival between the drip and the dryland treatments were with some of the conifers.

In the 1988 report, after four years of growth, it was noted that: "It appears that there is no advantage to drip irrigating shrubs. There was very good growth on all shrubs in both the dry and drip plots."

In the annual survival plot, only Colorado blue spruce showed a big increase in survival due to drip irrigation (90% vs. 20%).

The 5-year results of the study indicated that the response of the various species to drip irrigation was quite variable. Weed control in all plots was excellent. In most cases, the increase in growth of the irrigated treatments over the dryland treatments was not significant. Even in those cases where the increase was significant, it is very doubtful whether the benefit realized would justify the cost of drip irrigation, as the increased growth did not equal one years' growth.

At the end of 18 years the tallest shrub species is caragana at 13.8 feet. Most drip irrigated shrubs show a slight height advantage that has been carried over from initial establishment. Is this enough of a difference to justify the cost of a drip system?

Shrubs are planted for low level density; we don't need fast, tall growth. They can provide wildlife habitat and snow control benefits in as little as 3 years. As far as survival between drip and dry, there is no advantage to the irrigated shrubs.

After six years of growth all of the drip irrigated mid-trees were a little taller than their dryland counterparts. There was basically no difference in survival between drip and dry.

After 18 years, two of the species show a statistical difference in height growth between drip irrigated and dryland. The tallest mid-tree are the dryland Russian-olives, at 24.5 feet tall. A majority of the dryland trees are taller than the dripped ones. Again, it looks like there is no need for drip irrigation, as the trees can reach "working" size just as fast without added water.

The key at this site, and all other plantings in South Dakota, is weed control. This site has had excellent weed control.

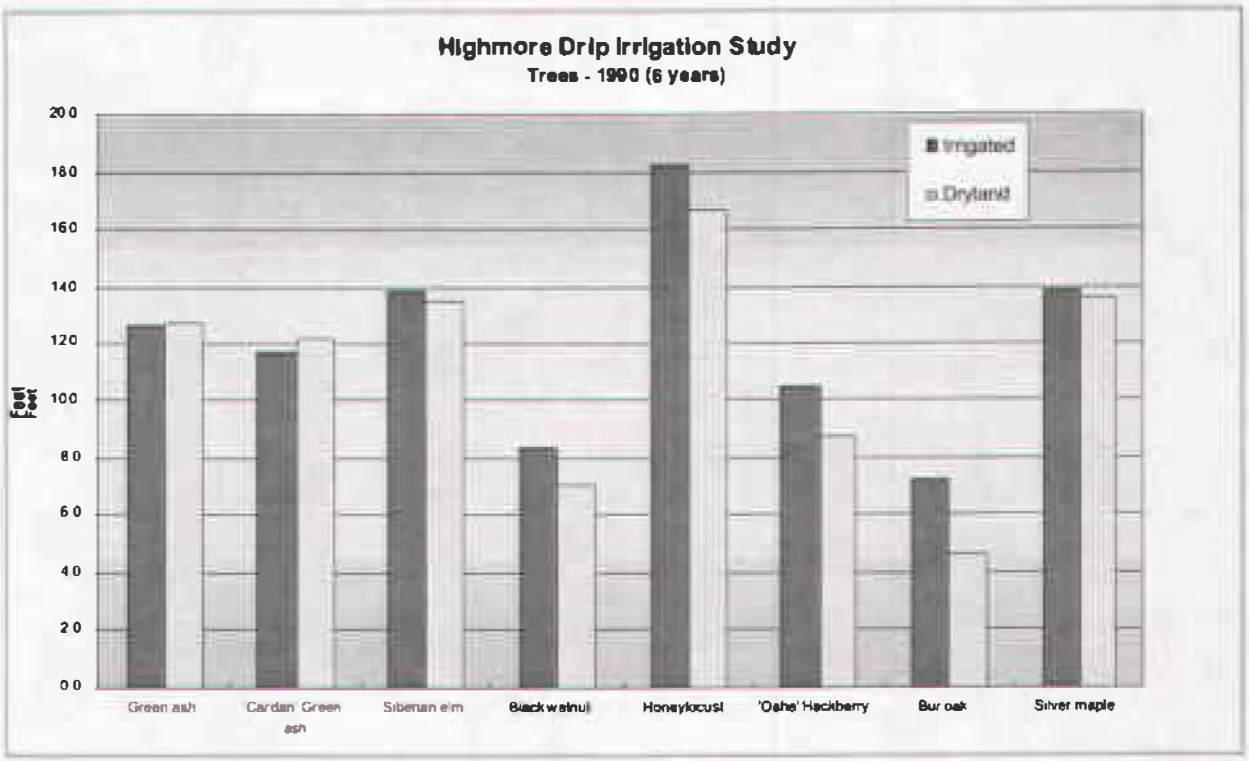
While still being watered in year 6 after planting, only Scotch pine showed a significant difference between the irrigated and dryland treatments. For all species except Siberian larch, the drip irrigated trees did have increased growth and survival. The pine benefited the most from being drip irrigated.

After 18 years there is no significant difference in height growth for any of the species. The tallest conifer tree is Scotch pine at 22.1 feet tall. It appears that long-term growth and survival of drip irrigated trees is not a concern. Most continue to grow at rates comparable to the dryland trees and maintain the early-on height advantage they initially had. For initial establishment and growth the pine and spruce seem to benefit most from the additional water.

After 6 years of drip irrigation, only hackberry and bur oak show a significant height difference for drip irrigated trees over the dryland trees. Except for green ash, the drip irrigated trees are a little taller. Basically there is no difference in survival between treatments.

Results of the annual plot: 1985 to 1990.

	Drip irrigated			*Dryland*		
Species	*Number planted*	*alive next spring*	*% survival*	*Number planted*	*alive next spring*	*% survival*
'Oahe' Hackberry	60	51	85	60	49	82
Bur oak	50	47	94	50	47	94
'Cardan' Green ash	60	60	100	60	58	97
Ponderosa pine (bareroot)	70	40	57	70	19	27
Ponderosa pine (potted)	40	38	95	40	32	80
Colorado blue spruce (bareroot)	60	57	95	60	42	70
Colorado blue spruce (potted)				10	10	100



There is no statistical difference between drip and dry for the tall deciduous trees. At age 18 the tallest tree is honeylocust at 33.5 feet. For the most part drip irrigation in an area of the state that gets 20 inches or more of precipitation is not feasible for deciduous trees and shrubs.

Although some species did benefit from the additional moisture, new technologies such as tree fabric and tree shelters may be a way to save available rainfall for the trees and provide other advantages.

Acknowledgements

Major dollars were Resource Conservation Act (RCA) funds made available to SCS offices early in the 1980s for demonstration and informational projects.