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Small Grain Crops in Southwestern North Dakota

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Abstract

New crop cultivars and advanced experimentals from public and private agencies must be developed for the continued viability of crop and crop-livestock systems. The objective of this research is to identify the genotypes of hard red winter wheat (HRWW), hard red spring wheat (HRSW), durum spring wheat (durum), spring barley (barley), and spring oats (oats) that are best adapted to growing conditions in southwestern North Dakota. To do this, 31 HRWW, 47 HRSW, 39 durum, 18 barley, and 35 oat cultivars were evaluated in separate adaptation experiments at Dickinson in 1997. Selected cultivars of each crop also were evaluated at Hannover, as were HRSW cultivars at Beulah. Arapahoe, CDC Kestrel, Seward, and Roughrider were among the highest yielding cultivars in the HRWW experiment at Dickinson. Differences in yield were not detected at the $P < 0.05$ level of significance among cultivars in the HRSW experiment. Mean yield was 44.5 bushels (bu)/acre for the HRSW cultivars evaluated, and gross economic returns averaged $147.14/acre. Mean yield was 32.7 bu/acre for cultivars in the durum experiment at Dickinson. Yield differences between durum cultivars were not detected; gross economic returns averaged $180.17/acre. Baronesse and Stander were among the highest yielding barley cultivars in the experiment at Dickinson. Gross economic returns were greater for these two cultivars than any other commercial barley cultivar, if barley grain was sold for feed. Bay, Brawn, Derby, Dumont, Monida, Otana, and Troy were among the highest yielding cultivars evaluated in the oats experiment at Dickinson in 1997. Brawn, Derby, Dumont, Hytest, Jerry, Monida, Otana, Troy, and Valley cultivars produced grain generating comparable or greater gross economic returns than other cultivars evaluated. These data show which small grain cultivars were best adapted to environmental conditions encountered at Dickinson in 1997.

Introduction

Crop production is a significant income generator for southwestern farmers and ranchers. Cash receipts from crops accounted for 52% of total farm income in the South Central, Southwestern, and West Central Crop Reporting Districts in 1994 (Anonymous, 1996). When government payments were considered, more than 57% of farm income came directly from cash receipts for crops. This excludes the value of forages grown and fed directly to livestock on farms.

Wheat, barley, and oats are the major small grain crops grown in western North Dakota. The annual value of these cereal grains grown between 1990-94 was more than $280,000,000 in the three southwestern crop reporting districts (Anonymous, 1996). Development of improved small grain cultivars is necessary to ensure that the farm income generated by grain crops, either directly by cash payment or indirectly through livestock, can be maintained or enhanced.

Cultivar comparison trials have been the foundation of yield, quality, and agronomic evaluation of crop cultivars in North Dakota. Early reports from the Agricultural Experiment Station contained data obtained from comparison trials (Hays, 1893a, 1893b). These trials still are important to obtain information for cultivar release and recommendations (Cox et al., 1988; Frohberg, 1991). Each year HRWW, HRSW, durum, barley, and oat cultivars are evaluated in comparison studies at the Dickinson Research Extension Center (DREC). These comparisons include both named cultivars and experimental lines from NDSU, and other public and private breeding programs in the U.S. and Canada. Evaluations are used to make cultivar recommendations.

Grain produced in plots from the comparison trials is used in quality evaluations in the Department of Cereal Chemistry and Food Technology at NDSU, Fargo, ND. Quality evaluations of experimental lines are compared with cultivars currently grown by producers. The quality and agronomic performance of an experimental line at various locations is one of the major bases for the recommended release of that line as a named cultivar or its removal from consideration for further testing.

Experimental lines from other state experiment stations and private plant breeding companies also are evaluated for quality. Although data from this project are not instrumental in the eventual release or rejection of lines from these sources, the data do provide information on agronomic characteristics before release and does help in cultivar recommendations.

Soils at the DREC represent many southwestern North Dakota soils. However, not all prominent soil types occurring in the southwestern portion of the state occur at the DREC. Moreover, local climatic differences between different areas in the region exist. For these reasons, cultivar comparison studies are conducted at sites besides the DREC to provide an area test of crop cultivar performance at several locations in southwestern North Dakota.

Materials and Methods

Cultivars were evaluated in comparison trials at Beulah, Dickinson, and Hannover, ND. Grain for planting generally was provided by plant

breeders at North Dakota State University in Fargo, or from drill strips at the DREC. Cultivars developed from neighboring land-grant institutions, Canada, and private plant breeding companies were included.

Cultural practices including tillage and seeding, fertilization, herbicide application, and harvesting followed currently acceptable agronomic procedure for conducting cultivar comparison trials. Cultivars and genotypes of each small grain crop (HRWW, HRSW, durum, barley, and oats) were evaluated in separate experiments. Plots were arranged in a randomized complete block design with blocks replicated four times. Demonstration strips also were maintained for grower observation, crop field tours, and for a sufficient amount of seed for quality evaluations. Crop trials were conducted on both previously fallowed and continuously-cropped land. Experiments were located on both conventionally-tilled and no-tilled seedbeds.

Plant growth was monitored throughout the growing season. Variables measured on each plot at Dickinson included: days to heading, plant height, plant lodging at physiological maturity, grain yield, kernel weight, and grain volume weight. Crude protein (CP) concentration was determined by NIR reflectometry for grain of commercially available cultivars of each crop, except oats.

Data collected at off-station sites included grain yield, grain volume weight, kernel weight, and grain CP concentration for wheat. Quality characteristics for product acceptance will be determined by the Department of Cereal Science and Food Technology at North Dakota State University from grain samples provided, but are not provided in this manuscript.

Data were analyzed using a computer statistical program.

Results and Discussion

HRWW

Plants of all cultivars survived the winter during 1996-97 (Table 1). We attribute this level of survivability to establishment of this experiment in a no-till seedbed. Snow covered seedlings in the no-till seedbed to a greater depth, and for a longer period, than it covered seedlings planted in a conventionally tilled seedbed in the same field (data not provided). The snow insulated seedlings in the no-tillage seedbed from the cold ambient air temperatures recorded during the winter (Eriksmoen et al., 1997).

Arapahoe, CDC Kestrel, Seward, and Roughrider were among the highest yielding HRWW cultivars in 1997 (Table 1). These same cultivars, along with Elkhorn and Nekota, generated comparable or greater gross economic returns than the other commercially available cultivars evaluated in 1997: Agassiz, Alliance, and Pronghorn. Average economic returns generated by the HRWW cultivars compared favorably to those generated by the HRSW cultivars evaluated at Dickinson in 1997 (Table 2), suggesting that HRWW production may be an alternative to HRSW production in southwestern North Dakota.

HRSW

Average grain yield was 44.5 bu/acre for the 47 cultivars at Dickinson in 1997 (Table 2). Yield ranged from 26.9 bu/acre for the cultivar BacUp to 57.3 bu/acre for the cultivar ND 695, although differences were not detected at the $P < 0.05$ level. Uncontrolled variability, as indicated by the high coefficient of variation (C.V. %) associated with analyses of the data, explains why yield differences between cultivars were not detected. Complex soil patterns comprise most fields at Dickinson, confounding the ability of a randomized complete block design to reduce uncontrolled variability between plots. Plots will be arranged in a lattice rather than a randomized complete block in an attempt to improve our ability to detect yield differences between HRSW cultivars, beginning in 1998.

The cultivars 2375, 2398, AC Barrie, Amidon, Ernest, Keene, Russ, and Verde were among the highest yielding cultivars at Hannover (Table 3) in 1997. Of these, 2398, Amidon, and Keene, along with McNeal, have produced comparable or greater amounts of grain than other cultivars evaluated at Dickinson over the past three years (Table 2). Both 2398 and McNeal are short cultivars, while Amidon and Keene are tall.

The CP concentration of grain averaged 16.1% at Dickinson in 1997 (Table 2). The grain CP concentration was more than 15% for each cultivar at this location, except Keene. In contrast, the CP concentration of grain averaged only 13.7% at Hannover (Table 4). Environmental differences between the two locations may account for the differences in the CP concentration of grain.

The HRSW experiment was damaged at Beulah by hail. Average yield was only 17.5 bu/acre for the twelve cultivars at this location (Table 3). The CP concentration of grain averaged 15.9%.

Gross economic returns averaged $147.14/acre for the 47 cultivars evaluated at Dickinson (Table 2). Differences between cultivars for economic returns were not detected. At Hannover, the cultivars 2375, 2398, Amidon, Ernest, Keene, Russ, and Verde generated comparable or greater returns than 2370, Butte 86, Grandin, and Oxen (Table 4).

Durum

Grain yield averaged 32.7 bu/acre for the 39 durum cultivars evaluated at Dickinson in 1997 (Table 5). Differences in yield were not detected between cultivars, which ranged from 21.6 bu/acre for the cultivar D931011 to 43.6 bu/acre for the cultivar D91080. No cultivar was superior to others for grain yield at Hannover (Table 6); yield averaged 38.9 bu/acre.

Grain CP concentration averaged 17.5% for commercial durum cultivars at Dickinson in 1997 (Table 5). The cultivar Vic was comparable or superior to other cultivars for grain CP concentration. Grain CP concentration averaged only 14% for six cultivars evaluated at Hannover. AC Melita produced grain with a CP concentration that was comparable or superior to grain CP concentration of other cultivars.

Gross economic returns averaged $180.79/acre for the durum cultivars at Dickinson (Table 5). Differences between cultivars for economic returns were not detected. Returns averaged $230.75/acre for the six durum cultivars evaluated at Hannover (Table 6).

Barley

Average grain yield was 76.9 bu/acre for the 18 barley cultivars at Dickinson in 1997 (Table 7). The 6-rowed barley cultivar Stander

produced more grain than all other cultivars, except Baronesse and Logan. Logan was superior to five other barley cultivars for grain yield at Hannover (Table 8). Over the past three years, Logan and Stander have been comparable or superior to other barley cultivars for grain yield at Dickinson (Table 7).

Less grain was produced by the cultivar Bowman than any other barley cultivar at Dickinson in 1997 (Table 7), and at Hannover (Table 8). Kernel test weight was less for Bowman than for Conlon, Stark, and other commonly grown, two-rowed cultivars. These data, and results of other experiments (Eriksmoen et al., 1995; 1996), show that Bowman is inferior to other two-rowed barley cultivars (e.g., Conlon, Logan, Stark) for grain yield and kernel quality. Franckowiak (1997, per. comm.) suggested that Bowman is susceptible to new races of net and spot blotch and, therefore, is unable to produce as much grain as can Conlon, Logan, and Stark cultivars. We suggest that Bowman should be replaced by Conlon, Logan, and other cultivars in cropping systems in southwestern North Dakota.

Oats

The cultivar Brawn was among the highest yielding, commercially available oat cultivars at Dickinson in 1997 (Table 9). Other cultivars producing comparable yields to Brawn included Bay, Derby, Dumont, Monida, Otana, and Troy. Whitestone and CDC Boyer produced comparable or greater amounts of grain than four other oat cultivars at Hannover (Table 10). Among hulless oat cultivars, Paul was superior to AC Belmont for grain yield at Dickinson (Table 9), but not at Hannover (Table 10). Kernel test weight was heavier for Paul oats than AC Belmont oats in both experiments.

The oat cultivars Brawn, Derby, Dumont, Otana, and Troy generated gross returns that were comparable or higher than those generated by other cultivars at Dickinson in 1997, if oats were sold to local elevators for livestock feed (Table 9). Highest economic returns were generated by the cultivars CDC Boyer, Jerry, and Whitestone at Hannover (Table 10).

Conclusion/Implications of Research

HRWW

Elkhorn, Arapahoe, CDC Kestrel, Roughrider, and Seward generated comparable or higher gross economic returns than other cultivars at Dickinson in 1997. These five cultivars have good winter survival characteristics, except Arapahoe. Roughrider is superior to the other cultivars for milling and baking uses (Eriksmoen et al., 1997), and this cultivar is an excellent choice for HRWW producers in southwestern North Dakota.

HRSW

Grain production has averaged 44.5 bu/acre for cultivars evaluated at Dickinson in each of the last two years. The cultivars 2398 and McNeal have been among the highest yielding commercial cultivars grown at Dickinson over the past several years (Eriksmoen et al., 1995, 1996, 1997). Disease and grain quality problems associated with these two cultivars suggest that other high yielding, disease

resistant cultivars are needed. Experimental cultivars are being developed which have shown high yield potential in southwestern North Dakota, as data in Table 2 show. Commercially available cultivars that are well adapted to growing conditions include Amidon and Keene. Of these, Amidon produces grain with superior milling and baking characteristics. Amidon also shows some tolerance to dryland root rot. For these reasons, we suggest that the cultivar Amidon is among those best adapted to growing conditions in southwestern North Dakota.

Durum

No single durum cultivar has been superior to others for grain yield or returns in the last three years at Dickinson. AC Melita, Ben, Belzer, and Munich are cultivars that have compared favorably to other cultivars for grain yield at Dickinson; all have been released for commercial production in the last five years. Lloyd, Renville, Sceptre, and Ward are older cultivars that still are competitive for grain yield and economic returns. We suggest that any of these cultivars are adapted to growing conditions in southwestern North Dakota.

Barley

Stark was the most widely grown barley cultivar in the Southwest Crop Reporting District in 1996, followed by Bowman (Anonymous, 1997). The cultivar Logan has been superior to both Bowman and Stark for grain yield at Dickinson in 1995, 1996, and 1997. Conlon is another two-rowed cultivar that has compared favorably to Bowman and Stark. We suggest that Conlon and Logan may be superior to Stark for grain yield and economic returns. Bowman is inferior to these cultivars for grain yield and sometimes grain quality.

Stander, Excel, and Foster are six-rowed barley cultivars adapted to growing conditions in southwestern North Dakota. We recommend these three cultivars in environments favorable for the production of malt quality barley.

Oats

Hulless oat cultivars have generated excitement among oat growers in southwestern North Dakota because of their excellent feed grain quality, and because of potential industrial applications (D. Barondeau, 1998, per. comm.). The hulless oat cultivar Paul has been superior to other hulless cultivars for grain yield and test weight at Dickinson. Among hulled oat cultivars, no single cultivar has been superior to others for grain yield over the past three years. The cultivar Otana was developed in 1977 and continues to produce large amounts of grain compared with newer cultivars. Brawn, Calibre, Derby, Monida, Troy, and Whitestone are other cultivars that have produced large amounts of grain during 1995, 1996, and 1997.

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Table 1. Days to heading (DTH) from planting, winter survival, plant height, lodging score (LDG), grain yield, kernel test weight, crude protein (CP) concentration, and gross economic returns of hard red winter wheat cultivars in an experiment in 1997 located at Dickinson, ND.

Cultivar	DTH	Winter survival	Plant heigh	LDG	Test weight	CP	Grain yield		Returns	2-year average
							1996	1997		
	days	%	in	0-9	lb/bu	%	bu/acre		$/ac	bu/ac
Agassiz	43	100	31	4.8	62.6	15.0	64.1	61.9	198.91	63.0
Alliance[1]	38	98	21	6.3	60.9	12.7	70.2	59.9	188.79	65.0
Arapahoe	39	100	24	2.3	61.1	15.3	74.5	71.7	230.17	73.1

CDC Kestrel	43	100	26	2.0	62.1	13.5	77.8	74.1	237.43	76.0
Elkhorn	43	100	26	2.3	61.8	15.3	64.4	66.3	212.40	65.4
ND 8889	43	99	27	3.5	61.5	--	74.4	72.9	--	73.6
ND 8955	42	100	24	4.0	60.4	--	77.3	63.3	--	70.3
ND 8955-A	43	100	24	4.5	60.9	--	--	66.1	--	--
ND 9257	42	99	24	3.0	60.9	--	76.1	66.6	--	71.4
ND 9272	40	100	23	2.3	61.1	--	78.2	72.1	--	75.2
ND 9274	42	100	22	3.0	60.6	--	76.7	69.2	--	73.0
ND 9304	39	98	25	4.0	62.0	--	--	71.5	--	--
ND 9321	41	100	27	2.5	62.0	--	--	64.2	--	--
ND 9324	39	100	26	1.8	61.8	--	--	60.9	--	--
ND 9329	40	100	28	3.0	61.4	--	--	64.1	--	--
ND 9376	43	100	28	1.8	61.3	--	--	67.8	--	--
ND 9382	43	100	26	3.8	61.8	--	--	71.4	--	--
ND 9419	42	100	24	3.3	61.4	--	--	69.6	--	--
ND 9448	39	100	26	3.0	62.0	--	--	66.2	--	--
ND 9454	42	100	23	1.5	60.3	--	--	62.7	--	--
ND 9460	41	99	24	4.3	60.5	--	--	65.2	--	--
ND 9480	43	100	28	3.8	62.5	--	--	72.4	--	--
NE 90625	39	100	24	2.5	60.9	--	79.2	68.3	--	73.7

Nekota	38	99	23	3.3	62.3	13.8	69.3	64.3	205.54	66.8
Pronghorn[1]	38	99	23	6.8	61.8	14.1	--	47.6	152.65	--
Roughrider	43	99	28	3.5	62.0	15.5	68.8	68.1	218.26	68.4
SD 89119[1]	39	100	24	3.0	62.0	--	--	64.4	--	--
SD 89153	41	100	24	2.3	62.9	--	--	69.8	--	--
SD 92107	42	100	25	2.0	61.5	--	--	70.3	--	--
SD 92191	41	100	26	2.8	63.3	--	--	76.2	--	--
Seward	43	100	26	3.5	61.4	13.6	75.5	68.2	218.31	71.9
Mean	41	99.7	25	3.1	61.6	14.3	--	67	206.94	--
C.V. %	1.1	1.5	7.2	29.8	0.8	3.4	--	10.3	12.30	--
LSD .05	1	NS	3	1.3	0.7	0.7	--	9.7	37.15	--

[1]Plants in plots were damaged by gophers.

Table 2. Days to heading (DTH) from planting, kernel weight, plant height, lodging score (LDG), grain yield, kernel test weight, crude protein (CP) concentration, and gross economic returns of hard red spring wheat cultivars in an experiment in 1997 located at Dickinson, ND.

Cultivar	DTH	Kernels	Plant height	LDG	TW	CP	Grain yield			Returns	Average yield	
							1995	1996	1997		2-Year	3-Year

	days	lb	in	0-9	lb/bu	%	bu/acre			$/acre	bu/acre	
Semidwarf												
2370	55	14,452	21	0.0	53.5	16.5	46.8	44.5	36.8	122.07	40.6	42.7
2371	58	16,613	27	0.0	52.8	15.9	49.1	40.4	45.2	147.98	42.8	44.9
2375	55	14,211	20	0.5	55.0	16.9	49.1	45.5	31.1	108.25	38.3	41.9
2398	55	13,866	22	0.0	54.4	15.4	60.7	53.5	48.0	158.82	50.7	54.1
Grandin	55	13,446	24	0.8	55.6	16.3	54	41.2	42.1	146.04	41.6	45.8
Gus	57	16,905	24	0.0	54.0	16.4	52.8	42.5	45.4	155.28	44.0	46.9
Hamer	55	15,196	21	0.0	52.3	16.4	53.8	42.8	41.1	135.32	41.9	45.9
Lars	56	15,553	20	0.0	51.8	15.5	62.1	41.1	42.9	137.67	42.0	48.7
Len	58	13,864	24	0.0	52.9	15.5	--	--	47.7	151.39	--	--
McNeal	56	12,857	25	0.0	53.9	15.4	61.5	48.6	51.3	170.02	50.0	53.8
N 92-0434	56	12,792	22	0.0	54.6	--	--	--	49.3	--	--	--
ND 690	54	13,968	23	0.8	53.6	--	50.5	42.2	36.2	--	39.2	43.0
ND 695	55	14,471	24	0.0	55.1	--	--	52.1	57.3	--	54.7	--
ND 701	55	14,980	26	0.0	54.3	--	--	--	48.6	--	--	--
ND 704	54	14,525	24	0.5	55.3	--	--	--	51.8	--	--	--
Nora	53	13,739	19	1.0	54.9	16.7	--	45.9	38.0	129.14	42.0	--
Norlander	52	15,697	19	0.0	54.0	17.5	53.7	45.3	30.0	102.24	37.6	43.0
Oxen	51	14,320	23	0.0	55.4	15.6	54.5	44.7	48.2	164.71	46.4	49.1

SBE 0050	55	15,602	20	0.0	53.3	--	--	--	43.0	--	--	--
SD 3156	51	15,643	22	0.5	53.1	--	--	45.7	40.4	--	43.0	--
Verde	57	13,706	22	0.0	55.1	15.7	56.4	47.4	45.2	151.42	46.3	49.7
Tall												
AC Barrie	56	14,842	26	0.3	54.3	16.2	50.7	43.2	49.6	167.93	46.4	47.8
AC Cadillac	57	14,227	27	0.8	54.4	15.4	--	42.9	48.2	156.93	45.6	--
AC Cora	56	15,178	26	1.0	57.0	17.0	45.3	45	47.0	167.59	46.0	45.8
AC Eatonia	56	15,652	28	3.0	55.3	16.0	36	38.4	49.6	172.30	44.0	41.3
AC Elsa	55	18,272	23	0.8	51.1	16.5	--	43.6	40.5	127.49	42.0	--
AC Vista	54	12,420	22	0.8	54.1	15.4	--	--	39.7	131.65	--	--
Amidon	57	15,984	27	0.5	51.6	15.1	59.6	45.3	53.7	166.63	49.5	52.9
BacUP	52	15,434	20	0.3	55.8	19.4	--	33.2	26.9	95.95	30.0	--
Butte 86	53	14,080	26	0.5	54.6	15.4	52.7	48.6	47.4	159.47	48.0	49.6
Ernest	56	16,202	24	0.5	52.3	15.8	55.2	48.5	44.1	142.53	46.3	49.3
Gunner	58	16,089	26	0.0	57.0	16.3	--	43.7	52.3	185.12	48.0	--
Keene	57	16,477	28	0.0	55.6	14.4	58.8	45.8	54.6	178.11	50.2	53.1
Kulm	50	15,133	23	0.5	57.8	17.9	51.8	39.6	34.3	122.81	36.9	41.9
Majestic	58	17,490	25	0.0	53.0	16.7	--	36.7	37.7	126.37	37.2	--
ND 691	59	16,304	26	0.3	53.5	--	--	45.8	53.6	--	49.7	--

ND 694	56	15,092	27	0.8	52.4	--	--	44.2	47.4	--	45.8	--
ND 700	57	17,719	24	0.0	53.3	--	--	51.6	39.6	--	45.6	--
ND 702	55	14,833	22	0.0	54.9	--	--	--	37.2	--	--	--
ND 703	54	16,783	26	0.3	55.0	--	--	--	50.1	--	--	--
Russ	54	14,556	22	0.0	54.8	15.8	49.7	38.4	42.9	145.77	40.6	43.7
SD 3249	51	15,438	22	0.3	57.1	--	--	--	45.4	--	--	--
Sharp	52	14,584	23	1.3	55.5	16.4	48.2	44.6	37.6	127.19	41.1	43.5
Sharpshooter	53	14,263	22	1.0	56.5	15.7	--	--	48.6	165.48	--	--
SL 93609	57	12,455	24	0.0	56.1	15.1	--	--	53.6	186.40	--	--
Splendor	54	14,191	25	0.3	55.4	15.9	--	41.4	46.7	155.33	44.0	--
Trenton	56	14,795	25	0.3	54.6	16.1	53.6	47.1	41.6	141.49	44.4	47.4
Mean	55	14,998	24	0.4	54.4	16.1	--	--	44.5	147.14	--	--
C.V. %	1.5	6.8	15.1	144.5	2.9	7.4	--	--	29.6	29.1	--	--
LSD .05	1	1,429	NS	NS	2.2	1.7	--	--	NS	NS	--	--

Table 3. Grain yield, kernel test weight, kernel weight, crude protein (CP) concentration, and gross economic returns of hard red spring wheat cultivars in an experiment in 1997 located at Beulah, ND.

		Test		Grain yield	% of		2 year

Cultivar	Seeds	Test weight	CP	Yield		% of Grandin	Returns	2-year average
				1995	1997			
	lb	lb/bu	%	bu/acre		%	$/acre	bu/acre
2370	18,935	56.8	16.4	--	12.5	108	68.61	--
2375	17,629	58.9	15.4	44.6	24.4	213	110.40	34.5
2398	18,057	57.5	16.2	--	25.8	224	109.76	--
AC Barrie	21,028	56.3	17.0	--	15.4	134	69.42	--
Amidon	19,749	57.9	15.0	40.3	19.4	169	96.19	29.9
Butte 86	17,384	57.5	16.1	46.8	9.4	82	61.12	28.1
Ernest	19,032	57.9	15.9	41.2	18.0	156	85.06	29.6
Grandin	20,079	54.5	16.2	37.3	11.5	100	74.94	24.4
Keene	18,743	58.9	15.2	--	18.3	159	93.90	--
Oxen	21,090	56.5	16.3	--	16.9	147	82.31	--
Russ	19,233	57.3	15.9	--	16.3	142	89.00	--
Verde	19,834	56.5	15.6	--	22.6	196	100.18	--
Mean	19,233	57.2	15.9	--	17.5	--	86.74	--
C.V. %	1.5	1.5	--	--	15.8	--	--	--

LSD .05	3,746	1.3	--	--	NS	--	--	--

Table 4. Plant height, grain yield, kernel test weight, kernel weight, crude protein (CP) concentration, and gross economic returns of hard red spring wheat cultivars in an experiment in 1997 located at Hannover, ND.

Cultivar	Seeds	Ht	Test weight	CP	Grain yield		% of Grandin	Returns	2-year average
					1995	1997			
	lb	in	lb/bu	%	bu/acre		%	$/acre	bu/acre
2370	17,702	27	56.5	14.6	--	34.0	98	119.04	--
2375	15,800	28	57.9	13.6	36.0	40.0	116	137.22	38.0
2398	14,950	27	57.9	13.0	--	40.2	116	136.67	--
AC Barrie	16,895	32	57.0	14.2	--	36.6	106	126.55	--
Amidon	16,297	35	58.1	13.3	27.9	43.0	125	147.10	35.5
Butte 86	15,502	28	57.6	14.0	38.7	33.2	96	114.23	36.0
Ernest	15,795	34	58.1	14.0	31.3	42.7	124	148.11	37.0
Grandin	15,775	29	57.5	14.0	23.4	34.5	100	118.97	29.0
Keene	17,104	33	59.5	13.3	--	41.2	119	140.10	--
Oxen	18,540	26	56.0	14.1	--	34.7	101	118.16	--
Russ	16,451	31	57.0	13.5	--	40.3	117	137.45	--

Verde	17,073	28	56.6	13.4	--	41.5	120	139.48	--
Mean	16,490	30	57.5	13.7	--	38.5	--	131.92	--
C.V. %	4.2	4.0	0.7	3.0	--	8.1	--	7.8	--
LSD .05	994	2	0.6	0.6	--	4.5	--	14.82	--

Table 5. Days to heading (DTH) from planting, plant height, lodging score (LDG), grain yield, kernel test weight, kernel weight, crude protein (CP) concentration, and gross economic returns of durum wheat cultivars in an experiment in 1997 located at Dickinson, ND.

Cultivar	DTH	Kernels	Plant height	LDG	Test weight	CP	Grain yield			Returns	Average yield	
							1995	1996	1997		2-year	3-year
	days	lbs	in	0-9	lb/bu	%	bu/acre			$/acre	bu/acre	
AC Melita	55	13,199	22	0.0	52.3	17.8	49.1	56.4	32.6	175.47	44.5	46.0
Belzer	55	12,710	21	1.3	51.1	16.9	49.3	61.6	33.9	177.68	47.7	48.3
Ben	55	12,432	24	0.3	54.0	17.3	60.1	59.3	30.0	166.75	44.6	49.8
D88303	54	13,457	19	0.0	52.0	--	59.9	59.9	28.0	--	44.0	49.3
D89135	56	13,727	19	0.0	51.6	--	56.6	55.6	29.6	--	42.6	47.3
D901155	53	13,440	22	0.0	53.8	--	--	55.4	26.6	--	41.0	--
D901247	55	12,416	23	0.0	54.0	--	--	--	31.3	--	--	--
D901297	56	13,678	24	0.0	51.3	--	--	--	28.1	--	--	--
D901313	47	12,410	21	0.0	55.0	--	59.6	61.3	38.9	--	50.1	53.3
D901419	54	13,660	19	0.0	54.3	--	54.5	61.8	35.1	--	48.4	50.5
D901442	55	12,346	21	0.0	54.6	--	58.5	60.8	29.9	--	45.3	49.7

D901518	56	12,497	20	0.0	54.6	--	59.8	66.9	34.9	--	50.9	53.9
D901536	54	13,020	21	0.0	53.3	--	58.0	59.0	31.5	--	45.3	49.5
D91-1526	55	13,539	20	0.0	50.9	--	--	--	25.5	--	--	--
D91058	55	12,865	21	0.0	53.1	--	--	59.8	32.8	--	46.3	--
D91066	56	12,616	22	0.0	54.6	--	--	57.7	37.1	--	47.4	--
D91080	57	12,052	22	0.0	55.8	--	--	59.8	43.6	--	51.7	--
D920016	56	13,156	18	0.0	54.9	--	--	--	33.2	--	--	--
D920078	56	12,122	20	0.0	54.6	--	--	--	38.3	--	--	--
D921019	56	12,234	24	0.0	53.8	--	--	--	32.2	--	--	--
D921585	56	12,371	23	0.3	54.5	--	--	--	34.8	--	--	--
D930503	55	11,626	24	0.0	54.1	--	--	--	33.4	--	--	--
D931011	56	12,634	21	0.0	51.9	--	--	--	21.6	--	--	--
D931054	51	12,977	23	0.3	53.0	--	--	--	30.2	--	--	--
D931114	55	12,415	21	1.0	53.9	--	--	--	38.1	--	--	--
Dressler	54	11,998	24	0.0	54.9	17.2	--	58.3	37.8	213.81	48.0	--
Laker	56	12,089	22	1.8	53.3	16.8	50.0	57.0	29.4	160.06	43.2	45.5
Lloyd	56	11,942	20	0.0	53.8	16.0	46.9	63.8	33.6	183.10	48.7	48.1
Medora	54	12,995	21	0.8	55.3	16.7	45.0	52.5	37.6	213.49	45.1	45.1
Monroe	51	12,456	23	0.8	53.1	17.7	48.7	52.3	26.3	143.73	39.3	42.4
Munich	54	13,527	20	0.0	51.5	18.2	56.9	56.1	34.7	184.51	45.4	49.2
Plenty	57	12,645	25	0.0	51.6	18.5	50.3	57.2	30.7	166.63	43.9	46.1
Regold	56	11,283	23	0.0	54.5	16.6	53.0	55.7	33.1	183.90	44.4	47.3
Renville	55	12,828	23	0.3	53.4	18.0	54.3	60.9	31.1	171.32	46.0	48.8
Rugby	55	12,536	24	0.0	54.0	18.3	56.0	51.6	34.8	194.62	43.2	47.5
Sceptre	55	13,194	21	0.0	53.5	18.1	52.9	58.1	33.7	186.45	45.9	48.2
Vic	55	13,249	22	0.5	51.8	18.6	56.2	55.7	27.7	151.68	41.7	46.5
Voss	55	11,575	20	0.0	54.4	16.1	59.6	54.2	37.7	207.06	46.0	50.5

Ward	55	12,383	24	0.3	53.6	17.8	53.9	57.1	35.1	193.15	46.1	48.7
Mean	55	12,674	22	0.2	53.5	17.5	--	--	32.7	180.79	--	--
C.V. %	4.6	6.3	7.9	166.4	2.8	3.5	--	--	18.7	17.0	--	--
LSD .05	3.6	1,122	2	NS	2.1	0.9	--	--	NS	NS	--	--

Table 6. Plant height (Ht), grain yield, kernel test weight, kernel weight, crude protein (CP) concentration, and gross economic returns of durum wheat cultivars in an experiment in 1997 located at Hannover, ND.

Cultivar	Seeds	Ht	Test weight	CP	Grain yield		% of Renville	Returns	Average 2-year
					1995	1997			
	lb	in	lb/bu	%	bu/acre		%	$/acre	bu/acre
AC Melita	14,433	33	58.4	14.6	--	38.9	102	235.60	--
Belzer	13,522	34	57.1	13.3	--	37.7	99	219.27	--
Ben	11,987	35	60.4	14.2	--	42.7	112	257.17	--
D 88303	13,326	27	58.3	13.6	--	36.6	96	216.49	--
Munich	15,230	30	56.3	14.4	37.4	39.4	103	229.01	38.4
Renville	14,320	34	58.3	13.7	34.5	38.1	100	226.98	36.3

Mean	13,803	32	58.1	14.0	--	38.9	--	230.75	--
C.V. %	5.6	5.0	0.7	2.4	--	12.0	--	11.9	--
LSD .05	1,165	2	0.6	0.5	--	7.0	--	41.51	--

Table 7. Days to heading (DTH) from planting, plant height (HT), lodging score (LDG), grain yield, kernel test weight (TW), kernel weight, crude protein (CP) concentration, percentage of plump kernels, and gross economic returns of barley cultivars in an experiment in 1997 located at Dickinson, ND.

Cultivar	DTH	Kernels	HT	LDG	TW	CP	% Plump	Grain yield			Returns	Average yield	
								1995	1996	1997		2-year	3-year
	days	lb	in	0-9	lb/bu	%	>6/64	bu/acre			$/ac	-----bu/ac-----	
Six Row													
6 B 88-3213	50	12,522	24	1.5	46.6	13.0	87.0	--	62.2	78.8	141.78	70.5	--
Azure	50	13,241	25	4.0	43.8	13.4	79.1	57.8	60.7	72.5	125.36	66.6	63.7
Excel	53	11,992	26	1.8	45.3	13.6	84.7	65.2	67.2	79.8	142.49	73.5	70.7
Foster	54	12,208	26	2.3	44.1	13.3	88.2	56.3	64.1	81.3	141.69	72.7	67.2
MNS 85	56	12,313	28	4.3	46.3	14.8	86.8	--	--	74.0	133.14	--	--
Morex	50	13,602	28	4.3	44.3	13.9	82.9	45.8	54.2	63.3	110.75	58.8	54.4

ND 15403	52	12,236	27	3.5	44.8	13.5	84.5	--	--	76.5	135.18	--	--
ND 15477	50	12,744	25	1.8	44.8	13.5	85.9	--	--	77.4	136.32	--	--
ND 15483	51	13,254	25	3.0	45.1	13.6	80.7	--	--	73.4	130.96	--	--
Robust	55	11,156	28	1.5	47.5	14.1	90.6	56.7	56.8	78.6	141.52	67.7	64.0
Stander	55	12,050	27	0.5	46.9	13.6	91.0	67.1	62.2	94.1	169.42	78.2	74.5
Two Row													
Baronesse	58	12,081	22	1.8	44.9	13.3	79.5	--	--	88.0	155.51	--	--
Bowman	50	13,090	25	8.0	44.1	14.0	72.2	56.7	56.3	54.1	94.18	55.2	55.7
Chinook	58	11,466	28	3.0	47.5	13.6	76.2	62.9	57.7	82.4	148.39	70.1	67.7
Conlon	51	10,725	25	4.0	47.5	12.7	90.2	68.9	62.7	73.9	132.98	68.3	68.5
Harrington	58	14,150	27	5.5	42.9	13.9	58.2	50.4	56.9	71.1	120.32	64.0	59.5
Logan	54	10,497	27	2.5	47.3	13.2	85.5	73.0	74.9	90.2	162.33	82.5	79.4
Stark	56	11,406	28	3.3	47.0	13.7	79.6	58.9	56.2	74.4	134.00	65.3	63.2
Mean	53	12,263	26	3.1	45.6	13.6	82.4	--	--	76.9	136.46	--	--
C.V. %	1.6	5.2	3.6	30.8	1.4	2.7	5.4	--	--	6.6	6.9	--	--
LSD .05	1	909	1	NS	0.9	0.5	6.3	--	--	7.2	13.43	--	--

Table 8. Plant height, lodging score, grain yield, kernel test weight (TW), kernel weight,

and gross economic returns of barley cultivars in an experiment in 1997 located at Hannover, ND.

Cultivar	Kernels	Plant height	Lodging score	Test weight	Grain yield		% of Stark	Returns	2-year average
					1995	1997			
	lb	in	0-9	lb/bu	bu/acre		%	$/acre	bu/acre
Six Row									
Foster	12,236	27	0.5	42.2	38.4	63.7	121	106.23	51.0
Stander	12,459	29	0.0	44.1	--	65.3	124	113.88	--
Two Row									
Bowman	11,466	27	1.3	44.3	30.2	44.7	85	78.23	37.5
Conlon	10,265	25	0.3	45.6	--	55.0	104	98.26	--
Logan	10,238	28	0.0	46.5	46.1	72.2	137	129.35	59.1
Stark	10,104	30	0.0	47.0	35.8	52.8	100	95.00	44.3
Mean	11,128	28	0.3	45.0	--	59.0	--	103.49	--
C.V. %	4.6	4.6	137.8	1.8	--	6.5	--	6.8	--
LSD .05	767	2	NS	1.3	--	5.7	--	10.58	--

Table 9. Days to heading (DTH) from planting, plant height, grain yield, kernel test weight (TW), kernel weight, and gross economic returns of barley cultivars in an experiment in 1997 located at Dickinson, ND.

Cultivar	DTH	Kernels	Plant height	Test weight	Grain yield			Returns	Average yield	
					1995	1996	1997		2-year	3-year
	days	lb	in	lb/bu	bu/acre			$/acre	bu/acre	
AC Assinaboia	55	11,989	30	34.8	--	--	97.4	110.48	--	--
AC Belmont	57	19,496	30	34.2	91.3	74.0	60.2	67.29	67.1	75.2
AC Medallion	57	13,732	32	34.8	--	--	82.2	93.07	--	--
Bay	56	15,221	24	32.0	110.3	75.9	108.5	110.85	92.2	98.2
Brawn	55	12,226	24	32.8	100.6	84.1	124.8	131.02	104.4	103.2
CDC Boyer	56	11,542	31	34.3	--	--	74.2	82.69	--	--
Calibre	57	14,116	32	34.0	98.1	96.7	98.5	107.29	97.6	97.8
Derby	57	12,161	29	38.7	99.4	101.2	119.9	149.93	110.6	106.8
Dumont	56	14,759	30	33.7	80.0	73.9	118.6	129.22	96.2	90.8
Hytest	51	12,473	30	38.7	73.0	79.8	94.9	118.57	87.3	82.6
Jerry	50	12,972	26	37.8	95.4	85.3	95.3	117.71	90.3	92.0
Jim	46	13,527	21	38.0	71.7	91.3	68.6	84.96	80.0	77.2

Milton	51	15,641	25	36.7	82.3	70.1	91.4	110.54	80.8	81.3
Monida	57	14,791	27	34.2	105.9	87.6	109.3	120.66	98.4	100.9
Jud	55	13,801	29	35.0	115.3	65.5	99.5	112.46	82.5	93.4
ND 900697	56	11,906	30	34.8	--	96.2	128.7	145.38	112.4	--
ND 900779	55	14,043	27	35.0	122.7	88.2	84.9	97.35	86.6	98.6
ND 910117	56	13,513	29	36.2	--	81.2	102.6	121.57	91.9	--
ND 910569	55	13,843	26	34.5	--	63.9	101.9	114.30	82.9	--
ND 910592	51	14,014	24	35.8	--	58.9	93.3	110.35	76.1	--
ND 910779	58	11,036	34	35.3	122.6	81.7	118.7	135.60	100.2	107.7
ND 910916	57	12,600	25	34.3	--	107.8	126.3	141.23	117.0	--
ND 911048	55	13,801	25	36.0	--	89.9	94.6	111.91	92.3	--
ND 930122	52	13,460	25	34.7	--	--	102.6	115.99	--	--
ND 930376	51	14,791	27	36.0	--	--	87.7	102.59	--	--
ND 931318	56	15,481	30	35.2	--	--	106.7	122.28	--	--
ND 931475	57	14,294	34	34.0	--	--	102.4	112.99	--	--
Newdak	50	13,732	25	33.5	93.0	81.8	91.9	98.65	86.9	88.9
Otana	56	14,905	30	35.7	95.0	84.7	114.5	133.96	99.6	98.1
Paul	57	18,144	33	41.0	92.0	64.7	82.3	102.85	73.5	79.7
Robert	56	11,711	28	34.7	95.3	86.0	94.9	107.23	90.4	92.1
SW 18352	61	12,293	30	35.2	--	--	109.4	125.22	--	--

Troy	55	15,916	29	36.2	100.2	90.0	108.0	129.37	99.0	99.4
Valley	54	14,680	24	35.8	91.3	70.2	101.2	118.72	85.7	87.6
Whitestone	55	15,623	25	34.8	107.1	96.2	98.4	113.49	97.3	100.6
Mean	55	13,747	28	35.4	--	--	99.8	114.51	--	--
C.V. %	1.0	6.3	5.6	2.6	--	--	13.8	15.0	--	--
LSD .05	1	1,563	3	1.5	--	--	22.4	27.93	--	--

Table 10. Plant height, Lodging score, grain yield, kernel test weight (TW), kernel weight, and gross economic returns of barley cultivars in an experiment in 1997 located at Hannover, ND.

Cultivar	Kernels	Height	Lodging score	Test weight	Grain yield		% of Jerry	Returns	2-year average
					1995	1997			
	lb	in	0-9	lb/bu	bu/acre		%	$/ac	bu/acre
AC Belmont	18,217	33	1.5	37.3	--	55.6	79	67.96	--
CDC Boyer	11,805	34	2.0	32.9	--	75.0	107	79.55	--
Jerry	15,057	30	0.5	35.3	65.9	70.2	100	79.96	68.0
Jim	14,632	26	0.0	34.1	--	59.9	85	65.83	--

Paul	18,235	34	0.5	43.4	62.8	46.7	67	58.42	54.8
Whitestone	16,390	29	0.8	32.9	68.2	78.0	111	81.94	73.1
Mean	15,376	31	0.9	36.0	--	64.3	--	72.28	--
C.V. %	5.0	5.1	94.7	2.1	--	6.8	--	8.0	--
LSD .05	1248	2	NS	1.1	--	6.6	--	8.76	--

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